1st International Conference on Innovative Technology and Sustainable Development in Engineering - 2022

ICI

IGBC

ICITSDE-2022

Organized by Department of CIVIL ENGINEERING

PACE INSTITUTE OF TECHNOLOGY & SCIENCES

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1st
INTERNATIONAL CONFERENCE ON INNOVATIVE TECHNOLOGIES AND SUSTAINABLE DEVELOPMENT IN ENGINEERING

Author

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About Conference :-

International conference on Innovative technology and Sustainable development is an initiative taken by leading management within the department of civil engineering , pace institute of technology and sciences. The conference brings together research from academia, industry and regulatory organizations to deliberate on theoretical work, empirical findings and policy implications and related to innovative technologies and sustainable development.

Department of civil engineering is pleased to announce the 1st international conference on innovative technology and sustainable development (ICITSD 2022) during April 29th -30th, 2022. The aim of the conference is to provide a forum to showcase the cutting edge in the area of innovative technologies and sustainable technologies. The conference provides an excellent avenue to get quickly feedback and opportunity for networking among researchers, academicians, and industry executives working in the area of innovative technologies, sustainable development and allied areas we invite high quality original theoretical / applied empirical papers from faculty members, research scholars and industry practitioners.

About College :-

Pace institute of technology and science was established in 2007 by Srinivasa educational society at vallur, ongole, Andhra Pradesh. Over the last 15 years, Pace ITS has become one of the best institute for advanced scientific and technological research and education. Its mandate is "to provide for advanced instruction and to conduct original investigations in all branches of knowledge as are likely to promote the material and industrial welfare of India." In keeping with this guiding principle, the Institute has strived to foster a balance between the pursuit of basic knowledge and applying its research for industrial and social benefit.

Pace ITS reputation and pre-eminence ensures that it attracts the best young faculty members trained in the best laboratories around the India. Pace ITS research output is diverse, interdisciplinary and cuts across traditional boundaries. The Institute has over 11 academic departments and centers that come under six divisions. It also places equal emphasis on student learning, with a dedicated four-year undergraduate programme aimed at providing research-oriented training for young students in the basic sciences.

About Department of Civil Engineering :-

The department has existed since the inception of Pace Institute of Technology and Science in 2009, and the majority of its facilities are located in the Mokshagundam Visvesvaraya Block, which is the first building on campus.

The department is managed in five administrative divisions, which are also reflective of the technical expertise of the faculty in the division:

[1] Building Technology and Construction Management (BTCM)

[2] Water Resources Engineering (WRE)

[3] Geotechnical Engineering (GT)

[4] Structural Engineering (ST) and

[5] Transportation Engineering (TR)

We have well-established laboratory facilities in these areas with world-class testing facilities incorporating cutting edge technologies. The academic programmes, B.Tech, M.Tech offered by our department have achieved global.recognition. Our alumni network spans globally with eminent personalities holding prestigious administrative positions and leading academic institutions, industries and government sectors. The rich expertise of faculty members with advanced degrees and/or training from reputed institutions in India. The increasing interactions with national and international academia and industry have truly made our department one of the top choices of students.

To ensure that our research/teaching efforts make significant societal impact, we work closely with various private and public agencies and participate in policy making and advising in the implementation of latest technologies in the profession of civil engineering and allied areas. We look forward to the future with a lot of confidence in meeting the expectations of the various stakeholders and fulfilling our obligations of creating the next generation engineers and leaders in academia and industry. We are committed to providing the best quality engineering education to the young minds that join our department, in addition to being active participants in the development of the intellectual ecosystem of our nation and the world.

Key Note Speakers :-

- Dr.T.D.Gunneswara Rao.,
  Professor of CE, NIT Warangal
- Dr.K.Srinivasa Rao,
  Professor of CE, Andhra university
- Dr.V.Srinivasa Rao,
  Professor of CE, JNTUK

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Conference Themes :-

- Construction Engineering
- Project control and Management
- Structural Engineering Design Optimization
- Multidisciplinary Optimization
- Optimizations for Manufacturing Process
- Composite Structures
- Smart Structures
- Computational Mechanics
- Multi Scale Problems & Materials Design
- Micro and Nano Materials
- Bio Mechanical Structures
- Optimal Control for example in Seismic Design
- 3D Printing
- CAD / CAM
- Manufacturing Robots
- Renewable Energy & Distributed Generation
- Waste Management
- Smart Cities and Buildings
- Smart Industrial Applications and Consumers
- AL & Deep Learning

Dr.M.Venu Gopal Rao,
Chairman,
Pace Institute of Technology & Sciences.

Chairman's Message

I feel delighted to learn that Department of Civil Engineering, Pace Institute of Technology and Sciences is organising an **International Conference on Innovative Technology and Sustainable development in Engineering (ICITSDE-2022)** during April 29-30, 2022.

Science and technology are integral to each other and are fundamental for driving economic growth of any nation. The current generation activities in these domains are compelled and propelled by inter-disciplinary research.

I am sure **ICITSDE-22** would create a knowledge-fuelled environment to provide a common platform to all the participants including scientists and scholars to exchange their ideas on the advancements of emerging applications of innovative Technologies.

I congratulate the Department of civil Engineering, in particular, for takingthis initiative to organize such an event on so timely and contemporary topic. I extend my heartfelt wishes for the great success of this international event.

Dr. M.Venu Gopal Rao

Er.M. Vasu Babu,
Vice President,
Pace Institute of Technology & Sciences.

Vice Presidents's Message

It gives me great pleasure to extend my greetings and warmest wishes to the Department of Civil Engineering, Pace Institute of Technology and Sciences, Andhra Pradesh for organizing an **International Conference on Innovative Technology and Sustainable development in Engineering (ICITSDE-2022)** during April 29-30, 2022.

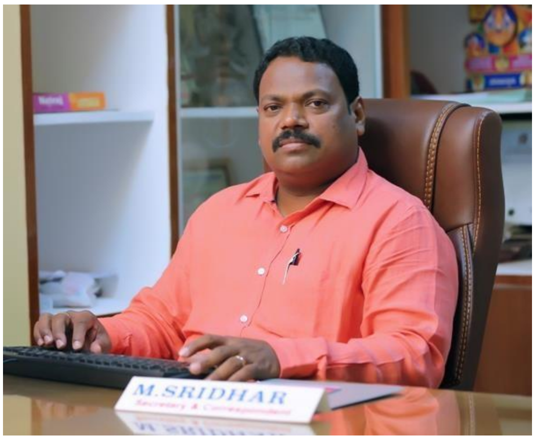
The key area which the conference covers the innovative technologies in the field of civil engineering. A significant challenge in the development of innovative technology understands the growth and transformations of various construction materials. From a practical perspective, a knowledge of how toselectively synthesize the waste materials in different fields of civil engineering.

Despite ample efforts and demonstrations that it can be highly beneficial to tune different properties of various construction materials so that they can be properly utilized.

I am quite sure that this conference will ignite the creative ideas and exchange of knowledge tofill up the gaps in ongoing research on construction materials and techniques.

I once again commend the core organizing team and wish the conference a resounding success.

Er.M.Vasu Babu



Dr. M. Sridhar,
Secretary & Correspondent,
Pace Institute of Technology & Sciences.

Message

I feel truly delighted to learn that that Department of Pace Institute of Technology and Sciences, Andhra Pradesh platform for the scientific community to share their ideas and research by organizing an **International Conference on Innovative Technology and Sustainable development in Engineering (ICITSDE-2022)** during April 29-30, 2022.

The very theme of this conference is exciting because it is focused on innovative Technologies involvement in Civil Engineering. We are witnessing a silent revolution through the variety of innovations and technologies developed through materials. Currently materials are being used in a variety of, manufacturing processes and products. It is no exaggeration that in the present times, interdisciplinary research forms the very basis of economy of any country and humanity has been the direct beneficiary through its outgrowth.

Besides development of relevant technologies, it is also important to understand underlying basic principles of science. Thus, ICISTDE-22 assumes special importance. I am hopeful that the participants shall immensely benefit from it.

My congratulations to the organizing team and I extend my best wishes for its successful completion.

Dr.M.Sridhar

Dr. M. Sreenivasan
Principal,
Pace Institute of Technology & Sciences.

Principal's Message

I am very happy to know that Department of Civil Engineering, Pace Institute of Technology and Sciences, Andhra Pradesh is organising an **International Conference on Innovative Technology and Sustainable development in Engineering (ICITSDE-2022)** during April 29-30, 2022.

Fostering technical excellence in the workforce is becoming very important today, with the rapid developments in technology. One of the major challenges for scientists is to apply their highly specialized research across various fields of human knowledge and engage in interdisciplinary investigation. This challenge has to be viewed as an opportunity for developing human resource in varied domains. The other major challenge is to identify how these advancements in materials can be used to improve the day-to-day working and environment of the common person.

In hosting this conference on innovative technologies in civil engineering, I am sure there will be many intellectually stimulating interactions and expression of productive ideas that would be beneficial to a wide range of participants.

I congratulate the department of Civil Engineering and extend my best wishes for its success.

Dr.M.Sreenivasan

Dr. G.V.K. Murthy,
Vice Principal & Director IQAC,
Pace Institute of Technology & Sciences.

Vice Principal's Message

I am pleased to know that the Department of Civil Engineering, Pace Institute of Technology and Sciences, Andhra Pradesh is organizing an **International Conference on Innovative Technology and Sustainable development in Engineering (ICITSDE-2022)** during April 29-30, 2022.

Developing skills to handle various problems of people with a scientific temperament is the current need of our society. Innovative technology research encompasses multiple disciplines that draw diverse knowledge from interdisciplinary sources.

I am sure that the stalwarts of material science and construction advancements will articulate the insight andwisdom suitable to human development during this great knowledge-forum

I congratulate the Department of Civil Engineering, Pace Institute of Technology and Sciences Andhra Pradesh for organizing such eventand convey my best wishes for all success.

Dr.G.V.K Murthy

Dr. R.Veeranjaneyulu,
Director-Admission,
Pace Institute of Technology & Sciences.

Director's Message

I am very happy to learn that the Department of Civil Engineering, Pace Institute of Technology, Andhra Pradesh is organizing the **International Conference on Innovative Technology and Sustainable development in Engineering (ICITSDE-2022)** during April 29-30, 2022.

It is these new civil engineering materials as well as the innovative technologies based on them that may act as structural material, anti pollution barriers what not. They are indeed at the focus of global research communities to provide the rays of new hope amidst such a challenging time.

I am sure that this two day's online conference will provide a platform for academicians, industry experts and researchers to share their innovative ideas, research work and technical skills. I also congratulate Mr.Gopu Ganesh Naidu, Head, Department of Civil Engineering, Pace Institute of Technology and Sciences, Andhra Pradesh and the entire organizing Team as well as faculty members of the Department of Civil Engineering for their spectacular efforts to make this Conference happen with so much of grace and vigour. I wish the Conference the best of success.

Dr.R.Veeranjaneyulu

Dr. T. Rama Chaithanya
Director, R&D
Pace Institute of Technology and Sciences

Message

It gives me immense pleasure to know that Department of Civil Engineering, Pace Institute of Technology and Sciences is organising an **International Conference on Innovative Technology and Sustainable development in Engineering (ICITSDE-2022)** during April 29-30, 2022.

The very theme of the conference is exciting, as it covers a very wide range of features of various technologies in civil engineering field. Emergence of tremendous potential applications is continuously bringing about significant changes in societal outlook. In the modern world, the walls of conventional subjects are collapsing and we are witnessing the diffusion of one domain's ideas into the other. The gelling of ideas can bring us all to a juncturewhere we can notice the oneness in knowledge emanating from diverse domains.

I am sure the deliberations and discussions in this conference will stimulate the younger mindsto embrace and learn the science and technology so that they can become tomorrow's pillars of a happy society.

My congratulations to the whole organizing team and best wishes for the grand success of the event.

Dr .T.Rama Chaithanya

Mr. Ramana Babu
Administrating officer
Pace Institute of Technology & Sciences.

Officer's Message

I am quite pleased to read that the Department of Civil Engineering at Pace Institute of Technology in Andhra Pradesh will host the International Conference on Innovative Technology and Sustainable Development in Engineering (ICITSDE-2022) on April 29-30, 2022.

These novel civil engineering materials, as well as the creative technologies that are based on them, have the potential to operate as structural elements, anti-pollution barriers, and so forth. They are, certainly, at the centre of global scientific communities' efforts to bring rays of new hope during this trying time.

I am confident that this two-day online conference will provide an opportunity for academics, industry experts, and researchers to exchange cutting-edge ideas, research findings, and technological expertise. I would also like to express my gratitude to Mr.Gopu Ganesh Naidu, Head, Department of Civil Engineering, Pace Institute of Technology and Sciences, Andhra Pradesh, and the entire organising team, as well as faculty members of the Department of Civil Engineering, for their extraordinary efforts in bringing this Conference to life with such grace and vigour. I wish the Conference all the best.

Mr. Ramana Babu

Prof. Gopu Ganesh Naidu,
Head of the Department,
Civil engineering,
Pace Institute of Technology and Sciences.

HOD's Message

As the Head of the Department of Civil Engineering, I am honoured to welcome great scientists, academicians, young researchers, and students from around the world to the 1st International Conference on Innovative Technology and Sustainable Development in Engineering, which will be held at Pace Institute of Technology and Sciences in Andhra Pradesh, India, on April 29th and 30th, 2022.

The massive and enthusiastic presence of adepts, young and brilliant researchers, and exceptional student communities at ICISD 2022 provides a glimpse into latest research and cutting-edge technologies, which generates enormous attention.

The purpose of ICITSD 2022 is to bring together a multi-disciplinary group of scientists and engineers from around the world to present and discuss ground-breaking ideas related to the conference's major issue. It promotes high-level research and the globalisation of high-quality research in general, making discussions and presentations more internationally competitive and focusing attention on recent outstanding achievements in materials science, particularly multifunctional nanomaterials, as well as future trends and needs.

We are looking forward to an amazing meeting with outstanding scientists from many nations throughout the world, as well as the exchange of fresh and fascinating findings. I'd want to thank my colleagues in the Department of Civil Engineering for their tireless efforts in developing an exceptional curriculum.

Prof. Gopu Ganesh Naidu.

Mr. Addanki Srujan Kumar,
Organizing secretary ICITSD2022
Department of Civil Engineering,
Pace institute of technology and sciences, Andhra Pradesh

Message

On this historic occasion, I'd like to express my heartfelt gratitude to the core committee and the Department of Civil Engineering at Pace Institute of Technology and Sciences in Andhra Pradesh for hosting the International Conference on Innovative Technology and Sustainable Development in Engineering (ICITSD 2022) on April 29&30, 2022.

This event provides an excellent opportunity for all students and academicians to raise issues and have them discussed in greater depth. I hope that the scientific presentations, poster sessions, and academic speeches will enable students and academics to have a broader understanding of the fundamental issues that the conference has aimed to address.

Mr.Addanki Srujan Kumar

STUDY ON MECHANICAL AND DURABILITY PROPERTIES OF CONCRETE ON USE OF DIFFERENT TYPES OF CEMENT WITH NOMINAL MIX DESIGN

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ABSTRACT

Concrete is the second largest used composite material in world, Concrete is used in the construction of foundations, columns, beams, slabs, and other load-bearing elements in buildings. Concrete consists of Cement, fine aggregate, coarse aggregate and water which bonded together gives the strength to the structures. Concrete has been influenced by many factors and water is the one of the important factors which affects the structures in both strength and durability aspects. And in current world there are different types of cement are available and their properties and usage varies with the types of the construction work. In this study M20 grade of nominal mix design is been used with different types of cement and varying the water to binder ratio. We have investigated the fresh property (Slump Cone test) and hardened properties (Compressive strength, modulus of elasticity and sorptivity) of concrete. From these results we have concluded that water to binder ratio significantly influences the strength and durability parameters where the water to binder is lesser better results has been observed and it has gradually decreased with increase in water content. When Portland pozzolana cement is compared with ordinary Portland cement it has shown better results in strength and durable aspects.

Keywords: water to binder ratio, workability of concrete, ordinary Portland cement, Portland pozzolana cement.

1. INTRODUCTION

Concrete can be regarded as a composite material. For reducing the cost of concrete, greater use of pozzolanic materials like fly ash, blast furnace slag and waste glass was suggested. The use of these materials as the substitute material in concrete would reduce the disposal problem now faced by thermal power plants and industrial plants and at the sametime achieving the required strength of concrete.

Fresh concrete or plastic concrete is a freshly mixed material which can be moulded into any shape. The relative quantities of cement aggregates and water mixed together control the properties of concrete in the wet state as well as in the hardened state.

As modern engineering practices become more demanding, there is a corresponding need for special types of materials with novel properties. Scientists, engineers and technologists are continuously on the lookout for materials, which can act as substitute for conventional materials or which possess such properties as would enable new designs and innovations resulting in to economy, so that a structure can

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be built economically. There have been so far many attempts to develop new materials, which is the combination of two or more materials. Such materials are called composite materials.

Investigations have been made by partial replacement of waste glass in place of fine aggregates and fly ash in place of cement. Also revealed that with proper proportioning of waste glass the required strength can be achieved at 28 days.

In the present investigation fly ash has been used as a partial replacement of cement and waste glass has been used as partial & complete replacement of fine aggregate and it is cured in different environments.

Fly ash is a naturally-cementations coal combustion by-product. It is extracted by the precipitators in the smokestacks of coal-burning power plants to reduce pollution. About 120 coals based thermal power stations in India are producing about 112 million tone fly ash per year. With the increasing demand of power and coal being the major source of energy, more and more thermal power stations are expected to be commissioned/augment their capacities in near future.

fly ash has been considered as a “Pollution Industrial Waste”. The Majority of thermal power plants 84% are run by coal.

Glass is amorphous solid material which is produced at high temperatures followed by crystallization. The effective use of waste glass for partial and full replacement of sand as an admixture in cement mortar and concrete has established in the country in recent years.

Recent investigation of waste glass has indicated greater scope for their utilization as a construction material. Greater utilization of waste glass will lead to not only saving such construction material but also assists in solving the problem of disposal of this waste product.

The recent investigations have also indicated the necessity to provide proper collection methods for waste glass so as to yield waste glass of quality and uniformity, which are primer requirements of waste glass for use as construction materials.

Chemical attack on concrete results in disintegration of concrete. The rate of disintegration determines the durability of concrete structures. All the reactions take place due to the aggressive substances present in the environment or within the concrete and their diffusion towards the reactive substance. The rate of chemical reactions depends mainly on the presence of water either in liquid form or gas forms and the rate of transport of the aggressive substances within and into the concrete. These reactions are often take place on longer periods of exposure of several years resulting in their detrimental effect.

In this investigation that Pozzolon cements are produced by adding pozzolons such as flyash in 20% replacement for Portland cement. On the 28^{th} day of production, the produced specimens are stored in HCl solution. The strengths are determined after the mortars are stored in solution for 56 days and 90days.

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2. LITERATURE REVIEW

- P.Turgut and E. S.Yahlizade(4) investigated on "Research into Concrete Blocks with Waste Glass"- a parametric experimental study for producing paving blocks using fine and coarse waste glass is presented. Some of the physical and mechanical properties of paving blocks having various levels of fine glass (FG) and coarse glass (CG) replacements with fine aggregate (FA) are investigated. The test results show that the replacement of FG by FA at level of20% by weight has a significant effect on the compressive strength, flexural strength, splitting tensile strength and abrasion resistance of the paving blocks as compared with the control sample because of pozzolanic nature of FG. The compressive strength, flexural strength, splitting tensile strength and abrasion resistance of the paving block samples in the FG replacement level of 20% are 69%, 90%, 47% and15 % higher as compared with the control sample respectively. It is reported in the earlier works the replacement of FG by FA at level of 20% by weight suppress the alkali-silica reaction (ASR) in the concrete. The test results show that the FG at level of 20% has a potential to be used in the production of paving blocks. The beneficial effect on these properties of CG replacement with FA is little as compared with FG.
- Ahmad Shayan "Value-added Utilisation of Waste Glass in Concrete"(2) concluded that A large proportionof the post-consumer glass is recycled into the packaging stream again, and some smaller proportion is used for a variety of purposes including concrete aggregate. However, a significant proportion which does not meet the strict criteria for packaging glass is sent to landfill, taking the space that could be allocated to more urgent uses. Glass is unstable in thealkaline environment of concrete and could cause deleterious alkali-silica reaction problems. This property has been used to advantage by grinding it into a fine glass powder (GLP) for incorporation into concrete as a pozzolonic material. In laboratory experiments it can suppress the alkali-reactivity of coarser glass particles, as well as that of natural reactive aggregates. It undergoes beneficial pozzolonic reactions in the concrete and could replace up to 30% of cement in some concrete mixes.
- Rasheeduzzafar et al. reported that blending of plain cements with 10% or 20% silica fume with improved corrosion resistance. Detvelin et al. reported that for any given curing conditions, the use of either 5%silicafume with 30%slag has more pronounced effect on chlorides permeability.R.K. Dhir et al. concluded that specifying by strength, cement content or W/C ratio alone cannot ensure adequate durability in chloride-containing environment. J.R Makehnie et al. Is reported that, amongst the various factors responsible for the premature deterioration of structures, corrosion of reinforcing steel owing to the ingress of chlorides in concrete has been identified as the most damaging factor. W.J.Mc Carter et al. [14] concluded that the absorption of chloride solution into concrete is less than absorption of water.

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3. EXPERIMENTAL ANALYSIS MATERIALS USED IN CEMENT CONCRETE

Cement:

(ANJANI cement of 53grade ordinary Portland cement was used) Ordinary Portland cement (53 grade) available in the local market of standard brand was used in the investigation. Portland cement is most commonly used type of cement in theworld today. Care has been taken that it has to be stored in airtight containers to prevent it from being affected by the atmospheric and monsoon moisture and humidity.

Fine Aggregate (Sand):

The size of the fine aggregate is below 4.75mm, natural sand used as the fine aggregate in concrete mix. Sand may be obtained from rivers, lakes but when used in concrete mix, it should be properly washed and tested to ascertain the total percentage of clay silt, slit and other organic matters doesnot exceed the specified limit.

Coarse Aggregate:

The material whose particles of size retained on i.s. sieve no. 4.75mm is termed as coarse aggregate. The size of coarse aggregate depends upon the nature of the work. The coarse aggregate used in the experimental investigation is 20mm size, crushed on angular in shape. The aggregates are free from dust before used in the concrete.

Fly ash:

Fly ash is the material produced in small dark flecks by the burning of powdered coal. It is also known as pulverised fuel ash. In this investigation fly ash is replaced with cement due to its pozzolanic nature.

Waste Glass:

Waste glass is a new source . supersol is an artificial light porous foamed material that is made by crushing , milling, banking and foaming waste glass. The waste glass is available from recycling plant.

HCL:

Acid etching involves allowing the reaction of a dilute solution of hydrochloric acid to the concrete surface. The acid chemically reacts with surface laitance1, dissolving itand allowing it and other water soluble contaminants to be washed away.

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4. TESTS CONDUCTED

3.1 Compressive Strength of Concrete Specimens:

Compressive strength of concrete is the most important parameter and representative of almost overall quality of concrete. It mainly depends upon the water/cement ratio of the mix and curing and age after it is cast. Compressive strength of concrete is determined by testing the cylindrical or cubical specimens of concrete using a compression testing machine, at various age such as: 7 days and 28 days

Fig I: Compression Testing Machine

The measured compressive strength of the specimen shall be calculated by dividing the maximum load applied to the specimen during the test by the cross sectional area calculated from mean dimensions of the section and shall be expressed to the nearest kg/cm^2, average of all values shall be taken as the representation of the batch provided andindividual variation is not more than that -15 percent of average.

Compressive Strength = Max. Load/Area = (W/A) Where, W = Maximum Load on Cube

A = Effected cross sectional areaFinal values are adopted using standard deviations.

3.2 Split Tensile Strength:

The splitting tests used for determining the tensile strength of concrete sometimes referred to as split tensile strength of concrete

This test is Compression–testing machine by placing the cylindrical specimen horizontally, so that its axis is horizontal between the plates of the testing machine. The load is applied uniformly at a constant rate until failure by splitting along the vertical diameter takes place. Load at which the specimen failed is recorded. Test is performed as per IS: 5816-1970.

The Split Tensile strength of cylinder specimens of size 150 mm X 300 mm.

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The cylinders were tested by placing them uniformly. Specimens were taken out from curing tank at the age of 7, 14, 28, 56 and 90 days of moist curing and tested after surface water dipped down from specimens. This test was performed on Testing Machine as shown in figure.

FIG II: Split tensile strength (f_S) = (2W)/(πLD)

Where, W = Maximum Load on Cylinder

L = Length of the Cylinder

D = Diameter of the Cylinderd = Depth of the Prism

3.3 Fire Resistance Test:

In this project tests performed for checking the fire resistance of concrete cube specimens in which cement and fine aggregate are partially replaced by fly ash and waste glass, at the temperatures 100˚c to 500˚c in muffle furnace for 1hour and 2hours respectively. This test was conducted after 28 days curing. After the respective curing periods the cube specimens were dried at room temperature for some time confirming that the specimens is free from wetness. Then the specimens which are to be tested are placed in muffle furnace and the time is to be noted. After the required time muffle furnace is switched off and cubes are taken out and are kept to cool at room temperature. Then the specimens are tested at universal testing machine. The cube specimens are placed on the machine such that the load is applied centrally. This test was conducted after 28 days .

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4.CONCLUSIONS

Based on the experimental study concrete for M40 grade concrete, the following conclusions are drawn:

1. The compressive strengths of concrete (with 0%, 5%,10%, 15% and 20% of weight replacement of cement with fly ash and 0%, 10%, 20% 30% and 40% of weight replacement of FA with waste glass) cured in Normal water for 7, 28, 56 and 90 days have reached the target mean strength.
2. The spilt tensile strengths of concrete (with 0%, 5%, 10%, 15% and 20% of weight replacement of cement with fly ash and 0%, 10%, 20% 30% and 40% of weight replacement of FA with waste glass) cured in Normal water for 7, 28, 56 and 90 days have reached the target mean strength.
3. The compressive strengths of concrete (with 0%, 5%,10%, 15% and 20% of weight replacement of cement with fly ash and 0%, 10%, 20% 30% and 40% of weight replacement of FA with waste glass) cured in 0%, 0.5%, 0.75% and 1% of HCL for 7, 56 and 90 days have reached the target mean strength.
4. On replacement of 10%,20% and 5% ,10% of FA bywaste glass and cement by fly ash in concrete mix their is an increase in compressive strength of 4.5% and 5.8% at
   7 days, 4.5% and 5.5% at 28 days is observed whencompared to control mix.
5. The spilt tensile strength of concrete increases at 10%,20% and 5%,10% replacement of fine aggregate by waste glass and cement by fly ash 2.23% and 4.83% at 7 days ,3.68% and 4.12% at 28 days when compared to control mix.
6. The compressive strengths of concrete cured in different concentrations of (0%, 0.5%, 0.75%) HCL acid solution for 7, 56 and 90 days indicate that at 0.75% of HCL acid there is increase in strength and beyond that the strengths decreases.
7. The strength decreases in acidic environment with age of concrete also with increasing of fly ash and waste glass content in concrete.
8. The compressive strength after exposing the specimens to temperatures of 100^0,200^0,300^0,400^0 and 500^0 c respectively in furnace for 60 minutes their is a nominal decrease in compressive strengths at the elevated temperatures.

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FILTRATION OF POLLUTED AIR TO IMPROVE THE INDOOR AIR QUALITY

(BREATHE BRICK)

N. Anusha[1] , P.V.Hari Krishna[2], Adusumalli Manikanta[3], B. Keerthi[4], P. Sowkhya sree[5], G. Komali[6]

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ABSTRACT

Breathe brick is a masonry element that filters polluted outdoor air to improve the quality of indoor air. As pollution rates rise due to a variety of factors such as deforestation, technological advancements, and other factors, this approach is advantageous in filtering outdoor air to enhance indoor air quality. For separating suspended particles, Breathe brick does not employ any filtration techniques. The filtration effect is created by the air itself. To funnel airflow into the brick, the brick is redesigned to have a faceted shape. The particle laden air is directed to the brick using pressure and temperature differentials. The main component of the breathe brick is a cyclonic separator, which is the cheapest and most effective type of separator. The cyclonic separator's efficiency is determined by particle size and velocity. It has a solid separation effectiveness of 70-80%, and if the fluid contains a considerable amount of solid particles, it has a separation efficiency of 99 percent.

Key Words: Breathe brick, Faceted surface, Cyclonic separator, Plastic coupler, Wind tunnel test.

1 INTRODUCTION

Without air, life on Earth would be difficult to sustain. Air quality is a critical aspect that must be taken into account in the current situation. Degradation of air quality causes a slew of issues that affect both individuals and the environment. Since the beginning of the industrial revolution, one of the biggest challenges that has plagued the world has been air pollution. As a result, there is a great demand for novel approaches to improve air quality. Carmen G Trudell and a group of undergraduates presented the design of the breath brick, which used vacuum cleaner technology to improve air quality. The origin of the innovation was the formation of a 'black cloud' in cairo that persisted for several months. The concept is to purify the air that enters the brick such that the air that exits is free of suspended particles. The main advantage of the breathe brick is that it does not use any energy to purify the air.

2 COMPONENTS

Concrete block, cyclonic separator, and plastic coupler are among the components of breathe brick. The first design was discovered to be relatively simple, consisting merely of a cyclonic separator and a waste stack, and voids for reinforcement bars were designed and given.

2.1 Concrete Brick

The cyclonic separator is built right into the stonework. It has the same measurements as a normal masonry unit. Because it does not have a separate filter, the brick is built

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with a faceted surface to direct is created by the air itself. Figure 1: breathable brick with faceted finish.

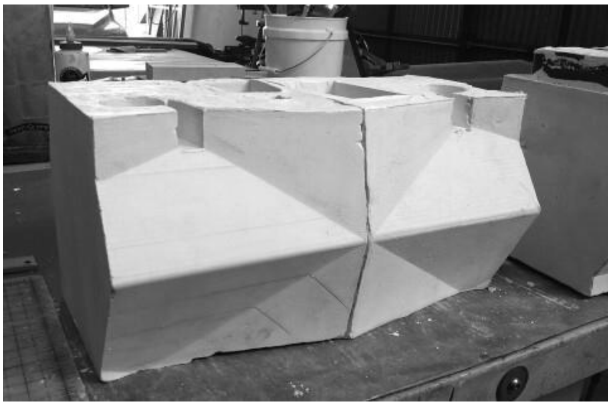
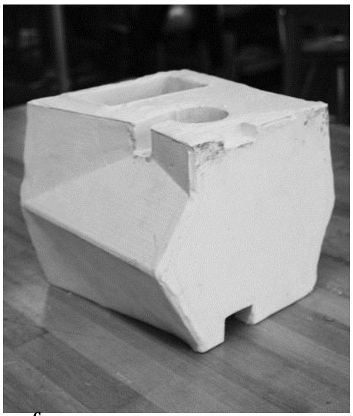

Fig-1: Breathe brick with faceted surface

2.2 Cyclonic Separator

It is the most basic and inexpensive separator, as it has no moving components and requires no maintenance. It removes particles travelling at roughly 15m/s and larger than 5m with a 98 percent effectiveness. The cyclonic separator has a cylindrical top portion and a conical lower portion. The cyclonic separator's separation principle is to augment the effect of sedimentation by centrifugal force by injecting tangential air absorption to the device.

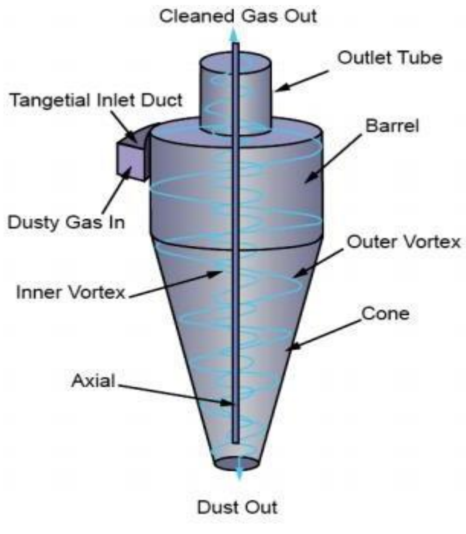

Fig-2: Cyclonic separator

2.3 Recycled Plastic Coupler

The coupler aids in the alignment of the blocks and creates a path for polluting air to enter the block. Within the chamber, internal baffles are used to create a directed flow of air. It can also be used to link to other cyclonic chamber.

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3 Breathe Brick Assembly

The breathe brick is made up of four modules that are connected by a coupler. The first module includes a cyclonic separator and a reinforcing bar cavity. The waste tube and reinforcing cavity of the second module are kept close to the first module and are connected via a coupler. The cyclonic separator, waste tube and reinforcing cavity is made up the third module. The third module is placed over the first and second module. It should be set up so that the first module's cyclonic separator is connected to the third module's separator. The waste tube in the second module is also connected to the waste tube in the third module. The fourth module consists solely of a chamber into which reinforcement bars can be inserted. These four modules are integrated to form the purification unit.

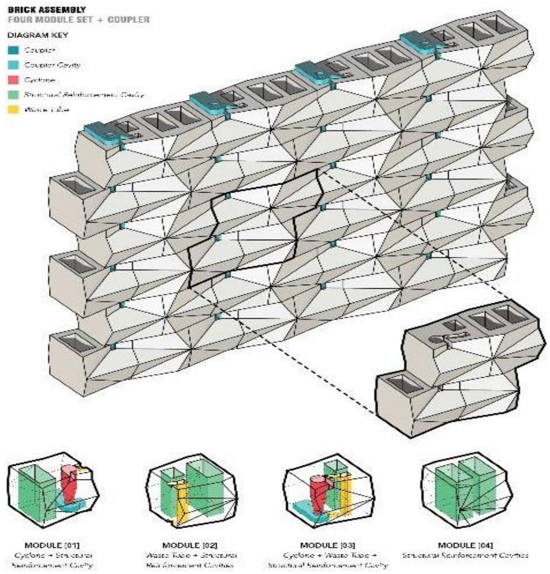

Fig-3: Breathe brick assembly

3.1 Breathe Brick Configuration

Air is drawn into the brick by a mix of wind and stack ventilation forces. The filtration wall is positioned against the prevailing wind since it works on pressure and temperature differentials. It is part of a comprehensive building ventilation system in which sun orientation and layout are key design considerations. Breathable bricks are included in the double wall construction. It serves as the double wall system's non-load bearing outer wall. The inner wall serves as a load-bearing structure. The outer filter wall purifies dirty air from the outside environment, and only cleaned air is admitted inside the chamber. In the event of a regular room with vents for the intake of ejected fresh air, the breathe brick serves as a passive filtration device. When it's combined with the current HVAC, it works as an active system.

4. WORKING

Through a coupler, contaminated air enters the breathe brick unit. To get to the cyclonic chamber, the air must pass through the baffles. The particle-laden air is admitted

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tangentially through the top of the barrel by the cyclonic separator, which has a cylindrical upper section(barrel) and a conical lower part, when the air enters the chamber, it creates a swirling motion. Due to the high density of particle-laden air generating an outer vortex, air travels from the barrel to the lower cone. The inertial force of the gas particles is converted to centrifugal force by the vortex generated by the particles 'swirling motion'. The velocity of a particle movement increases as the diameter of the cone decreases, resulting in an increase in centrifugal force. When a particle collides with the separator's wall, it loses energy and falls owing to gravitational force. As the particle is removed from the air, the density of the air decreases. As a result, the cleaned air forms an inner vortex and flows towards the barrel, where it is released from the breathe brick unit. The dust particles pass through the dust collector shaft and into the collection hopper at the base of the wall. Sweeping or vacuuming the hopper cleans it on a regular basics.

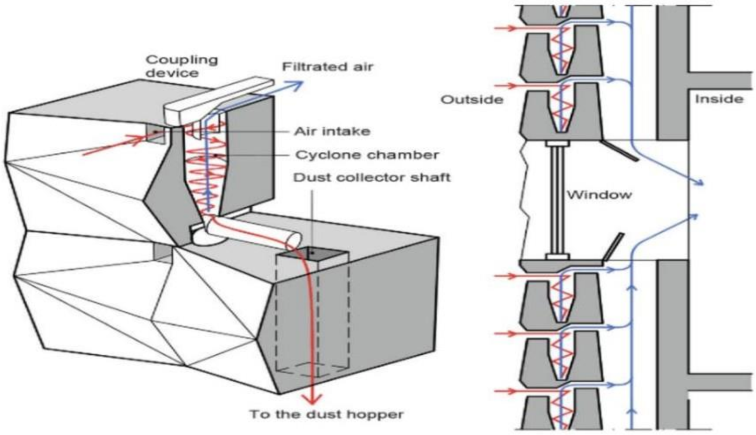

Fig-4: Working of breathe brick

5. WIND TUNNEL TEST

The collection efficiency of the breathe brick is tested in a wind tunnel. A cylindrical chamber (about 8 feet long), a lower speed fan at the front end to draw air into the chamber , a funnel to deliver particles into the chamber , a manometer to monitor air pressure, and an aerodynamic particle sizer make up the experimental apparatus. The air is sampled using an APS at several sites. 4 ft/s and 11 ft/s are used to evaluate flour and cornstarch. The maximal size range of the APS employed in the experiment is 20m. The collecting efficiency for flour at 4ft/s is 76percent, while for flour 11ft/s is 84 percent. The efficiency of cornstarch at 11 ft/s was determined to be 95%. As a result, the obtained results reveals that particle size and air velocity increase. It also demonstrates that particles larger than 0.5m can be trapped by a breathe brick. The breathe brick has a 30% efficiency for tiny particles like pollution in the air and a 100% efficiency for larger particles like dust.

6. CONCLUSION

Pollution is a problem that needs to be addressed right away, and the world is in a rush to find a solution. The Breathe Brick is an effective solution to the pollution problem. This method is particularly beneficial in highly polluted areas. They are inexpensive and easily accessible to families with typical incomes. They are also energy efficient because they do not require electricity to operate. This has the effect of increasing the air quality inside the room, hence reducing people's health problems to a large amount. Breathe brick walls provide individuals living in congested cities and towns with clean, healthful air .as a result, using breathe brick as a construction method can aid in the development of a healthy living environment.

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PARTIAL REPLACEMENT OF FINE AGGREGATE WITH AGRICULTURE WASTE &COARSEAGGREGATE WITH OIL PALM SHELL IN LIGHT WEIGHT CONCRETE.

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ABSTRACT

Lightweight concrete has utmost importance to the construction industry. Mostly present concrete research looks for high-performable concrete, by which is means a Cost effective material that satisfy staging requirements, including durability. Lightweight concrete is type of concrete which have an expansion agent in that it increases the volume of the mixture while we get extra qualities such as lower dead weight. It is light weight than normal concrete. The implementation of light-weight concrete had been vastly speeded across countries such as USA, Uk and Sweden. The after all main qualities of lightweight concrete are its low density and thermal conductivity. So its advantages are that there is a lower dead load, lower transport and handling expenses. In this investigational study, we will replace the coarse aggregate with light weight aggregates. Their strengths will be compared to between conventional cubes and the replaced cubes.

KEYWORDS: Concrete; Agricultural Waste; oil palm shell, Usefulness

1. INTRODUCTION

Major of the aggregate of normal concretes was natural stone such as lime stone and granite. With the growing amount of concrete used, natural environment and resources are largely exploited for resources. Synthetic light weight aggregate created from environmental waste like fly ash, is a viable new material. The usage of light weight concrete permits greater design flexibility and sustainable cost preserving, reduced dead load, less reinforcing steel and low foundations costs. Light-Weight Aggregate is a relatively new material. For the same crushing strength, the density of concrete prepared with such an aggregate can be as much as 35 % lower than the normal weight concrete. In addition to the deplete dead weight, the lower elasticity modulus and sufficient ductility of light weight concrete will be benefit in the seismic design of structures.

Light Weight Aggregates are categorized as follows:

(I)Inborn available materials which needed for further processing such as expanded clay, shale and slate, vermiculite etc.

(ii)Industrial waste products like sintered pulverized fuel ash, blast furnace slag or foamed , hematite etc.,

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2. MATERIALS AND METHODOLOGY OF EXPERMENTAL WORK

Materials:-

The cement used in this study was ASTM type I ordinary Portland cement (OPC) [21] with a specific gravity of 3.14 g/cm3 and a Blaine's specific surface area of 3510 cm2 /g. The cement content was kept continual at 550 kg/m3. Silica fumes (SF) having 5% cement by weight and a specific gravity of 2.10 g/cm3 was used as the supplementary cementitious material. To improve the mechanical properties of the concrete, densified SF was added as additional mineral admixture.

Local mining sand is used as the fine aggregate, having a specific gravity, fineness modulus, water absorption, and maximum grain size of 2.68 g/m3, 2.72, 0.97%, and 4.75 mm, respectively. The fine aggregate content was kept constant at 860 kg/m3 for all mixes.

Oil Palm Shells were used as the coarse aggregate in this case. Different species of Dura, tenera and pisifera, while different age categories of Dura and tenera used. The OPS aggregates used in this study are classified as "unripe" from 3 to 5 years of age, "young mature" from 6 to 9 years of age, and "young prime" from 10 to 15 years of age. The OPS were collected from a local crude palm oil factory in both original and crushed condition. It can be seen that the original OPS have concave and convex shapes with an even surface on the outer convex side.

Table 1 Physical properties of ordinary Portland cement

S.NO	Test Conducted	Result Obtained	Requirements As perIS:12269-1987
1	Fineness Modulus	2.34%	10% maximum
2	Initial settingtime	35minutes	30 minimum
3	Final settingtime	400 minutes	600 maximum
4	Specific gravity	3.14	2.98-3.15
5	Standard Consistency	30%	-

Table 2 Specific gravity of ops coarse aggregates

PARTICULARS	TEST1	TEST2	TEST3
Weight of empty pycnometer (W1)grams	625	625	625
Weight of pycnometer + 1/3rd	1050	1060	1060
Weight of pycnometer + 1/3rd	1750	1780	1780
Weight of pycnometer + water (W4)grams	1495	1495	1495
Specific gravity G = (W2-W1) \((W2-W1)-(W3-W4)	2.59	2.63	2.68

3. TESTS ON CONCRETE

CONCRETE SLUMP TEST:

Slump is a measure of concrete workability or fluidity. It is indirect measure of concrete consistency or stiffness. The concrete slump test is used for measurement of property of fresh concrete.

COMPACTION FACTOR TEST:

Compaction factor of fresh concrete is conducted to determine the workability of fresh concrete by compacting factor text.

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Table 3 Slump Test for Different Percentages of Ops

OIL PALMSHEL LS (OPS)	COARSE AGGREGATE	SLUMP(MM) 1	SLUMP (MM)2	AVERAGE
0%	100%	164	171	167.5
10%	90%	167	162	164.5
15%	85%	154	153	153.5
20%	80%	172	174	173.0
25%	75%	130	155	142.5
30%	70%	140	141	140.5
40%	60%	85	95	90.0

REBOUND HAMMER TEST:

Compressive Strength (Rebound Number) The rebound hammer is better to test the concrete without destroying it like compressive strength machine. The quality of ops concrete produced is of candid quality.

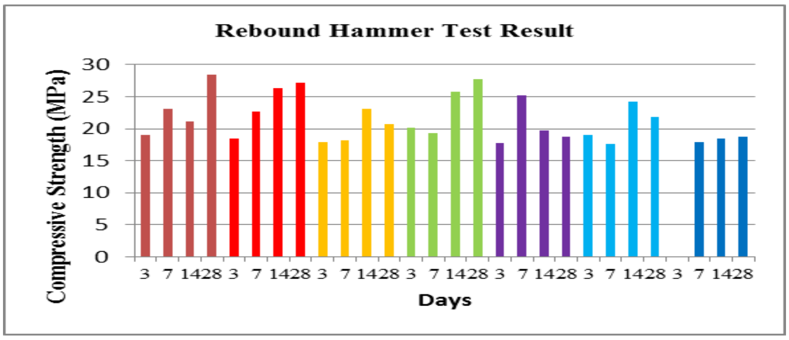

Fig.1 Rebound hammer test results

COMPRESSIVE STRENGTH

In Fig, it can be observed that all the concretes were still gaining strength until 28 days. The concrete % OPS replacement exhibited the best strength which is over 30 MPa and only 4.45 MPa lesser than control.

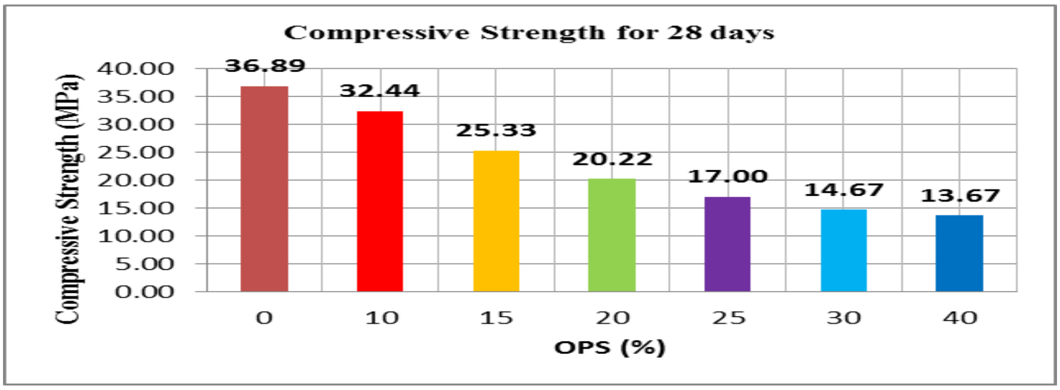

Fig.3 Compressive Strengths for all OPS replacement

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4. CONCLUSION

Oil palm shell has an adequate potential as a coarse aggregate in structural concrete production. Mix of full displacement of crushed stone by OPS does not give the desirable strength for light weight concrete. But concrete prepared with 50 % replacement is found sensible and can be used for low to moderate strength applications such as concrete members for low cost construct houses. It is an advantage for low income families, as this concrete can be used for the construction of less cost houses, especially in the region of oil palm plantations. Depletion of crushed stone and health problems in the region of factories can be reduced. By adding grace to the waste product, both waste management and concrete industries stand to benefit financially.

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EFFECT OF SUPER ABSORBENT POLYMER ON CONCRETE

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ABSTRACT

Water is an essential ingredient in the mixing, curing, and curing of concrete because insufficiently cured concrete can shrink, swell, and possibly crack. But now we need to save water and find ways to reduce water consumption. The use of SAP water is the most efficient use in concrete. Super absorbent polymer (SAP) (also known as slush powder) has the nature that it absorbs large amounts of water and turns into gel and at the same time swells or large volume change occurs when SAP reacts with water. The properties of M30 concrete with super absorbent polymer of 0%, 0.2%, 0.3%, 0.4% and 0.5% respectively. Concrete cubes and cylinders are cast and tested for 7 days, 14 days and 28 days

Keywords: Sodium poly acrylate, Super absorbent polymer, slush powder, self-*curing*.

1. INTRODUCTION

Superabsorbent polymers (SAPs) (additionally referred to as slush powders) can soak up and preserve extraordinarily huge quantities of liquid relative to their very own mass. Water absorbent polymers, labeled as hydrogels while cross linked, soak up aqueous answers through hydrogen bonding with water molecules. The cap potential of a SAP to soak up water is an issue with inside the ionic attention of the aqueous answer. In deionized and distilled water, a SAP can soak up three hundred instances its weight (30 to 60 instances its very own volume) and become 99.9% liquid, however while positioned in a 0.9% saline answer, it sinks the absorbency to 50 instances its weight. The presence of valence ions with inside the answer hinders the polymer's cap potential to bind to the water molecule. The usual absorbency and swell ability are managed through the kind and high-satisfactory of cross linking dealers used to make the gel. Rotatable discharges commonly have a bigger capability and soaking up thresholds in an extra degree. Excessive addition of water to clean concrete commonly improves the workability of the concrete, reduces concrete strength and will increase drying shrinkage of hardened concrete. The water gel created through using SAP in clean concrete offers cushioning and lubrication with inside the concrete mass, which in flip improves concrete workability and urban stability.

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2. MATERIALS

2.1. Cement:

Ordinary Portland Cement 53 was chosen for experimentation, owing to the high initial strength and quicker setting time. The physical properties as provided by the manufacturer are tabulated in table1.

Table 1 Physical Properties of OPC 53 Cement

Physical Properties	***Requirement IS 12269:2013***	***OPC 53***
Specific gravity	-	3.25
Normal consistency	-	33%
Initial setting time	Min of 30min	60Min
Final setting time	Max of 600min	345Min

a. Coarse Aggregates:

Locally available coarse aggregates and recycled coarse aggregates having a maximum size of 20mm, and 12.5 mm size were used in this work. The aggregates were tested as per Indian Standard Specifications.

Table 2 Physical Properties of coarse aggregates

Physical Properties	**Value**
Specific gravity	2.81
Water absorption	0.159
Bulk density	1660
Fineness modulus	4.534
Shape of grains	Angular

b. Fine aggregates:

The standard sand shall be of quartz, light grey or whitish variety and shall be free from silt. The sand grains shall be angular; the shape of the grains approximating to the spherical form elongated and flattened grains being present only in very small or negligible quantities.

Table 3. Physical Properties of Fine aggregates

Physical properties	***Value***
Specific gravity	2.62
Shape of grains	Rounded

c. Super Absorbent Polymer:

Superabsorbent polymer (SAP) is a polymeric material which is able to absorb a significant amount of water from the surroundings and to retain the liquid within its structure without dissolving it takes up water during the mixing process, so it can be used as a dry concrete admixture and the use of SAP permits free design of the shape and size of the formed inclusions. The super absorbent polymer used in this study is Sodium Polyacrylate, also known as water-lock, which is a sodium salt of polyacrylic acid with the chemical formula [-CH2-CH(COONa)-]n and broad application in consumer products. It has the ability to absorb as much as 200 to 300 times of its mass in water. The maximum water absorption is approximately 5000 times its weight. Sodium polyacrylate is anionic polyelectrolyte with

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negatively charged carboxylic group in the main chain. Below figure, shows the composition of the sodium polyacrylate.

Table 4 Properties of Super Absorbent Polymer

Item	Units	Specification
Appearance	-	WHITE GRANNULER
Form – dry	-	Crystalline white powder / granules
Form – wet	-	Transparent gel
Residual monomer	PPM	300
Moisture content	%	6.0
Decomposition in sun light	-	6 months
Particle size distribution	%	1.5 (>= 710 micrometer)
	%	30-45 (500-700 micrometer)
Density	g/cm3	0.57-0.63
Absorption under pressure	g/cm3	>=28 (0.3 psi)
	g/cm3	>=20 (0.7 psi)
Absorption Rate	S	<=30
Retention Capacity	g/g	>=30
Ph	-	6.0-6.5

Sodium polyacrylate is a chemical polymer composed of a couple of chains of acrylate compounds that own a advantageous anionic fee that draws water-primarily based totally molecules to bond with, making sodium polyacrylate a super-absorbent compound. Sodium polyacrylate is broadly used in agriculture and is included into the soil of many potted vegetation to assist them hold moisture and acts as a form of water reservoir. Florists usually use sodium polyacrylate to hold plant life fresh.

Fig 1: Sodium Polyacrylate.

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4. Experimental Analysis

4.1. Specimen preparation and curing:

Cubical samples with dimensions 150×150×150 were prepared in the laboratory. The compaction was done in 3 layers, with 25 blows per layer, using a standard 2.5 kg proctor hammer. This method has been recommended over other methods such as vibration and rodding. The samples were prepared in three batches and left in the mould for 1 day. The three batches were kept underwater. The curing process was done for 28 days.

4.2. Determination of density and porosity:

The functional and structural properties of concrete sample are strongly influenced by its density and porosity. In this study, the procedure outlined in ASTM C1754 was used for the determination of density and porosity for each of the wet cured samples. The process for the determination of density involves placing the cured samples in the oven at 60 °C for 7 days and noting down their hardened weight. For the determination of porosity, the samples are kept submerged in water for 35 min and the weight underwater is measured. The submerged weight and the oven-dried weight of SAP concrete are used in the relationship as given in ASTM C1754 for calculating the porosity.

4.3. Compressive strength:

Compression tests of the SAP specimens were carried out as per ASTM C109. The tests were done after 28 days for the single gradation and mixed gradation cubes. For the mixes containing less fine aggregate percentage, 7days, 14 days, and 28 days compressive strength were found accordingly.

5. RESULTS AND DISCUSSION:

5.1 Compression Strength:

The failure pattern observed from the compression test results leads to the following conclusions: The strength of SAP concrete with standard grade proportions are shows high compressive strength than SAP concrete with less percentages of fine aggregates . Compression strength test is conducted for 7days, 14 days, and 28 days.

Fig 2: Compressive strength of SAP concrete

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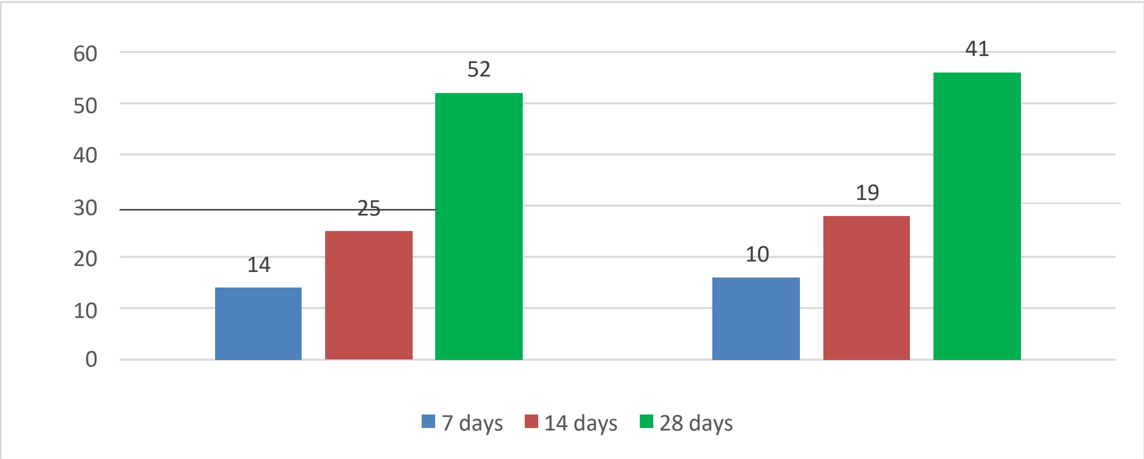
Table 5 Compressive strength of SAP concrete

Compressive strength (MPa)	*7 days*	*14 days*	*28 days*
SAP-CONCRETE	14	25	52
SAP-LESS FINE AGGREGATES	10	19	41



5.2 Water Absorption Test:

This check allows to decide the water absorption of coarse aggregates as consistent with IS: 2386 (Part III) – 1963. For this check a pattern now no longer much less than 2000g need to be used.

Water absorption offers a concept of power of aggregate. Aggregates having extra water absorption are extra porous in nature and are usually taken into consideration fallacious except they're observed to be perfect primarily based totally on power, effect hardness tests.

5.3 Split Tensile Strength:

Based on the test results of split tensile strength it states that there is slight variation in the strength of Sodium Polyacrylate concrete sample with only cement and Sodium Polyacrylate concrete sample with less amount of fine aggregates.

Fig 3: Split tensile strength of super absorbent polymer concrete

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Table 6 split tensile strength for super absorbent polymer concrete

SPLIT TENSILE STRENGTH (MPA)	*28 DAYS*
SAP-REGULAR	2.56
SAP-LESS FINE AGGREGATES	2.35

6. CONCLUSION

Internal hardening or self-hardening by adding sodium polyacrylate is an effective way to drastically reduce autogenous shrinkage. Since autogenous shrinkage is the main contributor to early cracking, internal hardening is expected to reduce early cracking as well. An additional advantage of internal shrinkage cross-linking over and above the reduction in intrinsic shrinkage is an increase in compressive strength. Because internal hardening maintains saturated conditions in the hydrating cement paste, the magnitude of internal self-hardening stresses is reduced and long-term hydration is increased. Internal post-curing is particularly effective for high-performance concretes containing fumed silica.

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FRESH AND HARDENED PROPERTIES OF GEO POLYMER CONCRETE PAVERS BY USING SEA SAND AND SEA WATER

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ABSTRACT

In this experiment, restricted river sand is substituted with sea sand and used as a substitute. In the absence of OPC, salt water is utilised instead of distilled water in the laboratory experiments.Paver is now employed in a variety of construction applications. The manufacture of OPC pavers necessitates extra curing room and a substantial volume of water. The biggest issue is the disposal of solid waste from fly ash. This project promotes sustainability by combining flyash, rice husk ash, sea water, and sea sand with waste management to create geo-polymer concrete pavers, a fantastic product. The results of this investigation reveal that the geopolymer concrete paver block has outstanding compressive strength in a short amount of time.

Key Words: Geo polymer pavers, sea water, sea sand, fly ash, Rice husk ash, alkaline liquids, compressive strength, flexural strength, alkaline liquids, compressive strength, flexural strength

1. INTRODUCTION

Nowadays, concrete is mostly utilized as a flexible building material, with the world's greatest consumption. Nonetheless, its increasing demand is depleting limited natural resources in its manufacturing. In order to prevent the destruction of these natural restricted aggregates resources, it is critical to use other alternative abundant materials in their stead.

Every tonne of OPC produced emits the same amount of CO2 into the environment, with the cement sector accounting for around 7% of world CO2 emissions.Freshwater supplies are limited, and as a result, humans in some parts of the world does not have enough fresh water to drink. However, sea water makes up 97 percent of the total amount of water on the planetIn conversely Sea sand can be found in vast quantities beneath the seas and oceans.The principal byproduct of coal combustion is fly ash, which is obtained from coal-fired powerplants. To dispose of these wastes on land, theymay require a huge amount of space. So that land area can be developed by using these wastes in concrete preparation.Dia generates around 20 million tonnes of rice husk ash each year and is one of the world's largest rice producers. It also produces

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a waste material

From the milling process, which is thrown on the ground, posing a severe environmental hazard to the area. As a result, rice husk ash is receiving a lot of interest in terms of commercial applications.For laboratory experiments on the properties of Geopolymer concrete in the absolute absence of Ordinary Portland Cement, sea water was used instead of distilled water, and sea Sand was utilised as an alternative to river Sand, while fly ash was largely replaced by rice husk ash.

2. .AIM AND OBJECTIVES OF THE STUDY

The main goal of this study is to look at the strength properties of geo polymer concrete made with fly ash and Rice Husk Ash and alkaline liquids containing sodium hydroxide and sodium silicate.

Finding

- the compressive strength of geopolymer concrete to investigate the effects of fly ash, Rice husk ash, dissolvable alkaline liquid, sea sand, and seawater.
- To investigate and determine the flexural and compressive strength of specimens made with sea sand and sea water, and to compare the end results to those made with distilled water and river sand.
- Sodium silicates and sodium hydroxides were used to construct high-strength Geopolymer pavers.
- High-strength Geopolymer pavers were made with sodium silicates and sodium hydroxides.

3 .LITERATURE STUDY

The following is a list of available literature on the effects of sea sand and sea water on cement concrete. And it was discovered that there have been very few studies on the use of sea sand and sea water in the preparation of geopolymer concrete. As a result, the purpose of this study is to compare geopolymer concrete made with seawater and sea sand to control geopolymer concrete made with distilled water and river sand.[1]. "A FEASIBILITY STUDY ON THE USE OF MARINE SAND IN CONCRETE FOR LONG-TERM DEVELOPMENT"M Karthikeya and V Nagarajan were the authors of this study. They made M30 grade concrete with a mix percentage of 1: 1.22: 2.54 and a w/c of 0.42 in their research. Ten percent, twenty percent, thirty percent, and forty percent of the fine aggregate content is substituted with sea sand. Up to 30% replacement, the results are satisfactory. Then, as an admixture, micro silica was used to boost the strength even more.[2]. Dr. K. N. Kadam, B. H. Shinde, and others titled this paper "STRENGTH PROPERTIES OF FLY ASH BASED GEOPOLYMER CONCRETE WITH SEA SAND." In their study, ocean sand (both treated and untreated) was used as an alternative to stream sand. The findings suggest that treated sea sand concrete performs similarly to river sand concrete. Untreated sea sand, on the other hand, has the same effect on the compressive strength of geopolymer concrete as untreated cement concrete.[3.] Sharon John, C. Banupriya, D. Vinitha, R. Suresh, and E. Divya titled their paper "EXPERIMENTAL INVESTIGATION ON

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GEOPOLYMER BRICKS/PAVER BLOCKS." Quarry dust was replaced with river sand for creating geopolymer bricks and paver blocks in their study. Fly ah, GGBS, sodium hydroxide pellets, and aggregates were mixed in appropriate proportions, water was added, and the mixture was cast. The final results demonstrate that a GPC paver block made with 25% fly ash and 75% GGBS has excellent compressive strength. The compressive strength of a geopolymer block made up of 65 percent Fly Ash and 35 percent GGBS was excellent[4]"EXPERIMENTAL INVESTIGATION OF GEOPOLYMER CONCRETE WITH FLY ASH AND GGBS" B M Jagadeesh, Manjunath M Katti, and Naveen M Katti authored this paper. The strength properties of Geopolymer concrete were investigated in their experimental study. To make Geopolymer concrete mixtures, ground granulated blast furnace slag, class F fly ash, and catalytic liquids are used in place of ordinary Portland cement. They varied the molar concentration (6M, 8M, and 10M) as well as the temperature in this investigation.

4. MATERIALS INVOLVED

ASH FLY:

Because of its high alumina and silica concentration, fly ash was chosen as the principal supply material. These chemical components are beneficial to the geopolymerization process. It is a product made from the ignition of coal in nuclear power plants that has a high silica and alumina content and, when used in large quantities, can help to reduce the negative impact on the environment by replacing concrete. Fly ash is divided into two "classes," Class C and Class F. The calcium hydroxide level of Class F Fly Ash is lower than that of Class C. Each type of fly ash has its own unique characteristics. Class F fly ash is used in this study.

Table No 1 Physical properties of Fly Ash

Sl.no	Properties	Values
1	Colour	Grey to Black
2	Appearance	Fine Powder
3	Odour	Odourless
4	Particle Size	35 Micron
5	Specific Gravity	2.19

HUSK ASH FROM RICE

In order to explore the impacts of RHA substituting**.** Fly ash in the proper percentage, RHA was used as a secondary source material.

Table No 2 Physical Characteristics Of Rha

Sl.no	Properties	Values
1	Colour	Grey / Black
2	Apperance	Fine Powder
3	Odour	Odourless
4	Particle Size	45 Microns
5	Specific Gravity	2.09

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Fine aggregate:

As a fine aggregate, river sand and sea sand are employed. River sand, which is a locally accessible natural sand, and sea sand, which is gathered from the seashores and has a size of 75 microns, are utilised after passing through a 4.75 mm screen

Table No 3 Chemical Composition Of River And Sea Sand

Composition	River sand	Sea sand
Alumina	12.43	2.32
silica	78.56	40.11
Potassium and sodium	1.89	33.82
Calcium	0.77	1.45
Titanium	0.19	0.53
Iron	1.79	1.13
Manganese	1.34	2.04

Table No 4 Physical Parameters of River Sand And Sea Sand.

Sl no	Properties	River sand	Sea sand
1	Finess modulus (%)	2.3	2.5
2	Moisture content (%)	0.18	0.21
3	Water absorption (%)	0.7	0.81
4	Specific gravity	2.8	2.4
5	Zone located	Zone II	Zone II

Coarse aggregates:

The coarse aggregate was made from machine-crushed rock acquired from a nearby quarry, and the aggregates are the major components of concrete. They help to reduce shrinking. And have an effect on the value Between 4.75 and 5.75 in. Coarse aggregates are those with a size range of mm to 50 mm. About 70 to 80 percent of the volume of concrete is made up of coarse particles. For this study, 10 mm and smaller aggregates were used.

Table No 5 Properties of Coarse Aggregates

Sl no	Properties	Values
1	Water absorption (%)	0.6
2	Curshing value	10.1
3	Abrassion value	29.77
4	Impact value	28.23
5	Specific gravity	2.22

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Alkaline liquids:

SODIUM HYDROXIDE (NaOH):- Alkaline sodium silicate and sodium hydroxide solutions are employed in this study. In this experiment, sodium silicate solution and sodium hydroxide in pellet form were utilized. For this experiment, we only use 6M (Molarity) sodium hydroxide.

NaOH has a molecular weight of 40. (Na-23, O-16, H-1).To make a 6 molNaOH solution, weigh 240g of NaOH flakes, which can be dissolved in distilled water to make a 1 litre solution. It isrecommended to prepare it 24 hours before the specimens are cast.

Sea water:

The early strength of cement is increased by a little amount when it is exposed to seawater. It does, however, diminish the cement's 28-day strength by roughly 10% to 15%. Changes in the mix or the addition of appropriate admixtures could compensate for the loss of strength**.**

Table No 6 Chemical Characteristics of Sea Water

Sl no	Composition	Total %
1	Calcium	1.01
2	Chloride	54.49
3	Magnesium	4.69
4	Potassium	1.19
5	Sodium	31.54
6	Sulphate	6.45
	TOTAL	99.37

Portable water:

When pollutants are present in a substantial amount of water, the basic properties of cement, such as strength and durability, suffer. There is a difference in the setting time of Portland concrete mixes that use suggested blending water compared to those that use fresh water.

5 .EXPERIMENTAL RESEARCH

This is a study effort based on trial and error. The effect of fly ash and RHS on alkaline liquids was evaluated in three stages: first, compare the compressive strength of this to the standard OPC by altering the proportion of fly ash substituted with RHS by 0%, 10%, 20%, and 30%. Second, a good percentage replacement of fly ash and RHA is taken (as determined in the first investigation), and this mix is used for all four different combinations (sea sand & sea water, River sand & distilled water, River sand & sea water, Sea sand & distilled water, Sea sand & distilled water, Sea sand & distilled water, Sea sand & distilled water, Sea sand & Third, the above mixtures are used in casting.

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INTERACTIVE DESIGN:

For Geopolymer concrete, there are currently no standard mix design methodologies. As a result, the Geopolymer Concrete formulation must be done through trial and error. The strength of cement concrete is widely understood, and it is inversely proportional to the water cement ratio. For geoolymer concrete, the simplest formulation is insufficient.

In order to create Geo Polymer Concrete, geopolymer paste binds fine aggregates, coarse aggregates, and other unreacted components together. Concrete technology approaches frequently make use of GPC mixtures.

Table No 7 Mix proportions Gap Mix Calculation

MIX NAME	MIX PROPORTION	W/B Ratio
100c	1:1.26:2.20	0.68
100fa0rhs	1:1.26:2.20	0.85
90fa10rha	1:1.26:2.20	0.85
80fa20rha	1:1.26:2.20	0.85
70fa30rha	1:1.26:2.20	0.85

6. SPECIMENS CAST, CURED, AND TESTED

6.1 Specimens are cast.

After determining the mix design, the materials RHA, Fly Ash, Fine, and Coarse aggregates were mixed in 1:1.31:2.16 proportions. In the proportions of 0%, 10%, 20%, and 30%, fly ash was substituted by RHA. The components were all dry mixed together in a uniform manner. The appropriate amount of Alkali liquids with the required substantial quality were added to the dry mix (alkaline liquid to binder ratio = 0.5), and the entire mixture was homogeneously mixed once more. To this mix, add more water and admiture, and thoroughly mix it again. This wet concrete was poured into the moulds and crushed in three layers by hand before being placed in the vibrator for final compaction.

6.2 Moulds' dimensions:

Geopolymer cubes with a compressive strength of 100*100*100 mm, beams with a flexural strength of 100*100*500 mm, and Paver blocks with a compressive strength of 225*105*75 mm were used. For curing, these specimens were casted and held at room temperature. The specimens were de-moulded after a day of casting.

d = Beam depth in millimeters6.2 Curing of specimens

After the concrete has completely set, usually 24 hours, the cast specimens are de-moulded. The de-moulded specimens are then stored in the open air to cure. In this investigation, the curing periods were 3 days, 7 days, and 28 days. After the specimens have been cured for a period of time, they are examined for compression and flexural strength.

6.3 Specimen analysis

Cast iron steel moulds were utilized to make the test specimens for compressive strength. To determine the strength of each mix, three specimens are prepared and

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tested at ages 3, 7, and 28 days. The flexural strength test specimens were made using beam-shaped specimens.

Three numbers of beams were cast for each mix proportion, and they were tested at the ages of 3, 7, and 28 days. Furthermore, pavers are casted and tested at 28 days of age.Test of compressive strength (A)

Cube specimens of 100 x 100 x 100 mm were created. They are tested for compression strength on a compression machine with a capacity of 2000 kN, according to IS code IS 516- 1959. The specimen's compressive strength is computed using the conventional equation F=P/A, where P represents the maximum load in N.

A= mm2 cross-sectional area

F = N/mm2 compressive stress

(B) Test for flexural strength

Specimens measuring 100 x 100 x 500 mm were made. They are put through their paces on a flexural testing machine. The technique of test and the strength of the test were estimated using IS 516-1959. The flexural strength is computed using the equation PL/bd2, where P represents the applied load in N and bd2 represents the bending moment.

(P = Applied load in N L = Span length in MM b = Beam width in MM)

7. DISCUSSION OF THE RESULTS

A) Fly ash and rice husk ash have different effects:

The compressive strength of geopolymer concrete with fly ash and rice husk ash as full replacements for cement. Their compressive strength results are summarized in the table below. When the amount of rice husk ash is raised, it can be seen that the compressive strength decreases progressively.

Table No 8 Gps Compressive Strength

MixID	*Fly ash & RHS*	*3 days (Mpa)*	*7 days*	*28 days*
GC 1	100 % and 0 %	18.51	29.20	40.18
GC 2	90 % and 10%	14.54	24.52	36.29
GC 3	80 % and 20 %	11.22	18.81	24.54
GC 4	70 % and 30 %	8.77	14.59	21.0
OPC	100 % Cement	12.50	22.20	32.0

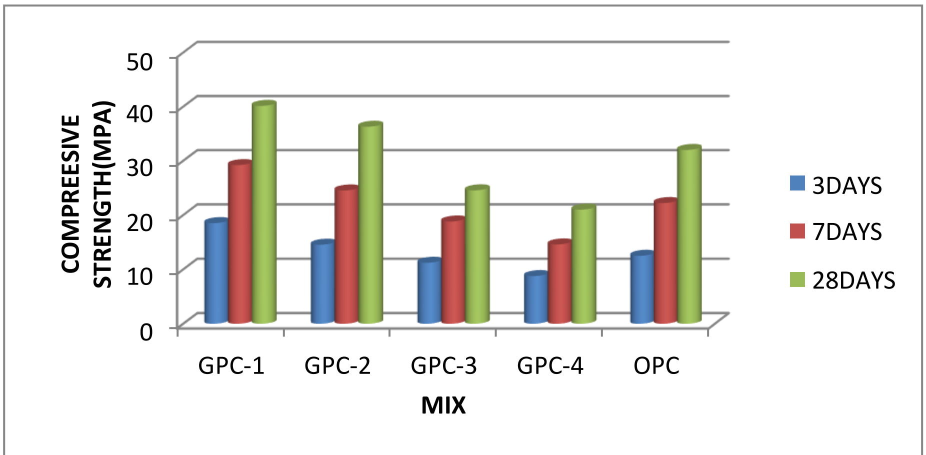

Fig. 1: Compressive strength fluctuation for FA and RHA Mix

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It has been discovered that replacing 100 percent of the fly ash with cement results in a higher compressive strength than standard OPC. Also, rice husk ash replaces fly ash by 10%. Additionally provides greater compressive strength thanOPC. It can also be used to make geopolyerconcrete. The remaining two mixes, GC 3 and GC 4, were both unsuccessful.to give compressive strength (i.e. strength that is less) in comparison to OPC mixtures.

(B) Using Fly ash and RHA, investigate the effects of seawater and sea sand

Studying the impacts of fly ash and RHA in the preceding paragraph, it is clear that replacing fly ash with RHA in a 10% variation produces better strength than OPC. As a result, it's appropriate for GPC preparation. As a result, we used this proportion of RHA (10%) and Fly ash (90%) in this study. The compressive and flexural strengths are used to determine the effects of sea water and sea sand.

STRENGTH IN COMPRESSION

The compressive strength of geopolymer concrete in which fly ash and rice husk ash have completely replaced cement. Their compressive strength data are shown in the table below. The results demonstrate that the strength of the combination of sea sand and sea water is lower than the OPC. However, when combined with distilled water, River sand has a higher strength than OPC. In addition, when compared to OPC and control geopolymer concrete prepared using River sand and purified water, the remaining two combinations, GPC 3 and GPC 4, produce good results. As a result, these GPC combinations are used in actual applications, and their variations are depicted in the figure below.

Table No 9 Using Sea Sand And Sea Water To Increase Gpc's Compressive Strength

MixID	*RHS & Fly Ash*	*3 days (Mpa)*	*7 days (Mpa)*	*28 days (Mpa)*
GPC 1	sand from the sea and water from the	9.60	15.89	26.77
GPC 2	Sand from the river and distilled water	12.32	21.43	32.89
GPC 3	Sand from the sea and distilled water	12.00	22.21	31.17
GPC 4	Sand from the river and seawater	12.20	23.49	32.0
OPC	Sand from the river and water from	12.50	22.20	32.0

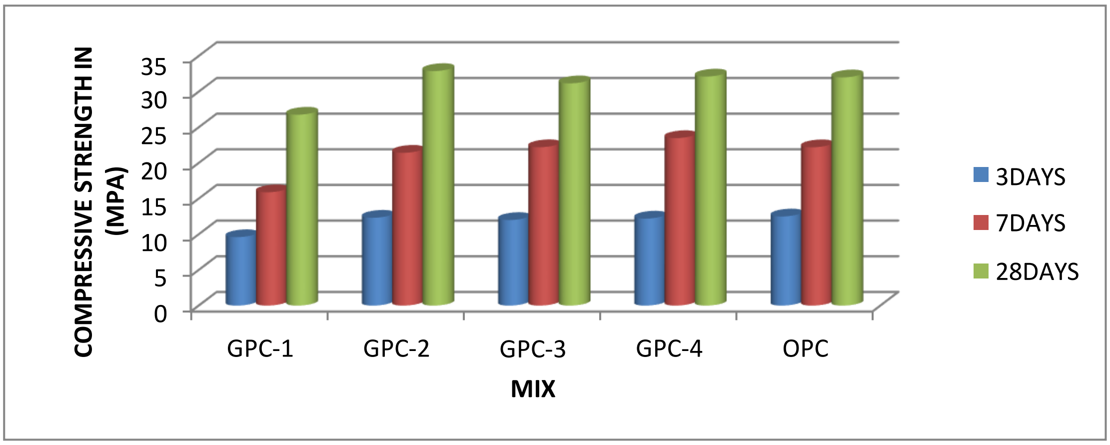

Fig. 2 Compressive strength fluctuation for FA and RHA Mix with sea water and sea sand

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STRENGTH IN FLEXIBILITY:

The flexural strength of geopolymer concrete built with sea sand and river sand with partial replacement was tested at the ages of 3, 7, and 28 days. In the table below, you'll find the various combinations. The mix of sea water and sea sand does not produce the desired result, according to the findings. Due to the use of river sand and distilled water, GPC 2 exhibits greater strength. In addition, when compared to Standard OPC, GPC 3 and 4 yield satisfactory results. As a result, GPC is utilized in these combinations in practice. Figure 2 illustrates the variation in flexural strength. We prepare one excellent product, called GPC pavers, in this project by combining several GPC mix combinations.

Table No 10 Gpc Pavers Compactive Strength

MixID	*RHS & Fly Ash*	*3 days (Mpa)*	*7 days (Mpa)*	*28 days (Mpa)*
GPC 1	sand from the sea and water from the sea	1.90	2.55	3.40
GPC 2	Sand from the river and distilled water	2.0	2.68	3.89
GPC 3	Sand from the sea and distilled water	2.18	2.46	3.75
GPC 4	Sand from the river and seawater	2.22	2.54	4.20
OPC	Sand from the river and water from the tap	2.16	3.0	4.00

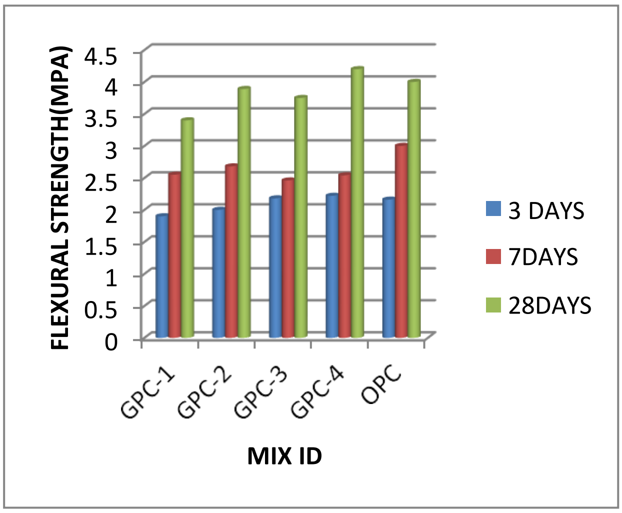

Fig.3 shows the effect of sea sand and sea water on GPC compressive strength**.**

(C) GPC paver strength qualities:

We prepare one excellent product, called GPC pavers, in this project by combining several GPC mix combinations. GP 1 and GP 2 mixes are utilised in this combination, with sea sand and distilled water in the first and river sand and sea water in the second. GPC pavers have a better Compressive Strength than Normal OPC Pavers for Both Combinations.

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TABLE 11 GPC PAVER STRENGTH SPECIFICATIONS

MIX	COMPOSITION OF MATERIALS	3DAYS(MPA)	7DAYS(MPA)	28DAYS(MPA)
GPC 3	Sand from the sea and distilled wate	12.50	21.78	31.45
GPC 4	Sand from the river and seawater	14.76	23.45	31.23
OPC	Sand from the river and water from the tap	12.32	21.87	31.18

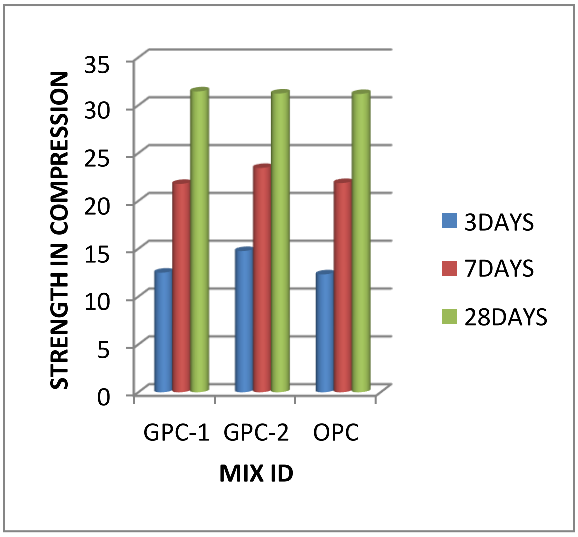

Fig.4 Illustrates the range in compressive strength for GPC pavers.

8. CONCLUSIONS

Replacement of 0 percent, 10%, 20%, and 30% RHA with fly ash geopolymer concrete, as well as 10% replacement of Fly ash with Rice husk ash based geopolymer concrete, results in higher compressive strength than the other alternatives. Furthermore, it has a higher compressive strength than normal Portland cement. As a result, the geopolymer concrete develops a lot of early strength. The strength of geopolymer concrete created with sea sand and sea water in the same mix is considerably lowered, and it fails to show good strength results. In comparison to control geopolymer concrete prepared with River sand and distilled water, the flexural and compressive strength of sea sand & distilled water and River sand & saltwater in such a combination of mixes is satisfactory. Furthermore, the strength exceeds that of typical Portland cement's compressive strength. When comparing conventional OPC concrete to each of these combinations, the following compressive strength at 7 days was higher than the compressive strength at 28 days. As a result, real applications employ these types of combinations.Geopolymer concrete Pavers with minimal calcium fly ash have exceptional compressive strength in a short time and are suitable for a variety of applications. The GPC paver block had a better strength at the seventh day than the OPC paver block had at the 28th day. As a result, it's reasonable to assume that GPC pavers achieve early strength before OPC pavers. The GPC pavers are made up of several mixtures, such as sea sand and distilled water in one and river sand and sea water in the other. In comparison to OPC pavers, the strength of such mixtures is greater. As a result, these pavers are employed for practical purposes. It is apparent that

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locally available elements like sea water and sea sand are employed in the manufacturing of geopolymer concrete and mortar for coastal construction.

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CHARACTERISTICS OF CONCRETES REINFORCED WITH STEEL FIBRES IN SHEAR, COMPRESSIVE, AND WORKABILITY

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ABSTRACT

Concrete's shear strength refers to its capacity to withstand forces that cause parts to slide past one another at an internal plane. The grade of the concrete, the proportion of fibres, and the proportion of tension steel in the beams all affect the shear strength. One of the goals of the current experimental study is to use push-off specimens to measure the variation in shear strength of concretes of grades M30 and M60 with and without steel fibres and with varied volume percentages of steel fibres. The current investigations show that for both concrete grades, an increase in the volume % of steel fibres results in an increase in shear strength. As the percentage of fibres rises, it is seen that the workability decreases. When the proportion of steel fibres in concrete increases, it is noticed that the concrete's compressive strength initially rises, but after a certain point, it falls.

Keywords- Shear strength, Compressive strength, Workability, Steel fibres, Push-off specimen, Concrete

1. INTRODUCTION

One of the most frequently utilised structural materials worldwide is concrete. It is made of water-mixed cement, admixtures, fine and coarse aggregates, and aggregates. The ability to withstand forces that tend to cause one element to slide over another at an internal plane is known as a material's shear strength. In addition to bending moments, many concrete members utilised in practise are also susceptible to shear stresses.. The grade of the concrete, the proportion of fibres, and the proportion of tension steel in the beams all affect the shear strength. By applying uniaxial compression to push-off specimens, one can evaluate the shear strength of concrete. A handful of the many researchers who have conducted investigations on the shear strength of concrete are briefly described here. FRP strips, according to Rahele Naserian et al. (2013), increased the push-off specimens' shear capacity. Compared to the control specimens, the slip (shear displacement) of the specimens with FRP strips was The grade of the concrete, the proportion of fibres, and the proportion of tension steel in the beams all affect the shear strength. By applying uniaxial compression to push-off specimens, one can

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evaluate the shear strength of concrete. A handful of the many researchers who have conducted investigations on the shear strength of concrete are briefly described here. FRP strips, according to Rahele Naserian et al. (2013), increased the push-off specimens' shear capacity. Compared to the control specimens, the slip (shear displacement) of the specimens with FRP strips was The use of steel fibres increased the concrete's strength and ductility. The quantity of stirrups needed can be decreased when steel fibres and steel stirrups are used together. In his investigation, Mariano O. Valle (1989) used push-off fibre reinforced concrete specimens made of high strength and normal strength concretes. Steel and polypropylene fibres were the two types of fibres that were employed. In comparison to normal strength concrete, fibres were found to be more effective at increasing shear strength in high strength concrete. Tan K. H. and Mansur M.A. (1990) conducted experimental research to ascertain the impact of steel fibre and stirrup percentage on the shear capability of the push-off specimens. It was discovered that steel fibres improved the shear strength and load-deformation properties of the normal strength concrete more effectively. *Based on their research, Swamy R. N. et al. (1987) came to the conclusion that steel stirrups were superior to steel fibres at transferring shear in normal weight concrete. The list of references continues at the end of this essay. When compared to normal weight concrete, the literature that is currently available shows that steel fibres are more effective at improving the shear capacity of light weight concrete.* Steel fibres will, as a result, help concrete function better structurally. The limited number of studies on the impact of steel fibres on the shear strength, compressive strength, and workability of concrete is another finding of the existing literature. In light of this, the primary goal of the current experimental effort was to compare the shear strengths of ordinary concrete and steel fibre reinforced concrete (SFRC) for different volume proportions of steel fibres (Vf). Concrete grades M30 and M60 were employed. Additionally, the variation in compressive strength and workability for different fibre volume percentages was examined.

Ordinary Portland cement (OPC) of grade 53 was employed in the current project. Used were fine aggregates completely retained on a 150 sieve size and passed through a 4.75mm sieve size. As a fine aggregate, naturally occurring river sand from the area was utilised. According to IS: 2386- 1963, the specific gravity and fineness modulus of fine aggregate were calculated. Fine aggregates were found to have a specific gravity of 2.63 and a fineness modulus of 3.65%. According to Indian code IS: 383-1970, the fine aggregates utilised were judged to be in compliance with zone II. As coarse aggregates, crushed quarry stones with a nominal size of 20 mm and below were employed. According to IS: 2386-1963, testing on coarse aggregates were done. The fineness modulus, water absorption, and specific gravity of coarse aggregate were all found to be 2.59, 4.24, and 0.45 respectively. Used was the superplasticizer "Master Glenium ACE 30(IT)" from BASF India Ltd. in Bengaluru. Typically, the manufacturer advises using 500 to 1200 ml per 100 kg of cementitious material. Concrete was mixed with and dried using potable water. In this work, steel fibres of the crimped round variety

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were employed. Table 1 lists the physical characteristics of the OPC cement and the characteristics of the fibres utilized in this work. Table 1: Properties of Cement and Steel Fibres Used.

Sl. No.	Particular	Value
Properties of CEMENT		
1	Specific gravity	3.09
2	Fineness (%)	8
3	Normal consistency (%)	30
4	Setting time (in minutes)	
Properties of STEEL FIBRES		
1	Fiber type	Crimped
2	Length	30 mm
3	Diameter	0.5mm
4	Density	7850 kg/m^3
5	Tensile strength	940 MPa
6	Aspect ratio	60

Using the IS: 10262-2009 method of mix design, the mix proportions for classes M30 and M60 were determined. The obtained mix proportion for M30 concrete with superplasticizer [Master Glenium Ace 30(IT)] was 1:2.20:2.96 with a w/c ratio of 0.40, and for M60 concrete with a w/c ratio of 0.30. The percentage of steel fibre ranged from 0% to 1.5%. For the M30 and M60 grades, the superplasticizer (Master Glenium Ace 30 (IT)) was applied in dosages of 0.5 and 0.7 liters/100 kg of cement, respectively. The amounts of components used for M30 and M60 grade concretes are shown in Table 2.

Sl. No.	Material	Quantity in kg/m^3
M30 grade Concrete		
1	Cement	369.40
2	Fine Aggregate	814.00
3	Coarse Aggregate	1094.50
4	Water	147.75
5	Super plasticizer	1.85
M60 Grade Concrete		
1	Cement	443.25
2	Fine Aggregate	767.46
3	Coarse Aggregate	1091.80
4	Water	141.82
5	Super plasticizer	3.10

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2.METHODOLOGY AND TESTS

Compressive Strength and Workability of Concrete

were 150 mm 150 mm 150 mm squares. Axial compression was used to compress them. the test specimens utilised by the compression testing machine to measure compressive strength. The workability of fresh concrete was assessed using the slump test in line with the applicable Indian Standard requirements.

Shear Strength

Direct shear force was applied to a push-off specimen to assess the shear strength of the concrete. Concrete is tested for shear transfer strength using a specimen that measures 230 mm by 150 mm by 150 mm and is compressed uniaxially in a compression-testing equipment. The ratio of the maximum shear force at which a specimen fails to the maximum shear area of a push-off specimen is known as the shear strength of concrete. The examples were created to make sure that unwanted failure modes caused by bending or compression do not occur when concrete fails in shear at the shear planecompression are abstained from. Figure 1 illustrates typical specimen dimensions for push-off and a failed specimen along the shear plane under loading.

Shear strength (τ) = Ultimate shear force/ Shear area

1.Typical Dimensions of Push-off Specimen Used and a FailedSpecimen under

3. RESULTS AND DISCUSSION

Effect of Steel Fibres on Workability of M30 and M60: The usual slump test was used to gauge the workability of both concrete grades. Figure 2 depicts the variation in slump values for concrete grades M30 and M60 with different fibre volume percentages (Vf). For M60 grade concrete, it has been observed that the slump value decreases to zero at about 1% of the fibre volume percentage and stays at zero thereafter. An increase in the volume percentage of fibres also lowers the slump value

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in M30 concrete. The workability of concrete is shown to decrease as the volume % of fibres rises; this pattern is consistent with findings from past studies.

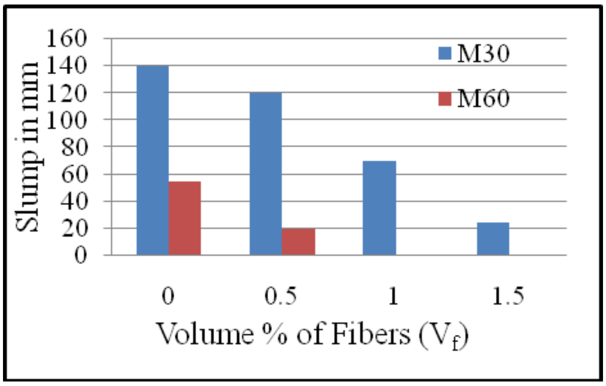

Fig.2: Slump Test Results for M30 and M60 Grades of Concrete

Compressive Strength of Concrete

Table 3 displays the results of the compressive strength test for concrete grades M30 and M60 after 14 and 28 days of curing. For M30 grade, it has been observed that the compressive strength initially raises, peaks at 1% fibre content, and then falls for both 14 and 28 days of curing. Peak strength for concrete of the M60 grade occurs at 0.5% of fibres for both 14 and 28 days of cure. Over 1% of steel fibres results in a decrease in compressive strength.

Table 3: Results of Compressive Strength Test on M30 &M60 Grades of Concrete

Sl. No.	Fibre Content(%)	Compressive Strength forM30 grade of concrete in N/mm^2		Compressive Strength for M60 grade of concrete in N/mm^2	
		14days	28days	14days	28days
1	0.0	33.37	35.25	60.22	67.12
2	0.5	34.87	38.10	60.78	68.40
3	1.0	35.25	38.78	60.78	68.20
4	1.5	33.26	34.00	49.32	50.85

Shear Strength of Concrete Using Push-Off Specimens

Table 4 displays the shear strength values for M30 and M60 concrete grades for various fibre volume percentages that were determined experimentally using push-off specimens in the current work. It can be seen that the shear strength of fiber-reinforced concrete at 14 and 28 days grows monotonically with an increase in fibre %.

Table 4: Experimental Values of Shear Strength of M30 &M60 Grades of Concrete

Sl. No.	Fiber Content(%)	Shear Strength (τ) for M30 grade concrete inN/mm^2		Shear Strength (τ) for M60 grade concrete inN/mm^2	
		14days	28days	14days	28days
1	0.0	7.66	8.17	3.33	5.50
2	0.5	7.83	9.33	6.00	6.50
3	1.0	9.17	10.00	8.50	8.50
4	1.5	10.67	11.17	9.33	10.33

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For both the M30 and M60 grades of concrete, various fibre content percentages must be dried. The test findings demonstrate that the shear strength of concrete of grade M60 is much lower than that of concrete of grade M30 with no fibre component. Due to the greater water-cement ratio utilised in M30 concrete, which creates superior bond strength and shear transfer strength along the shear plane than M60 grade concrete, this may be attributed to good aggregate interlocking with cement paste. It is evident that adding fibres to concrete of the M30 and M60 classes boosts the material's shear strength. As the percentage of fibres increases, concrete's shear strength rises as well. The improvement in shear strength of grades M30 and M60

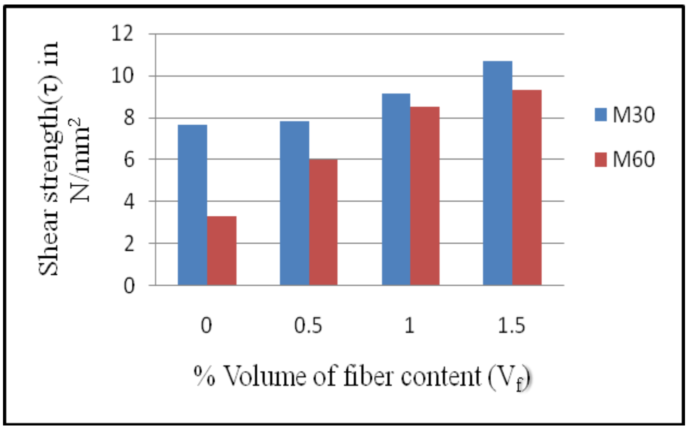

Fig.3: Variation of Shear Strength of M30 & M60 Grade of Concrete with Volume % of Fibres at 14 Days Curing

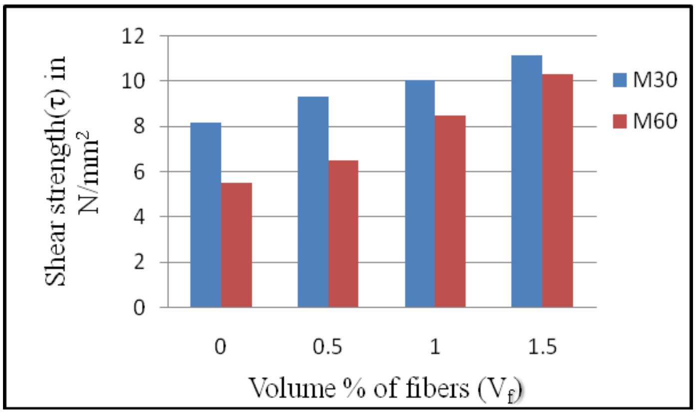

Fig.4: Variation of Shear Strength of M30 & M60 Grade of Concrete with Volume % of Fibres at 28 Days Curing

Also noted were the specimens tested in the current work's first cracking load and failure modes. The first cracking load and failure modes were seen to improve with the inclusion of fibres. In the case of both M30 and M60 grades of concrete, the failure modes of fiberless concrete specimens were brittle with little warning before failure. These specimens split into multiple parts and lost their integrity.

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4. CONCLUSIONS

These inferences are made in light of the current experimental work:

1. As the volume % of fibres increases, the slump value/workability of both M30 and M60 grades of concrete drops.
2. For both the M30 and M60 classes of concrete, the compressive strengths at 14 days and 28 days of curing rise initially with an increase in volume % of fibres. From the perspective of compressive strength, a fibre content of between 0.5% and 1.0% is ideal. Beyond 1.0 percent, the compressive strength starts to decline.
3. The shear strength of concrete grows monotonically as the volume % of fibres rises.
4. To answer the question of the ideal fibre proportion to employ in practise, take into account simultaneously the workability, compressive strength, and shear strength. A value of 1% of steel fibres may be suitable and used in practise if workability is addressed by adding superplasticizer.|
5. The ductility, failure pattern, and load at first cracking of concrete are all improved by the inclusion of fibres.

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SUSTAINABLE MANAGEMENT OF WASTE COCONUT SHELL AGGREGATES IN CONCRETE MIXTURE

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ABSTRACT

This study focuses on generating product using agricultural waste as well develop an alternative construction material that will lessen the social and environmental issues. It also paved the way to the recognition of using coconut shells and fiber as substitute for aggregates in developing concrete hollow blocks. This paper presents the result on the workability and compressive strength of concrete containing various percentage of coconut shell content as partial aggregate replacement. Workability test and compressive strength test were conducted in accordance to ASTM C136 and ASTM C137 respectively. Results show that replacement of appropriate coconut shell content able to produce workable concrete with satisfactory strength. Integration of coconut shell enhanced the strength of concrete making it to be the highest as compared to conventional concrete mixture.

Keywords: Coconut shells, construction materials, hollow blocks, recycled materials, technical specification

1. INTRODUCTION

Concern for sustainable development has emerged as one of the major societal issues of the late 20th century. This pertains among others to environmental issues and the conservation of natural resources. The beginnings of this awareness are difficult to pinpoint, but it is clear that it did not originate in the United States, where a public accustomed to an abundance of natural resources was relatively late to realize the limits of these resources and the real costs associated with their wasteful exploitation. But at present, environmental consciousness is being encountered in all walks of life. In the construction industry, increasing attention is being paid to the concept of “green buildings”.

The search for “green” or environmentally friendly materials in the building industry involves the development of new materials, but might also lead to the reconsideration of traditional ones

The use of coconut by products has been a long time source of income for some people in the country. The coconut has many uses. The fruit itself is used in many industries not only as food but for other uses as well. The energy industry has also seen the potential of the coconut as the coco-diesel was created as an alternative to the fossil fueled oils the Philippines import. Aside from its ornamental use, the shell

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has been powdered and used as glues and its charcoal form was used as activated carbon and used as filter material for masks and air-conditioning systems. In the construction industry, the husk is used as a mat in pre- venting the erosion of soils. Boards are created from the husk of the coconut by acquiring the fibers from the husk.

The high cost of construction materials like cement and reinforcement bars, has led to increased cost of construction. This, coupled with the pollution associated with cement production, has necessitated a search for an alternative binder which can be used sorely or in partial replacement of cement in concrete production. More so, disposal of agricultural waste materials such as rice husk, groundnut husk, corn cob and coconut shell have constituted an environmental challenge, hence the need to convert them into useful materials to minimize their negative effect on the environment. Research indicates that most materials that are rich in amorphous silica can be used in partial replacement of cement. It has also been established that amorphous silica found in some pozzolanic materials reacts with lime more readily than those of crystalline form. Use of such pozzolana can lead to increased compressive and flexural strengths

.The American Society of Testing Materials (ASTM) defines Pozzolans as siliceous or aluminous materials which possess little or no cementitious properties but will, in the presence of moisture, react with lime [Ca (OH)] at ordinary temperature to form a compound with pozzolanic properties. Recycling of the disposed material is one method of treating the agricultural waste. The used of coconut fiber and coconut shell could be a valuable substitute in the formation of composite material that can be used as a housing construction, such as concrete hollow block [1].

Coconut is famous as multi-function plant that all parts of its plant can be used for various activities [1], [2]. The use of this agricultural waste due to an assumption is that it can replace the existing material used in commercial product in order to reduce cost or improve mechanical proper-ties of the composite material. Industrialists in most of the coconut producing countries hail the economic, environ-mental and technological benefits of utilizing coconut farm wastes [2], [20]. On the farmers' side, agricultural residues can be a source of extra income. Traditionally, coconut farmers dispose the husks, spate, petiole and leaves by burning or allowing these farm wastes to rot in the field [1], [2]. However, worldwide interest in using farm residues for value-added products means that farmers can generate ad- additional income aside from amassing environmental dividends. Studies have shown that burning of agricultural wastes causes air pollution, soil erosion and even a decrease in soil biological activity that can eventually lead to decreased soil fertility [3] [21]. On the other hand, allowing farm residues to rot in the field may improve the productivity of the soil but the process of decomposition is very slow leading to accumulation of piles of agricultural wastes that can cause phytosanitary problem to the coconut plantation,

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since decaying debris is ideal breeding place for coconut pest like the rhinoceros beetle [2], [3].

Using agricultural and forest residues for industrial purposes is a much more environment-safe and friendly more than any other method of wastes disposal being commonly adopted nowadays. Research and development in the construction industry are shifting towards exploration of cellulose farm wastes and forest residues processing and production for building materials [3] [22]. The tremendous potential of agricultural and forest residues can be a solution to the problem of inadequate supply and high cost of conventional timbers and dependence from imported building materials. Current research and development efforts in the field of building materials should be supportive of policies of most governments that are aimed in the promotion of import substitution schemes, employment generation and self-reliance [3]. The enormous amount of residues that shall be generated from the farm and forest plantation would then make a stable source of alternative materials for the purpose of building affordable housing units for the majority of the country's population. Considered the most useful tree in the world, the coconut palm provides food, drink, clothing, shelter, heirloom his- tory, and financial security [3]. Hardly an inch of the coconut palm goes to waste in countries such as the Philip- pines where families rely on the coconut palm for survival and refer to it as the "tree of life."

The shell, husk, roots of the tree, fronds, flowers, and wood of the trunk are also become useful products. Char- coal filters used in gas masks and cigarettes are made from coconut shells that are burned, leaving pure carbon behind. Charcoal has the ability to trap microscopic particles and impurities and prevent absorption [4]. Charcoal made from coconut shells produces filters of exceptional high performance.

One third of the coconut's make-up is the hairy husk that is soaked in salt water until it is soft enough to spin into rope or twine that is known for its durability [5] [23]. The rope, called coir but pronounced coil, is highly resistant to salt water and does not break down like other fibers including hemp [6]. The coconut husk has household practicality in tropical countries where coconuts are part of almost every cuisine. The husk provides fuel for cooking as well as fiber for making clothing.

Building materials from agricultural and forest wastes are ideal for socialized or low-cost housing since these are generally cheaper than conventional materials [7] [24]. For ex-ample, residues from coconut plantation like husks, fronds and spate can be processed and transformed into excellent stabilized cement-bonded boards or wall panels and corrugated roofing sheets at a much reduced production cost than the conventional cement blocks, galvanized iron sheets, asbestos panels or plywood sheets. Likewise, rice hull/straw, corn stalks, abaca wastes and sugar cane bagasse are locally available materials that can be readily used in manufacturing cement-bonded boards. In addition, indigenous and small diameter trees like “bagalunga” and giant “ipil-ipil” are abundant in coconut plantations particularly in Mindanao, Philippines, either as intercropped or naturally-grown, which can be economically processed into cement-bonded boards [7], [25]. The availability of suitable materials

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is intimately linked to the development of a new product, such as producing a concrete hollow block using coconut fibers and shells. Generating this product using agricultural waste will introduce alternative construction materials with a low production cost and lessen the social and environmental problems [7], [8]. Modern construction technologies being developed, respond to ecological and social issues of excessive use of raw materials from nature. The main objective of this study will give partial re-placement for the aggregates and will determined the ability and benefits to the concrete hollow block when substitutes [26], [38]. The simple concrete block will continue to evolve as architects and block manufacturers develop new shapes and sizes. These new blocks promise to make building construction faster and less expensive, as well as result in structures that are more durable and energy efficient [8] [27]. Some of the possible block designs for the future include the biaxial block, which has cavities running horizontally as well as vertically to allow access for plumbing and electrical conduits; the stacked siding block, which consists of three sections that form both interior and exterior walls; and the heat soak block, which stores heat to cool the interior rooms in summer and heat them in winter [8] [28].

The researcher made this study to explore the use of coconut shells and fibers as an aggregate. Analyze the performance and the effectiveness of the coconut shells and fibers as aggregates in concrete hollow blocks in terms of physical properties like color, texture, size, and density and by mechanical properties like compressive strength, modulus of elasticity, absorption, thermal conductivity and fire resistance to obtain a design technical specification of concrete hollow blocks [7], [8].

Moreover, this study intends to provide a new point of view about concrete masonry that serves as an assurance with regards to economic crisis. The result of this study will provide and introduce an alternative construction material with a low production cost.

2. EXPERIMENTAL INVESTIGATION

Project Design

The experimental program covers series of physical property test like sieve analysis, specific gravity, moisture content and mechanical property test such as compressive test were undertaken in accordance with the ASTM [9], [29]. The coconut shell and fiber used in this re-search was taken along Rizal province. As shown in figure 1, the materials gathered were screened discarding foreign materials then placed in a container and sealed to preserved and retain its natural conditions in order to achieve an accurate data for the experiment. As the production starts, the required amounts of sand, coconut shell, fiber and Portland cement are measured to obtain the proper amounts of each material. After the dry materials are blended a small amount of water is added. The concrete is then mixed for six to eight minutes. Once the load of concrete is thoroughly mixed, it is dumped into an inclined bucket conveyor and transported to an elevated hopper [30]. [31]. On top of the block machine at a measured flow rate, the concrete is

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forced downward into molds. The molds consist of an outer mold box containing several mold liners. The liners determine the outer shape of the block and the inner shape of the block cavities. . When the molds are full, the concrete is compacted by the weight of the upper mold head coming down on the mold cavities [10] [32]. Most block machines also use a short burst of mechanical vibration to further aid compaction. The compacted blocks are pushed down and out of the molds onto a flat steel pallet. The pallet and blocks are pushed out of the machine and places them in a curing rack. The blocks are pushed off the steel pallets, and the empty pallets are fed back into a block machine to receive a new set of molded blocks.

Table 2 and figure 2 show the passing percent of coconut shell and fiber according to the size dictated by the hole-size of the sieve, and thus separated into different classifications of sizes [13], [16] [35].

Table 2. Sieve analysis of coconut shells and fibers

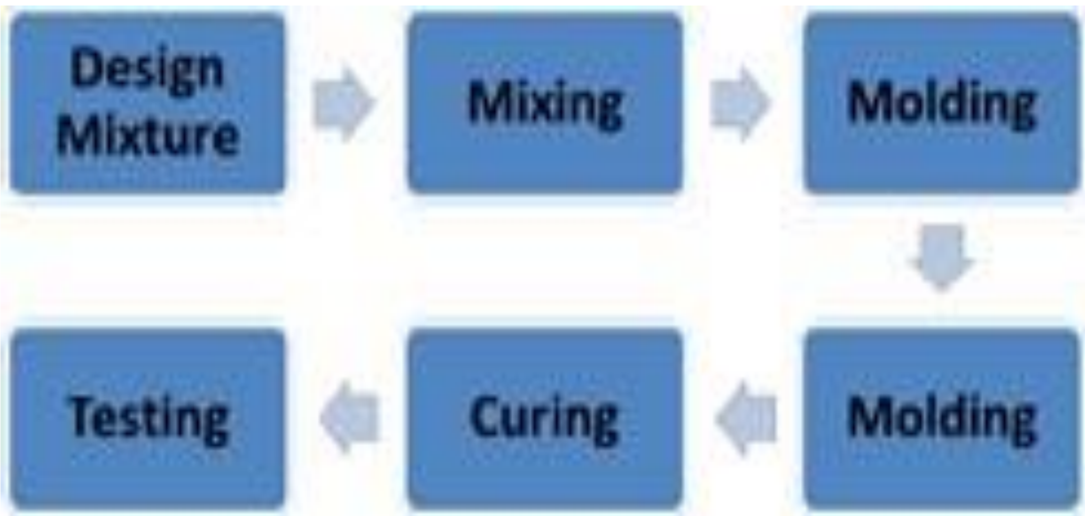

Fig. 1. Project design

Project Development

As shown in figure 3, the researcher develops this experiment through collecting coconut shells and fiber. If gathered materials are wet, it will undergo drying process, or if dry it will be directly screened to discard foreign materials. Shells are crushed and fibers are stripped from coconut husk, after crushing and stripping it will be screened again to discard foreign materials. Physical property is observed through sieve analysis, if it will confirm with the standards [11], [33]. Concrete hollow block sample is done by mixing crushed coconut shell and fiber, sand and cement. Mixture is poured to the machine to form a 4 inches concrete hollow blocks. The next stage is curing the specimen for 7, 14 and 28 days [11], [12], [39]. On the said

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dates the specimen will undergo laboratory test such as compressive strength test, moisture content, and absorption.

Sieve No.

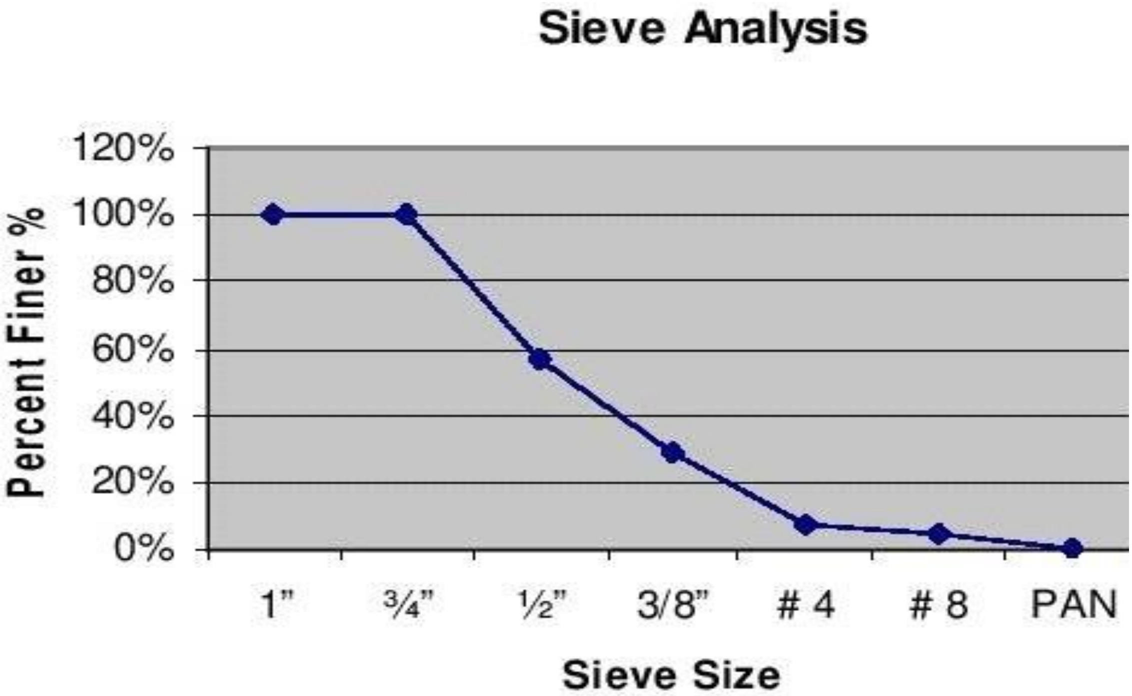

Fig. 2. Sieve analysis of coconut shells and fiber

3. RESULTS AND DISCUSSION

Physical Properties of Concrete Hollow Blocks (CHB) Table 1 shows the physical properties of commercial CHB and CHB with coconut shell and fiber. The color is simply observed through visual inspection. CHB with coconut and fiber is much darker than the commercial CHB. The texture of both specimens are absolutely rough, they are the same with this property. Both CHB has a dimension of 100mm x 400mm x 800 mm. It is commonly used material for construction purposes such as wall panels and partitions. Moreover, CHB with coconut shell and fiber has a density of 1213.59 kg/m³ while commercial CHB has a density of 1529 kg/m³.

Property	Commercial CHB	CHB with coconutshell and fiber
Color	Gray	Dark Gray
Texture	Rough	Rough
Size	100 x 400 x 800mm	100 x 400 x 800mm
Density	1529kg/m^3	1213.59 kg/m^3

Table 1. Physical properties of CHB

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Mechanical Properties of Concrete Hollow Blocks(CHB)

As shown in table 3 and figure 4, the compressive strength of CHB w/ coconut shell and fiber in 7 days of age reached a load capacity of 34.42 KN to 43.5 KN, and stress capacity of 1.67Mpa to 2.11Mpa. For 14 days of age reached a load capacity of 48.02 KN to 60.25 KN and a stress capacity of 2.33MPa to 2.92MPa. For 28 days of age reached a load capacity 65 KN to 84.99 KN and a stress capacity 3.16MPa to 4.13MPa. This signifies that the number of aging requirements was achieved [14], [15], [34].

As shown in figure 5, the commercial CHB, in 7 days of age reached a load capacity of 11.65 KN to 17.58 KN, and stress capacity of 0.57MPa to 0.8MPa. For 14 days of age reached a load capacity of 14.71 KN to 20.24 KN and a stress capacity of 0.71MPa to 0.98MPa. For 28 days of age reached a load capacity 25.09 KN to 27.07 KN and a stress capacity 1.22MPa to 1.31MPa. This signifies that the number of aging requirements was achieved.

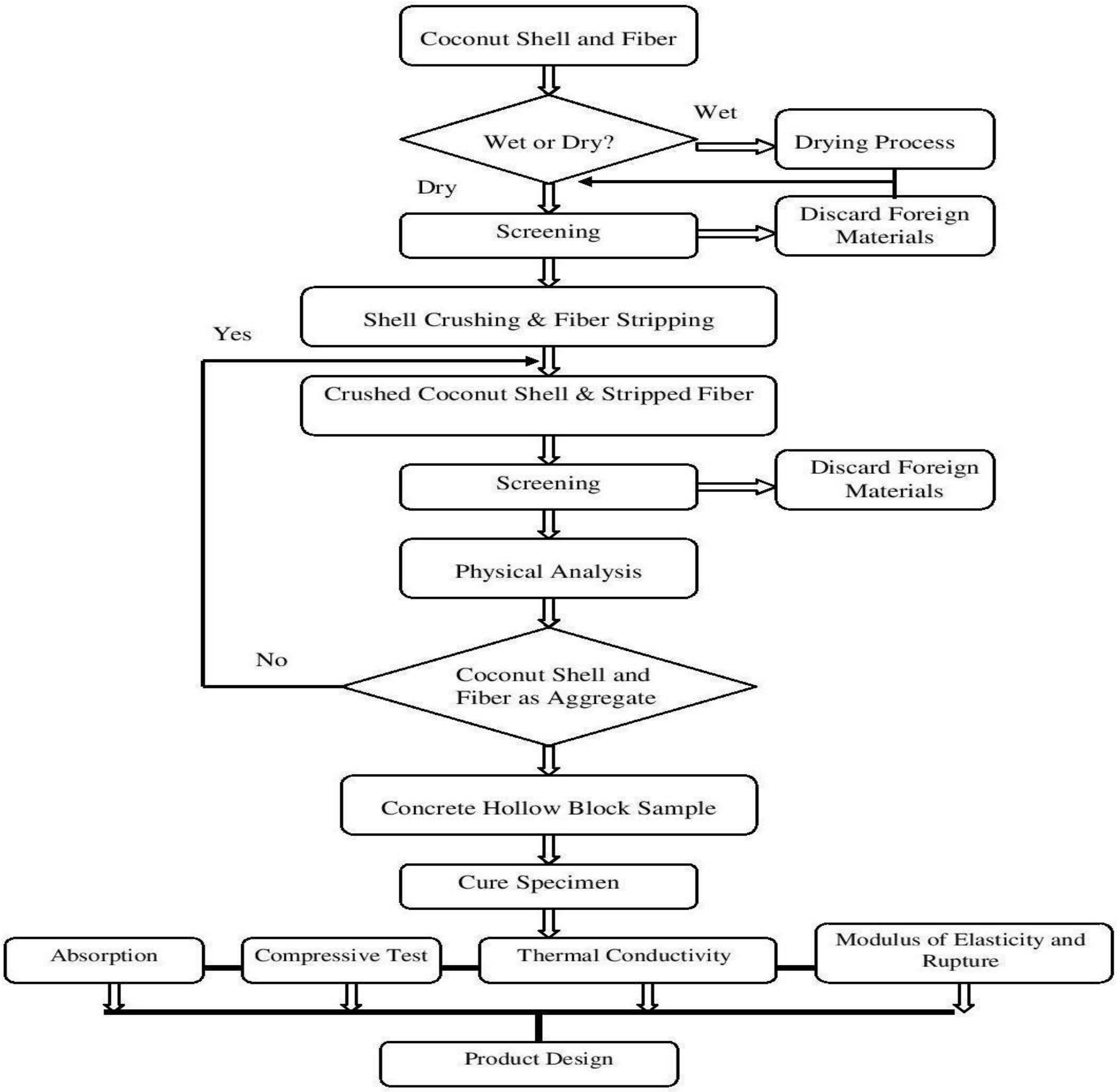

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Fig. 3. Project development

Time (days)	Commercial CHB			CHB with coconut shelland fiber		
	Specimen	Load(KN)	Stress(MPa)	Specimen	Load (KN)	Stress(MPa)
	1	17.58	0.8	1	43.5	2.11
7	2	11.65	0.57	2	34.42	1.67
	3	15.07	0.73	3	37.56	1.82
	1	20.24	0.98	1	48.02	2.33
14	2	14.71	0.71	2	60.25	2.92
	3	14.9	0.72	3	50.74	2.46
	1	27.07	1.31	1	65.00	3.16
28	2	25.09	1.22	2	75.63	3.67
	3	26.09	1.27	3	84.99	4.13

Table 3. Compressive strength test of commercial CHB andCHB with coconut shell and fiber

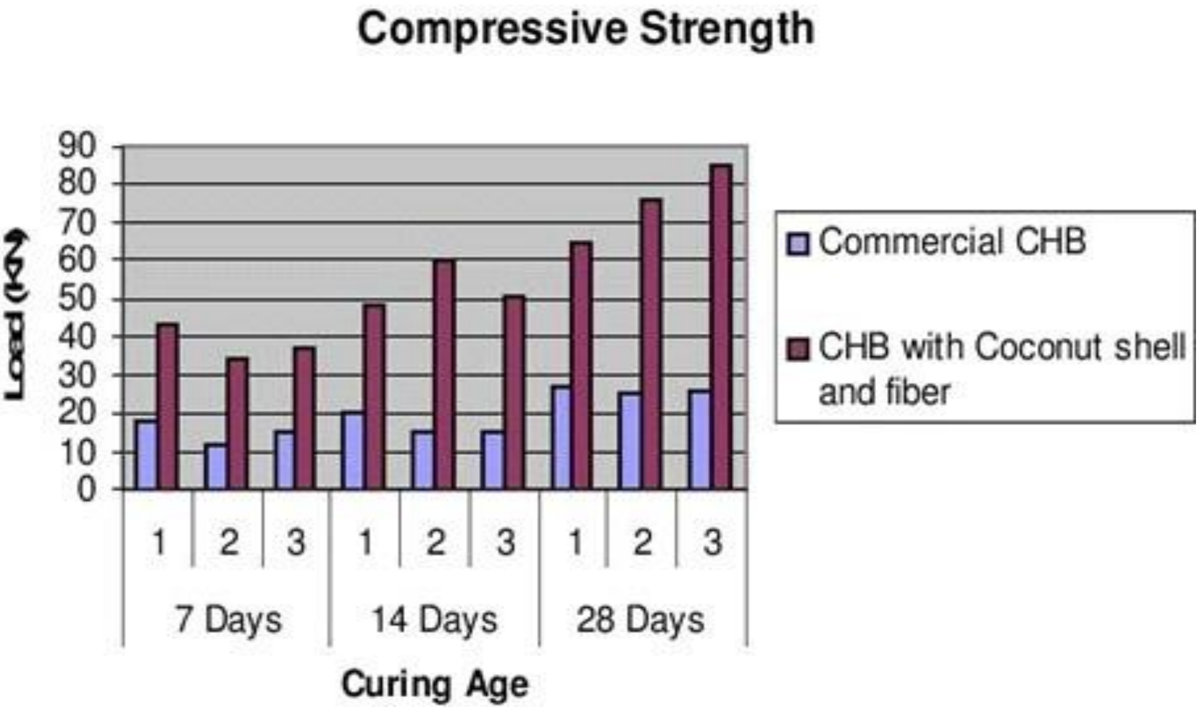

Fig 4. Compressive strength of commercial CHB and CHB withcoconut shell and fiber 7th, 14th and 28th days of curing

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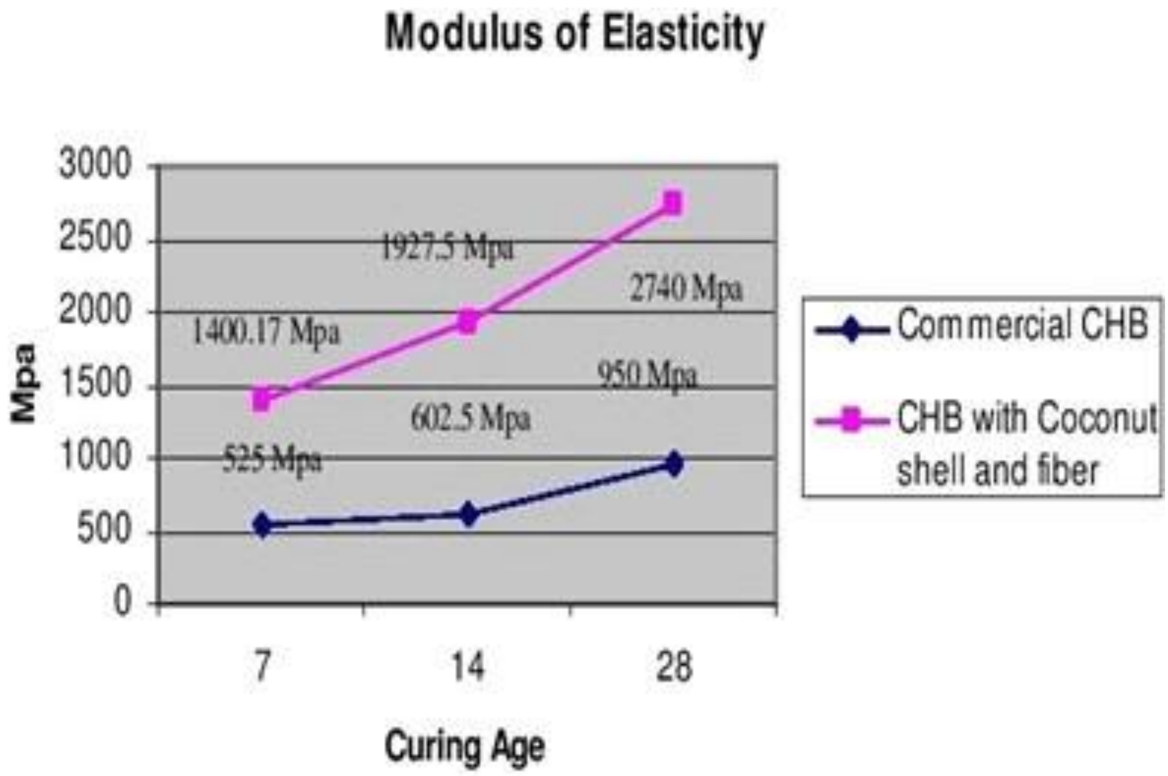

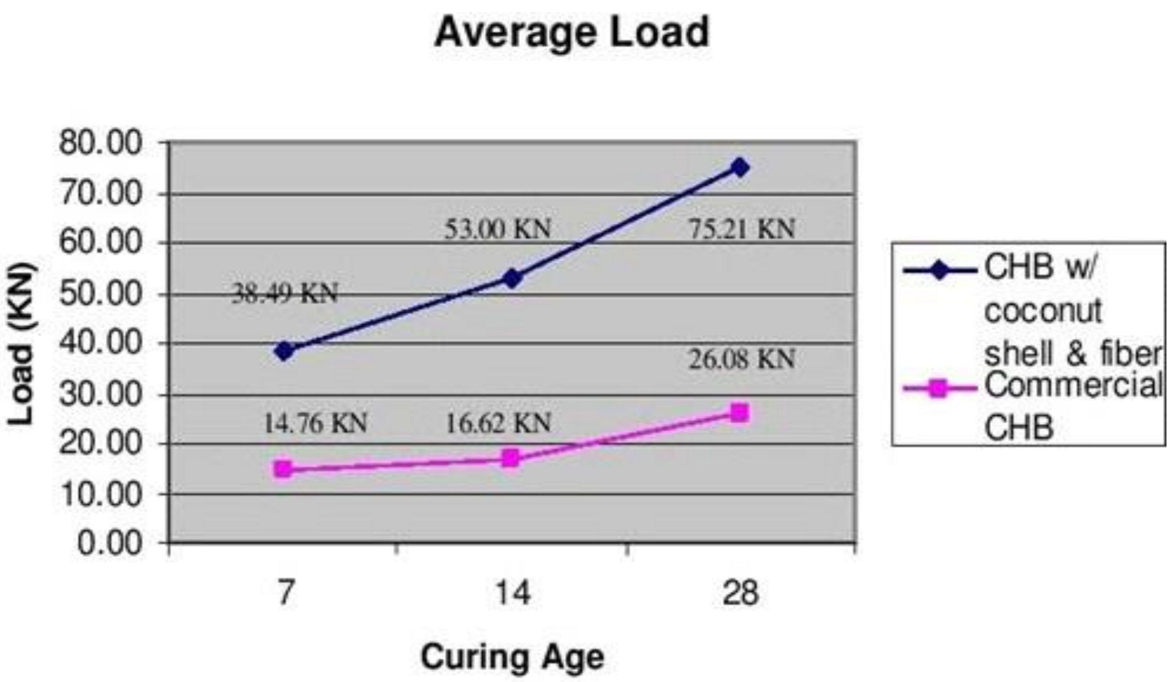

Fig. 5. Average Loads of CHB w/ coconut & fiber and commercialCHB after 7th, 14th and 28th days of curing

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Table 4 and figure 6 show that the average modulus of elasticity of CHB w/ coconut shells and fiber for 7^{th}, 14^{th} and 28^{th} are 1400MPa, 1927.5MPa and 2740MPa while commercial CHB for 7^{th}, 14^{th} and 28^{th} days has an average modulus of elasticity of 525MPa, 602.5MPa, and 950MPa. Using modulus of elasticity for concrete unit masonry, $\hat{E}_m = 750\ f$ ‘m and must not be greater than 20.5GPa [12], [19], [36]. Based from the results CHB w/ coconut shell sand fiber has greater modulus of elasticity rather than commercial CHB.

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Table 4. Modulus of elasticity of commercial CHB andCHB with coconut shell and fiber

Time (days)	**Modulus of Elasticity (MPa)**		
	Specimen	**Commercial CHB**	**CHB with coconutshell and fiber**
	1	600.00	1582.50
7	2	427.50	1252.50
	3	547.50	1365.50
	1	735.00	1747.50
14	2	532.50	2190.00
	3	540.00	1845.00
	1	982.50	2370.00
28	2	915.00	2752.50
	3	952.50	3097.50

Fig. 6. Average modulus of elasticity after 7^{th}, 14^{th} and 28^{th} days ofcuring

Table 5 and figure 7 shows that the average modulus of rupture of CHB with coconut shell and fiber for 7th, 4th and 28th days are 0.392 MPa, 0.54 MPa and 0.40 MPa.

Table 5. Modulus of rupture of CHB with coconut shell andfiber

Time (days)	**Specimen**	**CHB with coconut shell and fiber**
	1	0.4431
7	2	0.3507
	3	0.3822
	1	0.4893
14	2	0.6132
	3	0.5166
	1	0.3733
28	2	0.4020
	3	0.4270

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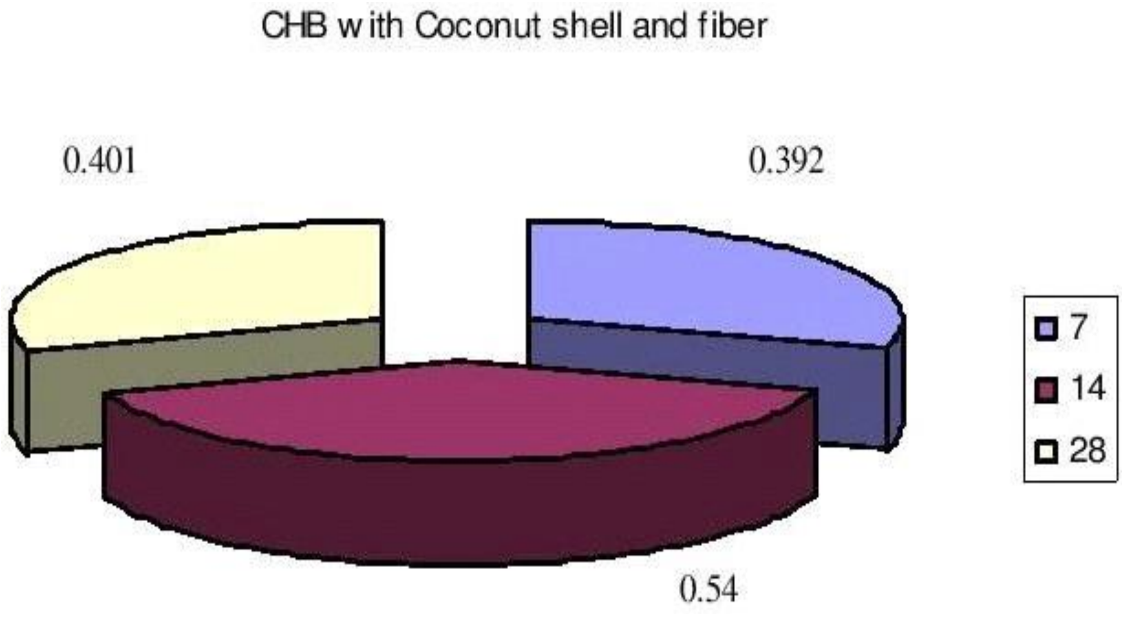

Fig. 7. Average modulus of rupture after 7th, 14th and 28th days of curing

Table 6 shows that CHB with coconut shell and fiber have lesser moisture content and water absorption than the commercial CHB.

Table 6. Moisture content of concrete hollow blocks

Specimen	Commercial of CHB	CHB with Coconut shell and fiber
Weight (Kg)	5.2	7.8
Oven dry weight		
(Kg)	5.0	7.6
Saturated weight		
(Kg)	5.4	7.8
% Moisture content	8.0	5.41
% Water absorption	4.0	2.63

Table 7 shows that CHB with coconut shell and fiber can resist freezing gained a large value of load. In cold temperature, CHB with coconut shell and fiber has a load capacity of 96.69 KN and stress capacity of 4.69 MPa

Table 7. Thermal conductivity at cold temperature

Table 8 shows that even in high temperature condition, CHB with coconut shell and fiber can resist. It was subjected to compressive test to determine if the strength will change [17], [18]. In warm temperature, CHB with coconut shell and fiber has a load capacity of 50.47KN and stress capacity of 2.97MPa

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Table 8. Thermal conductivity at warm temperature

Specimen	Weight (Kg)	Load (KN)	Stress (MPa)
1	6.8	50.47	2.97
2	9.4	59.98	2.97

Table 9 shows that the specimens are subjected to a high degree of temperature for a certain period of time. It was subjected to compressive test to determine if the strength will change. Data's gathered shows that CHB with coconut shell and fiber can resist in fire. This means that CHB with coconut shells and fiber can resist in high degree of temperature [19]. [37]. [40]. The results at 28th days attained an average load capacity of 64.15 KN and 3.175 MPa for average stress.

Table 9. Fire resistances of CHB with coconut shell andfiber.

Specimen	Weight (Kg)	Load (KN)	Stress (MPa)
1	9.8	68.32	3.38
2	9.4	59.98	2.97

Good Indicators	Significance
• Particles shape andTexture.	Affects workability of freshconcrete.
• Resistance tocrushing.	In high strength concrete,aggregate is low in crushingvalue. This will not give highstrength even though cement strength is higher.
• Absorption andsurface moisture	Affects the mix proportions andcontrol water content to maintain water-cement ratio
• Grading	Economizes cement content andimproves workability.
• Resistance to freezing and heating.	Where frost action deteriorates concrete due to alternate freezing and heating.
• Lightweight	Reduce weight of structure.




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Fig 8. Preparation of CHB with coconut shell and fiber

Fig. 9. Molding of CHB with coconut shell and fiber

Fig. 10. Commercial CHB and CHB with coconut shell and fiber

5. CONCLUSIONS

This early study found that addition of coconut shell as partial aggregate replacement reduces the concrete workability owing to its shape and rougher texture. However, it is interesting to note that replacement of natural coarse aggregate by coconut shell resulted in the increase of compressive strength compared to conventional concrete mixture. Nevertheless, integration of too much of coconut shell produces harsher mix which causes difficulties to produce dense concrete thus disrupts the strength performance.

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DESIGN OF FLOATING TUNNEL

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ABSTRACT

An invention in transportation engineering called the submerged floating tunnel sets a new trend. In situations where using traditional techniques is not an option, it offers quick and simple access to transportation. When submerged tunnels and bridges are not cost-effective due to the water bed being excessively deep, stony, or highly undulating, SFT is used instead. A variety of loads are applied to SFT, which is based on the buoyancy principle. The intended strength, stiffness, and durability must therefore be considered when designing SFT. Analysis of the design is challenging because SFT has not yet been built. To analyse SFT under various environmental, accidental, and variable loads, numerous studies were carried out. To reduce the likelihood of damage, the structure must undergo constant review and inspection. To extend the life of SFT, proper repairs and replacements must be made without impairing the structure's functionality.

Search terms - Transportation, Principle of Buoyancy, Submerged Floating Tunnel

1. INTRODUCTION

To traverse waterways, bridges and underwater tunnels are frequently employed. The submerged floating tunnel (SFT) is a breakthrough in social and environmental development.SFT is also known as the Archimedes Bridge, suspended tunnel, and submerged floating bridge. Maximum depth of the river bed is 8 km, with an average depth of 3.3 km. When a bridge is built to cross a body of water, it is impractical to use support columns down to a depth of 8 km. The pressure will also be extremely high at 8 km of depth if a submerged tunnel is used, making survival impossible. To traverse waterways, bridges and underwater tunnels are frequently employed. The submerged floating tunnel (SFT) is a breakthrough in social and environmental development.SFT is also known as the Archimedes Bridge, suspended tunnel, and submerged floating bridge. Maximum depth of the river bed is 8 km, with an average depth of 3.3 km. When a bridge is built to cross a body of water, it is impractical to use support columns down to a depth of 8 km. The pressure will also be extremely high at 8 km of depth if a submerged tunnel is used, making survival impossible.

2. STRUCTURAL COMPONENTS OF SFT

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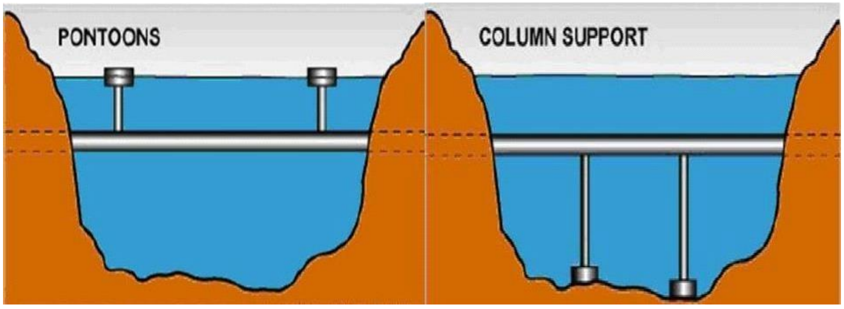
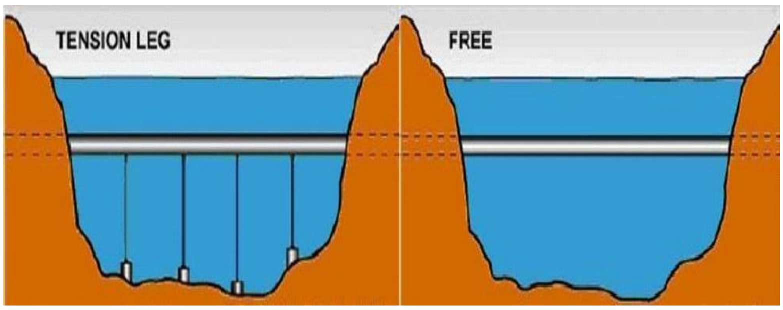
SFT is made up of many parts that support and manage forces acting on the structure. These are crucial for giving SFT the necessary strength and stiffness.SFT tube, an anchorage system, and shore connections make up the fundamental parts.

The tube's intended use is to transport equipment and traffic loads. Its cross sections might be round, elliptical, or polygonal, and its length ranges from 100 to 500 metres.To create the entire SFT structure, various tube sections are joined. Steel, concrete, or a combination of both materials make up the tube. A vertical curvature focused in the tube's midsection is the ideal shape for SFT tubes. During installation, shortening the tube is made simpler by this curve. The difference in buoyancy at the tube's midpoint causes slight bending to the tunnel. The amount of water present in the middle of the tube during installation also results in little bending and axial force.

Pontoons, columns, tethers to the water's surface, and unanchored systems are all options for the anchorage system. Wind, tide, wave, etc. have an effect on SFT anchored by pontoons. When the water depth is too great and column anchorage would be too challenging and expensive, pontoons could be offered. When the water is not too deep, column anchorage is used.



SFT tethers are offered under tension for all potential circumstances, and it is anticipated that no slack will impact the tether in all load conditions. The tether can be connected to the bottom of the water either vertically or obliquely. There is no support offered in the case of a unanchored SFT, besides at landfalls. The length of SFT will be constrained even though it can be used regardless of water depth.



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Strong connections are used to connect the SFT tube to the ground's highly stiff tunnel. These connections need to be able to prevent tube movement and shouldn't experience any form of stress. To keep water from entering the tube, the joints must be watertight. In regions where there is a high likelihood of earthquakes and landslides, appropriate precautions are also offered.

3. DESIGN PRINCIPLES OF SFT

SFT is made to transport live goods, dead loads, and traffic. It is therefore made with the utmost safety, longevity, and adaptability in mind. The buoyancy to weight ratio, resistance to flow, and lasting performances all play a role in the design of SFT. The best design strategy is also influenced by environmental and economic issues. The buoyancy to weight ratio should be less than 1 for good SFT design.Studies indicate that the number should range from 0.5 to 0.8.The SFT must meet requirements for strength, stiffness, and stability during construction and operation. To resist the hydrodynamics of SFT, the fluctuation of surface curvature should be mild, similar to the requirements for seismic protection of buildings.

4. CONSTRUCTION OF SFT

Despite the fact that the SFT's design is based on floating bridges and offshore structures, it is built similarly to an immersed tunnel. The prefabrication of SFT tubes, transportation, and installation of the tubes and support systems make up the three stages that make up the construction process.

The length of each portion of the prefabricated tube depends on the spacing of the fastening system and the circumstances surrounding transportation. The cross sectional dimension should be chosen such that it can include air channels, ventilation, escape routes, and space for carrying traffic. By using double walled portions, the tube's interior is kept airtight. The material and structure itself provide the watertight tube, which is required. Using high performance fibre reinforced concrete will help to prevent surface fractures while eradicating penetration cracks altogether.

5. STRUCTURAL DESIGN

Prefabrication, floating, installation, and operation are some of the processes that are involved in the construction of SFT. As a result of the complexity of the change occurring during these stages, the tube must be constructed after both longitudinal and transverse study. The tube is subjected to a variety of loads, including constant loads (such as the tube's own weight, buoyancy, and hydrostatic pressure), variable loads (such as vehicle, water head, temperature, and hydrodynamic loads), and accidental loads (caused by seismic activity, blast leaking, and shipwrecks).Wave and current loads are examples of hydrodynamic loads that result from water-tube interaction. The anchorage system conveys temperature, waves, currents, and vehicle loads. The ultimate limit state and serviceability limit state methods are the foundation of the

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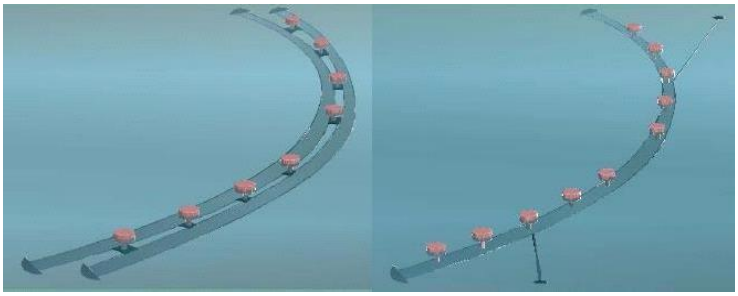
structural design of SFT. Its design is comparable to that of conventional hydraulic structures. Limit of fatigue

To analyse the stress and displacement under progressive damage situations, state theory, which is based on structural reliability theory, is employed.

The shape of the SFT can be circular, rectangular, or polygonal, with the latter two shapes being better suited to handling hydrodynamic forces. Tethers or pontoons balance the tube's vertical position. Vertical stiffness is added to the system by pontoons and vertical tethers, but horizontal stiffness is unsatisfied. For stability, the long, thin SFT tubes need enough horizontal rigidity. By using horizontal arching tubes or by including inclined tethers, one can increase the horizontal stiffness of a tube. When crossings are deep or wide, inclined tethers are expensive. This issue can be resolved by using two horizontal arches that are installed roughly parallel to one another. These structural links that connect the arches at regular intervals give space for one-way traffic and an escape route in the event of a fire. An alternative to the two tube system is the horizontal stiffening tendon system. Pre-tensioned tendons that are securely fastened to the shore are employed in this system.



Design of Tube Joint

During the building and operation phases, the joints in SFT should be watertight and not allow seepage. The joints must be capable of transferring the load throughout all phases of SFT operation. For optimal seismic performance, it should transfer stress and deformation during construction. Depending on the required stiffness and deformation, the joints can be either rigid or flexible.

Ventilation

Since the quality of the ventilation system affects the engineering cost and the environment inside the tube, the ventilation system in the tube should be properly designed. Major disaster relief systems are made possible by effective ventilation. As a result of lowering the quantity of dangerous gases like carbon monoxide, SFT ventilation creates a healthy environment inside the tube. In the event of a fire, it also aids in clearing the heat and smoke while enhancing visibility inside the tube. According to the studies, the design wind speed for a tunnel with one-way traffic should not exceed 10 m/s, and for a tunnel with two-way traffic, it should not exceed 8 m/s. Environmental protection guidelines should be followed when it comes to the noise that the ventilation fan an exhaust emission create inside the tube.

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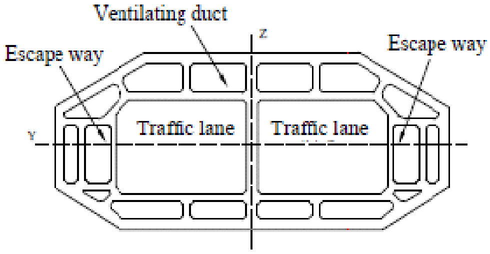
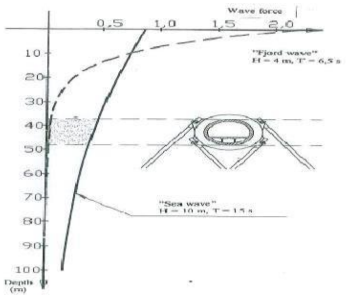


6. CHALLENGES IN DESIGN AND CONSTRUCTION OF SFT

Balance between dead load, moving load, buoyancy, and anchorage force is crucial for the SFT's stability. Environmental forces such as wind, current, and other such forces, in addition to these loads, also aid in the stability of SFT. Wave and current actions on the SFT result in fluid-solid coupling vibration on the structure and its constituent parts, which complicates structural analysis. The SFT tube and its components may experience corrosion issues as a result of ongoing exposure to a salty environment, which might result in structural collapse. The SFT also faces the difficulty of collision accidents, thus appropriate safety measures must be taken to lessen or eliminate the probability of accidents.

Wave Force

The Morison equation can be used to determine the fluid force acting on SFT. The layered integration approach is used to calculate how the horizontal and vertical wave forces change with depth. Studies done in the fjord basin have examined the durations and heights of various waves. The outcome reveals a significant discrepancy between wave period and associated wave height. As a result, the intensity of the wave force is dependent on the wave period; waves with a longer period produce stronger waves.



The figure's interpretation demonstrates that by putting the SFT at a significant depth, the effect of fjord wave force can be lessened, and that SFT placement for sea waves should be even deeper. Only decimeter-sized swell force results in the development of moderate wave force. Due to its flexibility, SFT may have high dynamic eigen periods. Therefore, it is necessary to prevent harmful resonance for long periodic resonance. Another source that generates lengthy periodic resonance is internal waves, which are

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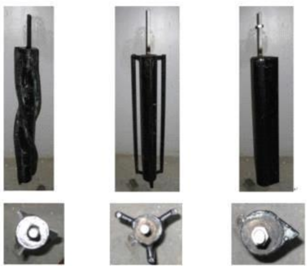
brought on by changes in water density brought on by salinity changes. With a lighter, denser layer on top of a denser layer, different layers are created.

Current Force

Both symmetrical and antimetrical current profiles result from the wide variations in current speed around the fjord's surface. The constant in line force created by the current as it interacts with the SFT tube has an intensity proportional to the square of the current velocity. This symmetrical current force is countered by the axial force created by the arched SFT tube. The strength of a tube's resistance is determined by its bucking capacity. The bending capacity of the tube or the addition of support tendons must be used to resist the antimetric current force because it does not produce axial force in the arched tube.

Vortex shredding occurs when the current force strikes an obstruction. When current flows through a cylindrical tube, the frequency of vortex shredding is inversely proportional to the current velocity. Vortex induced vibration (VIV), which is created when the frequency of the vortex reaches the inherent frequency of the tube, causes line and cross flow vibrations to occur. Vibrations caused by cross flow in tubes has to be minimised. This can be accomplished by using a tube with an outside diameter of 16 metres and a maximum current velocity of 1.5 metres per second. For the vertical vibration modes, a fundamental period of 30 seconds or less is offered. Because inline vibration is so low intensity, its only negative effects are fatigue. The instantaneous amplitude on tendons is impacted by the vibration in the SFT tube. Cross flow vibrations are inevitable for supporting systems like tendons and tethers. The fundamental period should be smaller than 3–4 seconds, and the tendon diameter should be set at 1 m. At the pertinent depth, the current velocity is decreased to 1 m/s. The tendons or cables should be inclined 45 to 60 degrees.By applying several techniques, such as selecting the proper structural characteristics, adding damping devices, or using disrupting flow devices, VIV on tendons can be completely eradicated. many obstructions to flow, including spiral fringe, The spiral fringe has the greatest impact on all working situations, whereas control rod and fairing operate on current direction, according to experiments using control rod and fairing. Galloping is a phenomena that happens when the current velocity is higher than the velocity needed to cause VIV. On the other hand, tubes having circular cross sections do not experience this phenomena.



Artificial Damping

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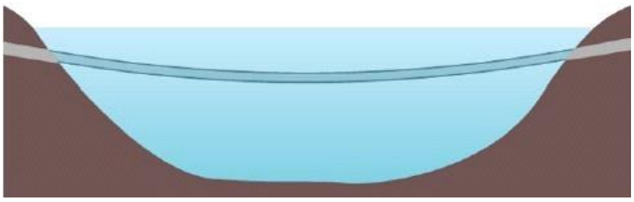
The SFT is subject to a variety of weak ambient forces that, unless they are amplified by a strong vibrating force, may not cause any harm to the system. Keep the basic eigen period lower than the period of force to reduce the challenge brought on by this vibration. However, by using this approach, more anchors will be needed with less space between them, increasing the cost of SFT construction. Artificial dampers can be added to the system as a fix for this issue, which will lessen anchor points and limit the resonance phenomenon. The damping system is given as tuned mechanical dampers, where the internal mechanical system's eigen period is used. is set to the desired frequency to be muted. Alternative options for a damping system include space below the SFT road, heavy concrete blocks hung from chains below the tunnel, and available space. More hydrodynamic dampening may be provided by the chains that are provided under the tubes. Another option is to install water basins beneath SFT's roads that are connected by a tube. Viscose damping is produced by the water movement the tube causes between the basins.

Accident Analysis

Even though there is very little chance of an accident in SFT, the consequences would be severe if it did. Earthquake-related accidents, ship collisions, and terrorist strikes are a few of the potential threats to the SFT. The pontoon may sustain damage as a result of a ship collision, so pontoon connections are made so that this damage has no immediate impact on the SFT's stability. By separating the pontoons into distinct compartments and adding connections to the tube with weak links, damage to the pontoons can also be reduced.



According to tests, the green function, reaction spectrum method, large mass method, pseudo-excitation method, and finite element method (FEM) can all be used to analyse an earthquake's effect. With the use of the programme ANSYS/LS-DYNA, the dynamic behaviour of an underwater explosion may be examined. The FEM's simplified elastic support beam model can be used to study the SFT's reaction to impact and collision loads. According to studies, due to model size and computation cost, the effects of submarine collision on SFT and the numerical analysis are useless.

Durability

The design life of the constructions, such as bridges and tunnels, is 120–150 years. However, the likelihood of corrosion is high for a submerged floating tunnel because of its constant exposure to a salty environment. Once a crack appears in an SFT of reinforced concrete, it leads to a decrease in strength when

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exposed to corrosion and shortens the life of the structure. Continuous inspection, repair, replacement, etc. are therefore necessary if it is discovered that a component's life is less than the design life of the entire structure.

7. CONCLUSION

SFT creates a new option for extremely deep water transportation where the current options are cumbersome and expensive. This is a great choice for connecting underground infrastructures in contemporary cities with rural networks. SFT has a relatively low energy usage compared to other underwater transportation systems due of the gentle gradient. SFT lessens environmental contamination, allowing for the preservation of the natural beauty. Construction of is one of SFT's key benefits.

Due to the fact that the SFT tubes are prefabricated, they don't create any disruption in heavily inhabited areas. Even though SFT is still a new concept, its application allows for a quick and effective transportation system.

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ESTIMATING THE STRENGTH OF RECYCLE AGGREGATE BY CREATINTG WITH HCL

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ABSTRACT

The qualities of recycled aggregates play a major role in whether replacing natural aggregate (NA) with recycled aggregate (RA) is appropriate. Aggregate qualities suffer with the presence of loose mortar particles and surface fissures. A surface treatment technique that improves the characteristics of coarse recycled aggregate is shown in this experimental investigation. In this work, hydrochloric (HCl) acid with a 0.1 M concentration was used to treat recycled aggregates. The fundamental characteristics of RA before and after therapy, as well as its impact on concrete, were looked at. The findings indicate that medication has improved RA's behaviour. When compared to natural aggregate concrete, recycled aggregate concrete typically has a 10–30% lower strength value. Compared to utilising untreated recycled aggregates, employing treated recycled aggregates in concrete can significantly increase strength.

Keywords: Hydrochloric acid, Compressive strength, Natural Aggregate, Recycled Aggregate, Surface Treatment Method.

1. INTRODUCTION

One of the biggest industries, the construction sector, uses a lot of cement, aggregate, and sand. The primary material utilised in construction is cement concrete. Old, dilapidated buildings that have been demolished leave behind enormous amounts of concrete rubble. The annual global production of concrete waste is about 1.183 billion tons1. In every nation, this concrete waste has grown to be a serious issue. For it to be relevant and conform to the current urbanised environment, it must be able to protect natural resources, save the environment, and promote sensible energy use. Therefore, the amount of land needed for its disposal is reduced thanks to the reuse of this debris. To obtain the necessary aggregate within the parameters of mixing gradation, this concrete debris must go through crushing and screening operations. Study on the use of debris from demolished structures is extremely important because construction waste is steadily increasing with the growth of metropolitan areas. The strength fluctuation of concrete when recycled material is utilised has been the subject of numerous studies, including 2,3,4,5,6,7,8,9,10,11,12, and 13. Numerous studies on the properties of recycled

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aggregate have been conducted due to how much simpler it is to obtain and how much less expensive it is than natural aggregate. The most significant finding from recent research using recycled aggregates was a fall in the strength value. This decrease in strength is caused by the mortar particles adhering to the stone particles. The attached mortar particles cause a weak porosity and fracture layer to emerge, which significantly affects the strength property of recycled aggregate concrete. Researchers have looked at the workability of concrete and found that mineral admixtures can provide concrete the necessary workability14,15,16. Numerous studies have been conducted and various treatment options are suggested in an effort

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to lessen the amount of mortar that is adhered to the aggregate. Mechanical, thermal, and chemical treatments, either individually or collectively, were suggested as treatment methods17,18,19,20,21,22. They were utilised to enhance the characteristics of recycled aggregate and reduce the number of loose particles that stuck to the aggregates.In order to explore the strength and durability characteristics of the recycled aggregate concrete, an attempt was made to improve its attributes by treating the recycled aggregates with hydrochloric acid.

Materials Used

All concrete mixtures contained ASTM type 1 ordinary Portland cement, which has the following specifications: specific gravity, specific surface area, and 28-day compressive strength of 3.15, 3960 cm2/g, and 43 MPa, respectively. In Table 1, the elemental configurations of the cement are listed. Throughout the experiment, locally accessible river sand was used as the fine aggregate, and a sieve analysis based on BS EN 933-1:2012 23 was completed. The results of this study indicated that the used fine aggregate belongs to the category of medium size fine aggregate. For the purposes of this experiment, control specimens were made of naturally crushed granite aggregates. On the university campus, an ancient structure that had been dismantled provided the recycled coarse materials. The age of the building was about 15 years. The demolished beams were crushed through impact crusher. The reinforcements and aggregates were separated and cleaned. The required size of the recycled aggregate was attained by further crushing and the loose particles were removed through water washing. The nominal size of recycled aggregate used for this work was less than 20 mm and its particle size distribution were shown in Table **2.** To enhance the workability of the concrete, a Type-F naphthalene sulphonate formaldehyde condensate based superplasticizer (SP) in aqueous form conforming to ASTM C 494 [24] was used.

Table 1 Chemical Compositions of the Cement

Description	SiO_2	Al_2O_3	CaO	Fe_2O_3	Na_2O	MgO	K_2O	SO_3	Cl
Cement (%)	24.5	7	63	0.55	0.4	2	0.6	1.5	0.05

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Table 2 Sieve analysis of aggregates

Aggregate	Aggregate passing (%) according to sieve size (mm)										Fineness modulus
	0.15	**0.3**	**0.6**	**1.18**	**2.36**	**4.75**	**10**	**12**	**16**	**20**	
Sand	0.8	7.9	24.6	44.8	76.9	100	100	100	100	100	3.45
Natural Coarse Aggregate	0.0	0.0	0.0	0.0	0.4	1	23	49.2	74.5	100	7.52
Recycled Coarse Aggregate	0.0	0.0	0.0	0.0	0.5	0.9	34	58.4	85.3	100	7.21

2. EXPERIMENTAL PROGRAM

Surface treatment for recycled aggregate

The recycled aggregates were treated with hydrochloric acid (HCl) at a low concentration of molarities of 0.1 M to remove the loosely adhering mortars. Despite its acidity, HCl is one of the safest strong acids to handle since it contains the non-volatile and benign chloride ion. As a result, it is thought to be appropriate for extracting mortar from recycled aggregates. 0.1M HCl solution was used to treat the recycled aggregates by immersing them in it for 24 hours. To verify a very effective acid reaction in the elimination of loose particles connected to the initial aggregate, the vessel was periodically shook. After that, sanitised water was used to completely wash the recycled aggregates. The surface treatment of recycled aggregates by pre-soaking recycled aggregates in HCl solution was demonstrated in Fig.1 before and after. Due to the efficiency of employing recycled aggregate 25 that had been HCl treated, there was a notable improvement in the recycled aggregate concrete. Table 3 displays the characteristics of both natural and recycled aggregates.

High range water reducing additive was employed at 2% by mass of cement content to promote the workability of concrete and decrease the water content, leading to a reduction in water content of 19.81%. All aggregates were pre-soaked in water for 24 hours prior to casting in order to prevent recycled aggregates from absorbing a lot of water and to maintain a uniform slump. The workability of the concrete was increased when recycled aggregate was employed in saturated, dry surface conditions. For the aforementioned mix design, each mix was produced using a pan mixer. Concrete mixes made from recycled aggregate and treated recycled aggregate were given the designations RAC and RACHCl, respectively, whereas concrete mixes made from natural aggregate were given the designation NAC. The "Methods of Tests for Strength of Concrete (IS: 516 - 2004)" 28 were followed for casting the concrete.For any of the tested concrete combinations, no bleeding or segregation was observed. 100 mm cubes and cylinders measuring 100 mm x 200 mm were formed for each concrete mixture. All the necessary specimens were cast in a laboratory setting using steel moulds. After 24 hours, the specimens were removed from the mould and cured in water for 28 days at a temperature of 27 2 °C.

ISBN: 978 - 81 - 959860 - 0 - 2

Compressive and split tensile tests are performed on specimens:

Experimental results employing concrete cubes and cylinders, respectively, were used to determine the compressive strength and split tensile strength in accordance with IS 516-2004 28. A compression testing device with a 3,000 kN maximum loading capability was used to complete the task. For various concrete mixes, the results of the compressive strength test and split tensile strength were displayed in Figures 2 and 3, respectively.

Density and water absorption ratio

The volumetric water absorption test was carried out in accordance with ASTM C 642-2013 29 guidelines. The cube specimen's dry weight was determined by oven drying it at 105°C for 24 hours with a 28-day-cured specimen. They were then removed, brought to room temperature, and had their weights taken. The dried specimens were set in a water tub, and the specimen weight was periodically measured every hour until a constant value was reached. The weight of the specimen changed from a saturated surface dry condition to a dry condition, and this weight change was used to calculate how much water the concrete had absorbed. The results were expressed as a percentage of the specimen's volume.

3. RESULTS AND DISCUSSIONS

Properties of Aggregates

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Table 3 displays the characteristics of the natural aggregate and recycled aggregate both before and after treatment. After treatment, it was discovered that the properties of RA had improved somewhat. Only 13% density variation was seen in the HCl-treated recycled aggregates, and the bulk density of RA was 15% lower than that of NA (1635.55 kg/m3). Similar to how the water absorption decreased following treatment, going from 6.5% to 5%. This improvement in RA characteristics denotes the removal of mortar that had adhered to the recycled aggregates.

Compressive and Tensile strength

According to IS:516-2004, the compressive strength of concrete mixtures made with 100% natural aggregate (NAC) and 100% recycled aggregate (RAC) before and after treatments was determined at ages 3, 7, 14, and 28 days, and is shown in Fig. 2. After 28 days, it was discovered that RAC's compressive strength was 30% lower than NAC's. This suggests that substituting RA for NA resulted in reduced compressive strength. This was brought on by the presence of loose mortar on the RA, which led to a weak interfacial transition zone and more water absorption because of mortar that had been attached.

Fig. 3 displayed the concrete's split tensile strength. The split tensile strength trend was similar to the compressive strength trend. No matter what kind of aggregates are used, ageing enhances tensile strength. However, when NA was swapped out for RA, a decrease in tensile strength was seen in concrete. At ages 7, 14, and 28 days, split tensile strength values of concrete with recycled aggregate were found to have decreased by 9%, 16%, and 14%, respectively, while the split tensile strength values of concrete with treated aggregate had decreased by only 6%, 4%, and 9%.

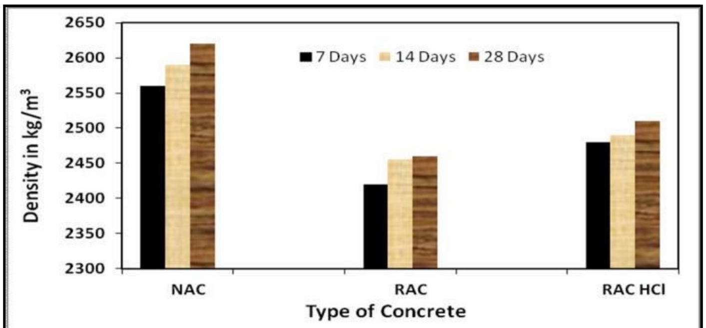

Fig. 4 Concrete Density

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even after therapy. This is as a result of the treatment using a low concentrated acid, which did not completely remove the attached particles from the aggregates. As a result, the attached particles in place prevented RAC from improving.

4.CONCLUSIONS

The following conclusions were drawn from the experimental study's findings:

1. The surface treatment method considerably enhances the characteristics of RA by successfully removing the loose mortar particles.

2. At all ages, RAC's compressive and tensile strength was lower than NAC's. However, treated RA developed concrete strength more effectively than untreated RA.

3. By including treated RA in concrete, the durability of RAC as measured by water absorption was increased.

4. Surface preparation by soaking the RA in HCl beforehand considerably enhances the characteristics of RA. Consequently, this method is regarded as advantageous and is applicable to large-scale RAC projects.

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ADVANCED EARTHQUAKE RESISTENCE TECHNIQUES

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ABSTRACT

Apart from the modern techniques which are well documented in the codes of practice, there are some other old traditional earthquake resistant techniques which have been proved to be more effective for resisting earthquake loading and are also cost effective with easy constructability

1.INTRODUCTION

Disasters are unforeseen events that have negatively impacted mankind since the beginning of our existence. There have been struggles to lessen these disasters' harmful consequences in reaction to such events. In the past few decades, the collapse of homes during earthquakes has resulted in numerous fatalities as well as millions of dollars in extended financial losses. Building liability typically arises from a lack of understanding of engineering science and from improper application of building codes. The task is particularly challenging in developing nations where the population is growing, cities and towns are expanding, and buildings are more susceptible to harm.2 – 4. Seismic waves are produced when there is an unexpected release of energy in the earth's crust, which is the result of an earthquake. The only method to avoid earthquakes, which are both far away and unpredictable, is to develop and build buildings with earthquake-resistant structures. There are numerous ways to survive earthquakes, but because they are expensive, most people do not use them. Here are several useful, low-cost methods to fend off earthquake effects. When compared to major earthquake attacks on affluent countries, this is sustained by minimal damage without any fatalities, yet a moderate earthquake can still cause widespread havoc in developing nations, as has been seen in recent earthquakes. It is not the earthquake that kills people; rather, it is the danger in structures that is to blame for the extensive destruction. The current research illustrates the various building typologies found on the Indian subcontinent and how they fared during previous earthquake disasters. Along with effective and efficient seismic design philosophies, it is crucial to ensure that strict structural design and construction methods that adhere to codes. Civil and structural engineers are the experts involved in the enterprise/construction of such structures and are in charge of creating structures that are earthquake resistan and have safe \surroundings.

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A. Understanding Of Earthquake And Basic Terminology Earthquake is well-defined as an unexpected ground shaking produced by the release of massive stored strain energy at the interface of the tectonic plates.

Fous It is the point in the earth from point at the seismicwaves originate.

Focal Depth:-It is the vertical distance between Focus andepicenter.

Epicenter:-It is the point on surface of the earth from vertically above the origin of an earthquake.

FIG.2BHUJ EARTH QUAKE IN INDIA

2.LITERATURE SURVEY:

In the recent and complex society, people's requirement for building structures has improved and many people expecting buildings to stay on fully equipped after large earthquakes. Consequent to these demands, a different seismic design methodology to produce flexible building structures due to large earthquakes is needed [1–4]. Unique structures provide the predominant functions, such as power plants, fire-fighting stations and hospitals, are constructed to stay on fully operational even though after large earthquakes. Plastic distortions are permitted for large seismic risks below the hypothesis of ductile actions in steel members and RC structures. The objective of this amendment was to defend efficiently human lives against large seismic risks by permitting building destruction. Thus, the building Damage was deemed for saving lives [5]. Multistory unreinforced masonry (URM) buildings were used, significantly in quite a few decades, and a large quantity of buildings are still established at economical for the period of urbanization in China. They structure provides many advantages, but their accomplishments during seismic risks are not satisfactory in the Tangshan earthquake, 1976 [6]. SCC relate with masonry involvement by horizontal reinforcements. In horizontal reinforcements vertical interval is usually 500mm, and horizontal reinforcements might be observed from design details of different experimental specimens. Largest ratio of

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longitudinal reinforcement is just over 1.0%. The longitudinal reinforcement ratio of SCC is low [7]. SCC is a primary structural design in seismic construction of masonry buildings in China, and masonry buildings with SCC are still counted as URM system propagating to the very low reinforcement ratio and also for small section of SCC [8]. Opinion of seismic destruction to URM piers, masonry piers endangered to in-plane packing may exhibition two characteristic types of behavior shear deformations, flexural, and consistent conceivable disaster modes perform such as diagonal tension, rocking, toe compression, diagonal stepped cracking and bed-joint sliding [9–10].

MODERN-DAY CONSTRUCTION METHODS FOR EARTHQUAKE RESISTANT BUILDINGS

The Prestressed concrete components in seismic risk resistant construction which ensures proper relationship between different elements of a structure. But this methodology have been generally implemented in New Zealand.

- **Shape-memory alloys**

This demonstrate exceptional characteristics desirable in a seismic risk resistant building. They have a capability to disintegrate considerable energy without permanent deformation or considerable destruction. Generally common shape memory alloys are makeup of metal blends comprising, nickel titanium, copper-aluminum-nickel and copper-zinc-aluminum-nickel. This is more suitable for extensive applications.

- **Seismic Dampers**

In Seismic Dampers are the diagonal braces in a moment resisting frame which is used for efficient lateral load resisting scheme. In modern area the structural seismic retort to control have taken the lead to the alternative of these bracings with seismic dampers. These dampers behaves similar to the hydraulic shock absorbers in cars considerably in case the sudden jerks are engaged in the hydraulic fluids and only small is transferred to the chassis of the car. In this case the seismic energy is conveyed through it and dampers is absorbed a small part of it and decrease the magnitude of the force which is acting on a structure. Generally used types of seismic dampers are included the friction dampers (energy is fascinated by surfaces within the friction between them rubbing beside each other), viscous dampers (energy is absorbed by silicone-based fluid passing between piston-cylinder structure), and yielding dampers (energy is fascinated by metallic components that produce). The friction dampers were delivered in an 18-story RC

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frame structure in Gurgaon, India.

- **Steel Plate Shear walls**

Shear walls are deemed as an important component of a lateral load resisting systems and steel is known for its flexible behavior. Merging these two attractive properties, an efficient load resisting system was established and has noticed wide applications in North America and Japan. These walls are intended and also, they turn as a bend as an alternative of buckling below the action of lateral loads. The walls are substantially lighter and thinner; thus, they reduce the building weight. So, these walls not needed to be cured and consequently, it leads to increase the speed of the construction process.

- **Carbon Fibers**

The tensile features and the constant nature of a spider web was studied by many researchers in Japan. This is the world's first seismic reinforcement structure made of carbon fiber material. An seismic risk Resistant Building Rendered with Carbon Fabric and it is redolent of a giant spider web has been erected in Nomi City of Ishikawa Prefecture in Japan.

- **Ecological ductile cementations composite (EDCC) spray**

A many researcher from the University of British Columbia (Vancouver, Canada) has established a new extreme method to make up the buildings resist against seismic risks. EDCC blends the fly ash, cement with polymer-based fibers, and other extracts in making it ecological and has been provided the molecular level to be malleable and strong at the same time. This material when utilized as a slim coating (10mm), was noticed to have enhanced seismic resistance of the structure by enduring a seismic risk of intensity 9 to 9.1 on Richter scale (Tohoku earthquake, Japan 2011). So this method has been proposed for retrofitting of the vacant structures such as an uncomplicated school building in Vancouver.

- **Blue mussel**

It is found sea decks and clinging to rocks all laterally the coast of New England. They are affixed in place by a gristly outcrop of cabling that occurs from among their twin shells. Generally the most ferocious of high tides Can't pry them very loose. To remain affixed to their precarious perches, mussels secrete sticky fibers well known as byssal threads. These threads are inflexible and stiff while others are flexible and elastic. Researchers are annoying to combine this particular element into structures in order to make up the building endure the seismic risks.

- **Seismic Invisibility Cloak**

ISBN: 978 -81 – 959860 – 0 - 2

A sequence of the borehole is mined about the periphery of the structure that needs to be endangered. These boreholes seem to work as a seismic cloak‖ that could hide a building or possibly an complete city from an earthquake's deadly waves. This makes the use of dampers, isolators, and also other vibration response control devices obsolete.

1.ISSUES INFLUENCE THE SEISMIC PERFORMANCE OF A BUILDING

various factors influence the Seismic performance of a building and are given below.

A.Height of the building

The seismic response of a building to a ground vibration is a function of its natural frequency. it is inherent mass and stiffness. These impacts vary with the height of the building and vulnerability. this outcome, in high seismic zones, the building height is constrained in accordance with the seismic hazard estimate for the specific to a region.

B.Irregularities

The obstacle to the load path in transporting the forces from roof to the foundation is produced by the vertical and horizontal irregularities present in the building. It is described about the irregularities is given in IS 1893.

C.Quality of Construction

The quality informed by the local construction practices in terms of compliance with coal provisions and the Status of maintenance or visual appearance is a major factor.

D.Ground Slope

Sloping terrain is often encountered in Himalayas, north eastern states, and also along with the eastern and western gates consequently a large number of buildings are in hill slopes. Based on the sloping angle, the slopes are classified into two types they are as the gentle slope (≤ 20°) and steep slope (> 20°). If the houses are built on gentle slopes, the ground is naturally leveled before construction. If the building is constructed on a steep slope, the foundation will differ in terms of elevation beside the plan of the building. Consequently the vertical members with changing mass and stiffness which leads to the vertical irregularity. The constancy of the ground plays the major constraints that impact the seismic performance of a building constructions.

3.REASONS WHY BUILDINGS FAILURE

A.Absence Of Joints Confinement

Requiring and appropriate confinement is very significant not only for the suitable implementation of the structures but for the protection of the structure as well as living lives.

ISBN: 978 -81 – 959860 – 0 - 2

B.No Usage Of Horizontal Bands

Horizontal bands are the most significant seismic Resistant feature in masonry building. The bands are providing to hold masonry buildings as a single unit by binding all the walls together and are alike to a closed belt delivering around cardboard boxes are the most significant of all and needs to be provided in nearly all buildings.

C.No Use Of Shear Wall

Intended to resist lateral forces and these are the outstanding structural system to resist earthquake and also offered throughout the complete height of wall. It offers large asset and stiffness in the direction of positioning. This is well-organized in terms of structure cost and effectiveness in minimalizing earthquake damages.

II.EFFECTIVE ROLE OF CIVIL AND EARTHQUAKE ENGINEERS

This is not the earthquake which extinguishes the societies, but it is in the insecure buildings which is accountable for the destruction. Keeping in opinion the huge loss of being and things in modern tremors, it has become a warm issue and worldwide lot of study is successful on to understand the purposes of such failures and understanding suitable lessons to ease the repetition of such destruction. The professionals complicated in this project and construction of these responsible structures is civil engineers. Who are liable for the building construction the earthquake resistant buildings and retain the society in a safe environment.

III.GENERAL NECESSITIES FOR EARTHQUAKE RESISTANT CONSTRUCTION:

A.Suitable Site Selection

The construction site has to be unchanging and safe enough to struggle the total building load, comprising that of its inhabitants and their properties. An appropriate site for the buildings shall be designated in accord with this guideline.

B.Appropriate planning.

The form and sizes of a building are significant for its seismic safety rendering to the rules. Buildings with irregular plans and elevations are feebler to seismic risks than those having regular ones. The optional form and proportion of buildings will be made by these guidelines

C.Appropriate Bonding Between Masonry Walls

The quality and category of the bond within the in folding elements is the main contributor to the strength and integrity of the walls. All the masonry units have to be appropriately revitalized to provide the consistency.

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4.STRATEGIES FOR EARTHQUAKE RESISTANT CONSTRUCTION

In accumulation to the earthquake design code 1893 the Bureau of Indian Standards has distributed to applicable earthquake design codes for earthquake resistant construction Masonry structures (IS-13828 1993).

- Delivering vertical reinforcement at significant locations such as internal corners, and external wall junctions as per code.
- Horizontal bands should be provided at lintel, plinth and roof levels as per code
- Proper workmanship and Quality assurance must be guaranteed for all cost without any concession In RCC framed structures (IS-13920)
- Grade of mortar should be as per codes definite for dissimilar earthquake zones.
- Asymmetrical shapes should be evaded both in vertical and plain configuration.
- In RCC framed structures the arrangement of lateral ties should be retained closer as per the code

CONCLUSION

Seismic Invisibility Cloak – A series of the borehole is dug around the periphery of the structure that needs to be protected. These boreholes appear to work as a seismic cloak that possibly will hide a building or perhaps a whole city starting an earthquake's deadly waves. This makes the use of isolators, dampers, and other vibration response control devices obsolete.

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A STUDY ON STRENGTH PARAMETERS OF SELF CURING CONCRETE

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Abstract: The impact of the curing agent polyethylene glycol (PEG-400) on the functionality of concrete is highlighted in this research. PEG is a chemical agent that is added to cement in varying amounts: 1%, 2%, and 3%. Glenium, a powerful plasticizer, was utilized to make concrete easier to work with. With normal curing and self-curing at 7 days and 28 days for M40 mixes, concrete properties like compressive strength and split tensile strength were examined. According to the findings, 2% of PEG 400 for M40 grade was shown to be the ideal dose for maximal strength. When self-curing concrete made of PEG 400 was utilized instead of ordinary concrete, a 12% improvement in compressive strength was seen on average. In comparison to conventional concrete, self-curing concrete has a 1.5% higher tensile strength.

Keywords: Compressive strength, PEG 400, self-curing concrete, split tensile strength

I. INTRODUCTION

Modern concrete technology has been developing quickly. Numerous properties of concrete can enhance a building or structure's sustainability performance. Concrete has to be properly cured for improved performance and durability. One significant issue in the building industry, particularly in India, that does not receive the proper attention and importance is concrete curing. According to Tyagi [1], steps must be taken to stop water from evaporating off of concrete's surface. Therefore, the process of curing can be seen as the creation of a favorable environment for continuous hydration in the initial stages. Self-curing concrete is one of the specialty concretes that have gained popularity recently, according to Junaid et al. [2], as it avoids human error, inaccessible structures, difficult-to-cure terrain, and locations where fluoride content adversely affects the property of concrete. By lowering the amount of water that evaporates from concrete, self-curing agents boost concrete's capacity to retain water when compared to conventionally cured concrete, as demonstrated by Mohanraj et al. [3]. In light of the fact that conserving water is a daily need (each cubic metre of concrete takes 3 m 3 of water in a building, most self-curing admixtures are self-curing). Water soluble polyethylene glycol (PEG 400) 0.5% was used as a self-curing agent in Azhagarsamy and Sundaraman's (2016) [4] study of the strength and durability characteristics of M20 grade concrete. Compressive strength measurements at 3, 7, and 28 days were made under standard curing and self-curing conditions. With 0.5% of PEG-400, it was discovered that there was an average increase in compressive strength of 12.73% and split tensile strength of 13.31%. This demonstrates that self-curing concrete performed better than traditional concrete. The shrinkage-reducing additive PEG 400 is used by Jagannadha Rao and colleagues (2012) [5] in concrete to promote self-curing and enhanced hydration. PEG 400 admixture's impact on compressive strength, split tensile strength, and rupture modulus was researched for both M20 and M40 mixes, increasing the amount of PEG by cement weight from 0% to 2%. When compared to traditional curing, it was shown that PEG 400 might strengthen self-curing. Additionally, it was discovered that for M20 grade concretes, 1% of PEG 400 by weight of cement was ideal, while 0.5% was ideal for M40 grade concretes to achieve maximum strength. PEG 400 was utilized as an additive by Patel and Pitroda (2013) [6] in ordinary concrete to improve hydration. By changing the amount of PEG in the cement from 0% to 2% by weight, the impact of admixture (PEG 400) on compressive strength, split tensile strength, and rupture modulus was investigated. According to the test results, using water soluble polymers in concrete has enhanced its performance.

For M20 grade concrete, 1% of PEG 400 by weight of cement was ideal for achieving maximum strength.

When there is a severe water scarcity, it is occasionally impossible to apply water cure due to cost considerations. Construction managers have a difficult challenge to prevent moisture leakage from the surface of flat concrete constructions like motorways and airports. Given that self-curing concrete would represent a new trend in concrete building, it was chosen for this project as a solution to these problems.

MATERIALS AND METHODS

CEMENT

PPC that complied with IS 1489-part 1 [7] was utilized, and it was tested in accordance with Indian Standards IS 4031-1988 [8]. The Table 1 lists the parameters of the cement that was utilized.

FINE AGGREGATE

As per IS 383-1970 [9] Specifications, fine aggregate was obtained that complies with zone II of the grading curve and has specific gravity of 2.6 and a fineness modulus of 2.12.

COARSE AGGREGATE

In accordance with IS 383-1970 [9] criteria, 20 mm nominal size, specific gravity 2.7, and water absorption 1.065% were tested in accordance with IS 2386 [10] standards.

SUPER PLASTICIZER

Super plasticizers are chemical admixtures used when well-dispersed particle suspension is required. They are also referred to as high range water reducers. Glenium B233, a modified polycarboxylic ether-based super plasticizer, was employed.

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S.No	Property	Result
1	Specific gravity	**3.15**
2	Normal consistency	**32%**
3	Initial setting time final setting time	**30 mins 600 mins**
4	Fineness of cement (by 90 micron sieve)	**5%**

POLYETHYLENE GLYCOL

A PEG grade with a low molecular weight is PEG-400. It is a thick liquid that is transparent and colorless. PEG 400 is often utilized in several pharmacological formulations, in part because of its low toxicity. It is somewhat soluble in aliphatic hydrocarbons but is soluble in water, acetone, benzene, glycerin, glycols, and aromatic hydrocarbons. PEG-400 has a melting point of 4 to 8 ^{o}C (39 to 46 ^{o}F; 277 to 281K), a density of 128 g/cm3, and a chemical formula of 2nH4n+2On+1.

WATER

Portable water that met the standards of the IS 456-2000 [11] Specifications was utilized.

PREPARATION OF SPECIMENS

The preparation of M40 grade concrete mix followed the guidelines in IS 10262-2009 [12]. Specifications. M40 mix ratios are 1:1.89:3.6. By using tilting drum type concrete mixture machines, the different mixes' ingredients were measured and made. To guarantee even ingredient mixing, precautions were taken. The specimens were pressed with a tamping rod after being cast in a steel mould. For the purpose of determining compressive strength and split tensile strength at 7 and 28 days, respectively, specimens of 150 mm 150 mm 150 mm size of cubes and 150 mm diameter 300 mm high cylinder specimens were constructed. As soon as the top surface of the concrete in the mould was rigid, the specimen's curing process began. For simple mix identification, CC refers to normal concrete, SCC 1 to self-curing concrete containing 1% PEG, SCC 2 to self-curing concrete containing 2% PEG, and SCC 3 to self-curing concrete containing 3% PEG.

EXPERIMENTAL INVESTIGATION

WORKABILITY

The slump cone test must be used to determine the properties of new concrete. According to IS 7320-1974, the slump cone test is the most used technique for determining concrete consistency. It may be done both in a lab and on the job site [13]. The slump cone test is employed as a control test and to determine whether concrete is consistent from batch to batch.

A cone with a height of 30 cm, a bottom diameter of 20 cm, and a top diameter of 10 cm is used for the slump cone test. The clean, flat surface is where the mould is set.

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Next, four layers of material are added to the mould, and each layer is tamped 25 times with the tamping rod. The top layer is filled, and then the concrete is With a tamping rod and trowel, the concrete is levelled after the top layer has been filled. The mould is then gently raised in the vertical direction while being progressively removed. It is measured the height difference between the mould and the highest point of the subsiding concrete. The concrete's slump is determined by the height difference that was measured.

COMPRESSIVE STRENGTH TEST

According to IS 516-1959 [14] requirements, a compression testing equipment with a 3000 kN capacity was used to evaluate the compressive strength of HPFRC mixtures. To achieve improved compaction and finish ability in concrete, fresh concrete was poured into steel moulds of the appropriate size and vibrated for three minutes. 150 mm 150 mm 150 mm concrete cubes were made, dried for 24 hours, removed from the steel moulds, and tested for compression after 7 and 28 days. The test specimens' compressive strength is calculated using the formula fc = P/A, where fc is the specimen's compressive strength in N/mm2, P is the highest load applied in kN, and A is the cross sectional area of the specimen.

SPLIT TENSILE STRENGTH TEST

Utilizing the steel moulds, cylindrical specimens measuring 300 mm 150 mm were created. After demolding, the specimens were placed in a curing tank. At 7 and 28 days, the samples were removed from the curing tank and tested for split tensile strength, as shown in Figure 1. According to IS 5816-1999 [15] standards, the test is conducted by positioning the cylindrical specimen horizontally between the loading surfaces of a compression testing machine. Split tensile strength was estimated using the formula

$$T=2P/LD$$

where P stands for compressive load (kN), T for split tensile strength (N/mm2), L for cylinder length (mm), and D for cylinder diameter (mm).

RESULTS AND DISCUSSION

WORKABILITY

To assess whether freshly laid concrete is workable, a slump test is done. The standard concrete has a 25 mm slump value. For SCC 1 and SCC 2, respectively, 1% and 2% of PEG were utilized in the concrete to achieve a 25 mm slump value. The slump value for SCC3 is decreased to 24 mm. Concrete has greater workability when 3% PEG is added than in other mixtures.

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COMPRESSIVE STRENGTH TEST

According to the findings of a 7-day compression test, conventional concrete reached strength of 21.1%, while self-curing concrete with 2% PEG reached a greater strength of 22 N/mm^2. Conventional concrete has strength of 37.3 N/mm^2 after 28 days of testing. According to Figure 1, self-curing concrete with 2% PEG has strength of 42.06 N/mm^2.

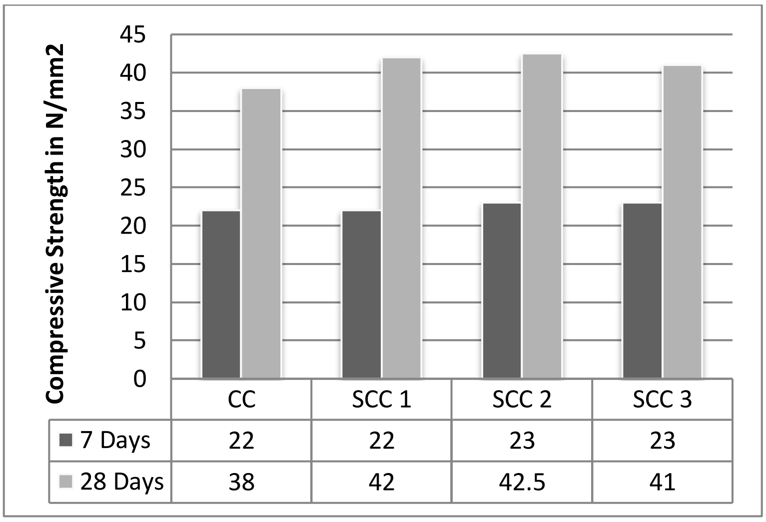

Fig.1.Compressive strength of SCC specimens.

SPLIT TENSILE STRENGTH TEST

At seven days, conventional concrete has a tensile strength of 4.5 N/mm2. At 2% PEG dosage, the tensile strength of self-curing concrete increases. Figure 2 shows a visual representation of the test findings. According to the findings, typical concrete has a tensile strength of 6.5 N/mm2 achieved. For a PEG dosage of 2%, the tensile strength of self-curing concrete reaches 7.1 N/mm2. Figure 2 [16, 17] provided a visual representation of the test findings.

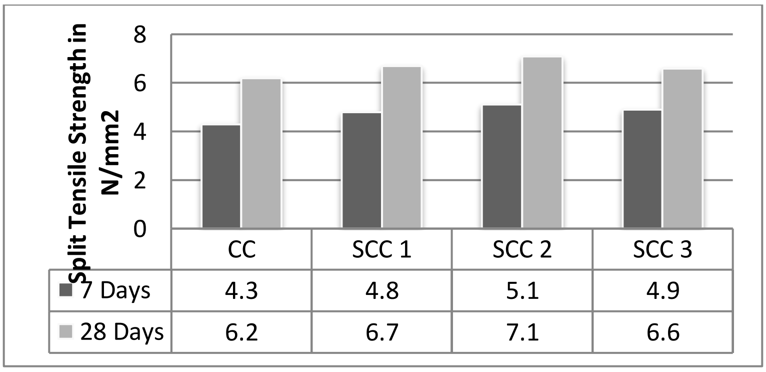

Fig.2.Tensile strength of SCC specimens.

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CONCLUSION

- For M40 grade, 2% of PEG400 was shown to be the ideal dose for achieving maximal strength.
- According to the results of the workability test, glenium dose promotes workability at a rate of 3.3%.
- When PEG 400 self-curing concrete was utilized instead of traditional concrete at the age of 7 days, a median improvement in compressive strength of 2.25% was seen.
- When self-curing concrete made of PEG 400 was employed instead of traditional concrete at the age of 28 days, a 12% improvement in compressive strength was seen on average.
- Self-curing concrete may be utilized efficiently in places where there is a shortage of traditional concrete since it has 1.5% greater tensile strength water and tough, impassable terrain.
- The solution to many issues arising from improper curing is self-curing concrete.

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DAMAGE EVALUATION AND IN CONCRETE MATERIALS BY ACOUSTIC EMISSION

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ABSTRACT

The nondestructive testing (NDT) of concrete and concrete structures has seen substantial study and application of acoustic emission (AE) techniques. Applying the rate process theory, it is possible to analyse the AE behaviour of concrete under compression for damage assessment. According to Loland's damage mechanics model, there is a correlation between the AE rate and the damage parameter. The relative damages of concrete in existing structures are successfully calculated by the compression test of concrete samples by calculating the intact moduli of elasticity of concrete from the database on the relationship. The method is used to calculate the amount of recycled aggregate in concrete samples. It is conceivable to estimate the recycled concrete's degree of deterioration. for detecting rust It is helpful to continuously check AE signals to get an earlier warning of corrosion in reinforcement. It is shown that AE parameter analysis may accurately pinpoint the beginning of corrosion in reinforcement and the initiation of corrosion cracking in concrete.

1 INTRODUCTION

The impacts of the environment could cause concrete and concrete structures to deteriorate. It is now vital to establish quantitative procedures for evaluating damage in concrete because the evaluation of concrete's degree of deterioration or damage has been in such high demand.

When diagnosing concrete structures, concrete's mechanical properties are typically assessed by taking core samples. However, the qualities discovered by the compression test have not been utilised in the evaluation of damage. Acoustic emission (AE) is known to be a promising method for determining the extent of damage in this situation. The rate-process analysis has been suggested by the authors as a method for evaluating AE activity when it is compressed (Ohtsu, 1992). The Damage Evaluation of Concrete by AE raTe-process Analysis (DeCAT) approach is used to determine the relative damage to concrete by computing an intact modulus of elasticity from the database based on a relationship between AE rate and the damage parameter (Suzuki and Ohtsu, 2004). The DeCAT system is used in this study to calculate the degree to which concrete samples comprised of recycled aggregate have degraded.

One of the most important deteriorations in reinforced concrete is corrosion of the steel reinforcing bars (rebars). A passive layer on the surface of the rebar is destroyed when the chloride concentration at the rebar exceeds a range of values with a chance for corrosion to begin.

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Corrosion starts after being destroyed. With the help of any available oxygen and water, the electrochemical reaction then continues. With time, corrosion products on rebar surfaces expand and start microcracks in concrete. The deterioration process is described in the Japanese standard specifications on maintenance (JSCE, 2001), as shown in F

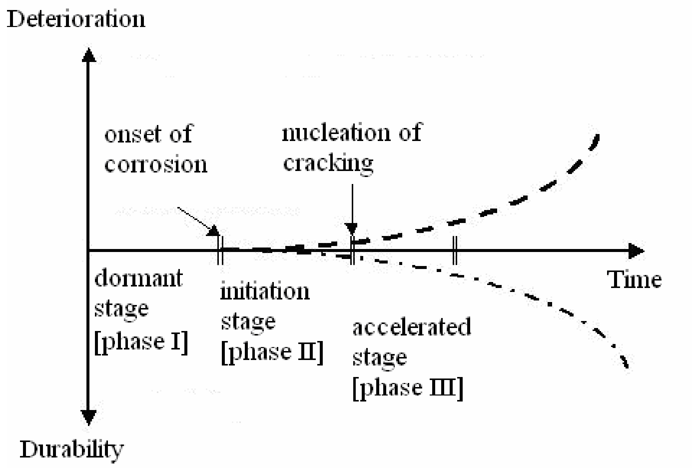

Figure 1. Corrosion process of reinforced concrete.

When corrosion begins to form and when cracks first appear, there are two transitional periods. The former is connected to the change from phase I's dormant stage to phase II's initiation stage. At this point, corrosion-related harm could start.

which is typically referred to as the time at which corrosion begins. The latter, which marks the change from the initial stage (phase II) to the accelerated stage (phase III), is crucial for determining how durable reinforced concrete constructions will be. Electrochemical methods of half-cell potential and polarisation resistance have been widely used for nondestructive assessment (NDE) of corrosion. However, it is well known that these methods cannot offer preciS

A relative ratio of the elastic moduli can be used to create a damage parameter in damage mechanics (Loland, 1980).

Determine the transitional phases at the beginning of corrosion and the beginning of nucleation cracking. 2 AE SIGNAL ANALYSISAnalysis of the AE rate-process

The formation of micro-cracks is connected with the AE behaviour of a concrete sample under compression. These micro-cracks accumulate over time until

Failure in the end.Along with the accumulation of micro-cracks, the number of AE events that correspond to the generation of these cracks increases rapidly. It indicates that the process is stochastic and is dependent on the number of cracks at a specific stress level. To quantify AE behaviour under compression, the rate process theory is introduced. The following rate process equation is used to calculate the number of AE hits dN caused by a stress increase from V to V+dV.

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dN

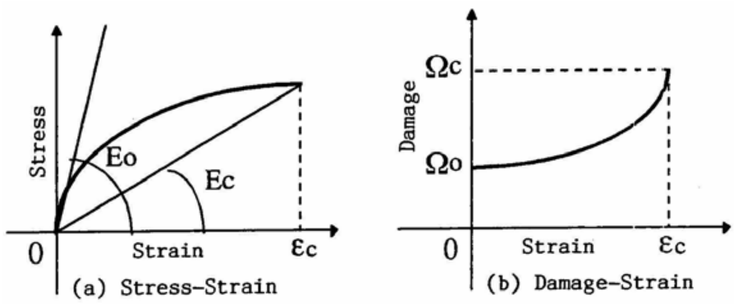
f (V) dV

□ where N represents the total number of AE events and (V) represents the AE probability curve at stress level V(%). The following hyperbolic function is assumed for (V) in Equation 1.

f (V) □ a □ b V (2)

In this equation, a and b are empirical constants. The rate is defined as the value 'a' that reflects AE activity at a certain stress level. The probability fluctuates at low stress levels depending on whether the rate 'a' is positive or negative. If the rate 'a' is positive, the probability of AE activity at a low stress level is high, indicating that the concrete is damaged. where E is the concrete modulus of elasticity and E* is the ideal modulus of elasticity, assumed to be intact or entirely undamaged. Assigning 0 to the initial damage at the start of the compression test yields the following equation:

A stress-strain relationship is commonly plotted in a compression test of a concrete sample, as shown in Figure 2 (a). Equation 5 associates the initial modulus of elasticity E0 with the initial degree of damage 0. The scant modulus of elasticity, Ec, is defined as the damage c at the ultimate strain c. The modulus of elasticity, E0, was estimated as a tangential modulus in this work after a parabolic function was used to approximate the stress-strain relationship.



As given in Equation 5, the initial damage Ω_0 is an index of damage. Still, it is fundamental to know the intact modulus of elasticity of concrete, E*. But it is not easy to determine the modulus E* of concrete taken from an existing structure. Consequently, it is attempted to estimate the modulus E*from AE measurement

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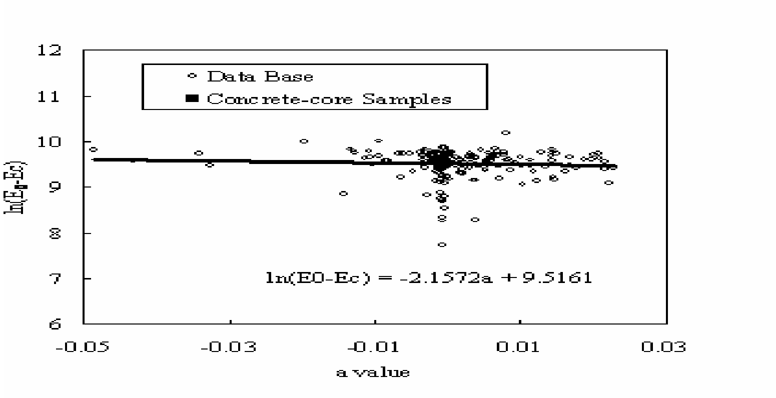

Figure 3. Database on rate ‘a’ modulus.

Figure 3 depicts a relationship between the decrease in moduli of elasticity, loge(E0-Ec), and the rate 'a' generated from AE rate-process analysis. Open circles represent previously tested concrete samples, while solid circles represent recently tested core samples (Suzuki and Ohtsu, 2004). A reasonable linear association exists between loge(E0-Ec) and the rate 'a' value. The decrease in elasticity moduli, E0-Ec, is given as

E0 Ec E * 1 c. loge E0

Ec loge E * c 0 loge

E xa c (7)

When a = 0, it is assumed that E0 = E*. This enables us to calculate the intact modulus of modulus of concrete, E*, using AE rate-process analysis as follows:

E *

Ec e c (8)

When we run the compression test, we add AE data to Figure 3 and use Equation 8 to determine the intact modulus. As a result, Figure 3 serves as the DeCAT system's database.

Analysis of AE parameters

AE signal characteristics were assessed using two indices of RA value and average frequency. These are defined by waveform parameters such as rise time, maximum amplitude, counts, and duration, as shown in Figure 4;

RA value = Maximum amplitude / Rise time, (9) Average frequency = Counts divided by Duration.(10)

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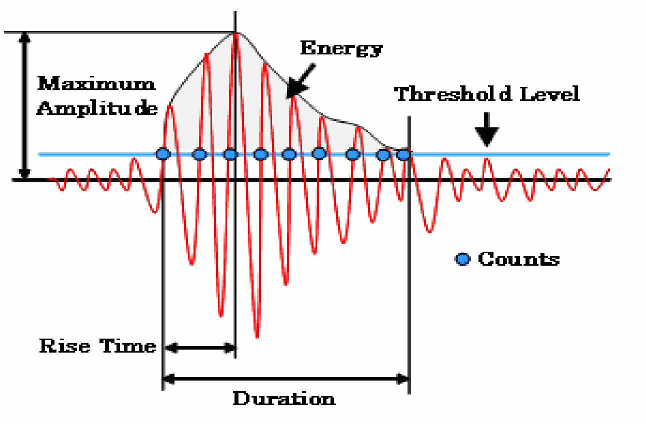

Figure 4. AE wavefrom parameters.

The Japan code (JCMS, 2003) divides AE causes of active cracks into tensile cracks and other-type cracks based on the relationship between RA values and average frequencies, as shown in Figure 5. The AE source is categorised as a tensile crack when the RA value is modest and the average frequency is high. In the opposite situation, an AE source is a crack other than a tensile crack, such as a shear crack. This criterion is used to categorise AE occurrences detected throughout the corrosion process.

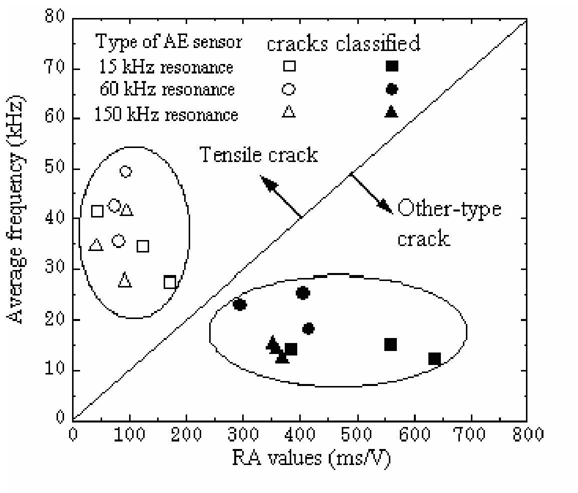

Figure 5. Crack classification by AE indices.

Furthermore, the amplitude distribution of AE events was used to evaluate the sizes of AE sources. The statistical representation of the relationship between the number of AE events, N, and the amplitudes, A, is as follows:

(11) $\text{Log10 } N = a - b\text{Log10}A$

In this equation, a and b are empirical constants. The latter is known as the b-value, and it is frequently used to calculate the size distribution of AE sources (Shiotani et al., 2001). Small AE events are mostly generated when the b-value is large. The case where the b-values grow tiny, on the other hand, implies active nucleation of big AE events.

ISBN: 978 -81 – 959860 – 0 - 2

3 EXPERIMENTS

Recycled aggregate concrete

Four types of coarse aggregate were used to create cylindrical samples 10cm in diameter and 20cm in height. Table 1 shows a list of these. There were two types of aggregate commercially available. The first was crushed aggregate, while the second was heated and milled. We have devised a system for removing coarse material from concrete using pulse-power, in which 100 pulses of 400 kV and 6.4 kJ/shot were released in water. As a result, recycled aggregate was extracted from cylindrical concrete samples formed of original aggregate and applied to recast concrete samples. The maximum coarse aggregate size in all types was 20 mm, and the water-to-cement ratio was 55%. To keep the slump vales at roughly 7 cm and the air contents at 6%, an air-entrained admixture was applied. Densities and absorption coefficients for these aggregates are provided in the table. It is recognised that densities fall and absorptions increase in recycled aggregate concrete when compared to original aggregate concrete. The pulse-discharged aggregate has the highest density and lowest absorption of the recycled aggregates.

Table. 1 Properties of coarse aggregate

Type of	Saturate	Dried	Water ab-
Crushed	2.53	2.49	2.71
Heated	2.59	2.54	2.10
Pulse dis-	2.95	2.90	1.42
Original	3.06	3.04	0.49

For each aggregate, 3 cylindrical samples were made and tested after 28 day-standard curing.

AE measurements were taken during the compression test. To limit AE events caused by friction, silicon grease was applied to the top and bottom of the specimen, and a Teflon sheet was inserted. To count AE hits, the MISTRAS-AE system (PAC) was used. An AE sensor (UT-1000: 1 MHz resonance frequency) was used to detect AE strikes. The frequency range was chosen to be between 60kHz and 1MHz.

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Figure 6. AE measurement in the compression test.

The dead time for event counting was set to 2 msec. It should be mentioned that the AE was measured at two channels, as well as the axial and lateral strains. The averaged AE impacts and strain of the two channels were estimated as a function of stress level.

Corrosion examinations

Reinforced concrete slabs with dimensions of 300 mm x 300 mm x 100 mm were tested. Figure 7 depicts the specimen configuration. For longitudinal alignment, 13 mm diameter reinforcing steel bars (rebars) are implanted with 15 mm cover-thicknesses. Concrete was mixed with NaCl solution when specimens were created. The lower-bound threshold value (chloride amount 0.3 kg/m3 of concrete volume, 0.088% mass of cement) established in the code (JSCE, 2001) was used to investigate the chloride concentration threshold limit for corrosion. After 28 days of conventional curing in 20°C water, the chloride content was tested and determined to be 0.125 kg/m3 in concrete volume (0.036% of cement mass). The concrete mixture proportion was the same as that of recycled concrete, but the maximum aggregate size was 10 mm. At 28 days of standard curing, the compressive strength was 35.0 MPa. Following the standard curing procedure, all surfaces of the slab specimen were polished. except for the bottom surface for one-directional diffusion, which was coated with epoxy, as shown in Figure 7.

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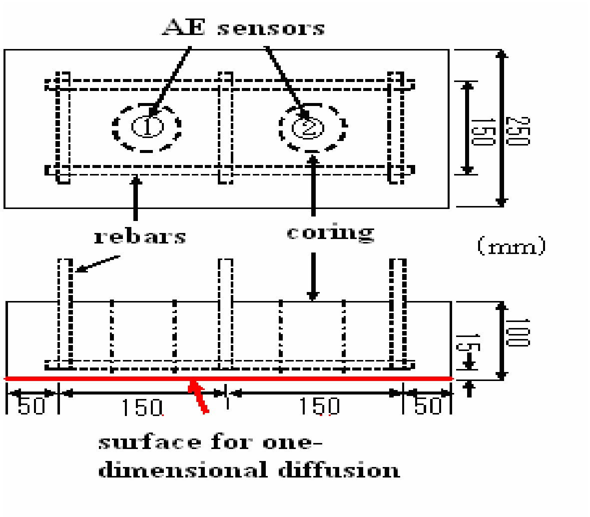

Figure 7. Sketch of a slab specimen.

An accelerated corrosion test as well as a cyclic wet-dry test were performed. The specimens were put on a copper plate in a container filled with 3% NaCl solution for the accelerated corrosion test, as illustrated in Figure 8. A steady 100 mA electric current was charged between the rebars and the copper plate. In the cycle wet-dry test, the specimens were cyclically placed in the figure's container without charge for a week and then dried at room temperature for another week.

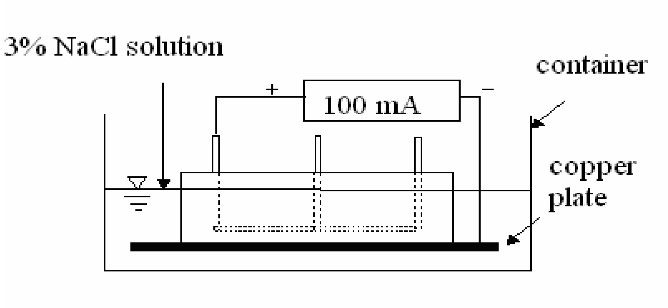

Figure 8. Test set-up for an acceleration test.

The AE was measured constantly using the LOCAN 320 (PAC). At the centre of the coring locations shown in Figure 7, two AE sensors were attached to the upper surface of concrete. A broad-band sensor (UT-1000, PAC) was used to detect AE signals. The measurement's frequency range was 10 kHz - 1 MHz, and the total amplitude was fications had a gain of 60 dB. The dead-time for event counting was set to 2 msec with a 40 dB threshold. A portable corrosion-meter, SRI-CM-II (Shikoku Soken, Japan), was used to measure half-cell potentials at the surface of the specimen. In the accelerated corrosion test, measurements were taken twice a day until the average potentials reached - 350 mV (C.S.E.), indicating that corrosion was possible in more than 90% of the cases (ASTM, 1991). The specimen was measured weekly in the cyclic test until the average potentials in dry conditions reached -350 mV (C.S.E.).The AE measurement was stopped during the half-cell potential measure

At various stages, chloride concentrations were monitored. Initially, the initial concentration was determined using a standard cylinder sample following a 28-day moisture-curing period. At other times, two 5 cm diameter core samples were collected from the specimens, the positions of which are shown in Figure 7. The potentiometric titration method was used to estimate total chloride ion concentrations after slicing the core into 5 mm-thick discs and crushing them.

4.RESULTS AND DISCUSSION

Damage assessment of recycled concrete

Figure 9 depicts the strengths and moduli of elasticity of four types of concrete. For each aggregation, these are the average values of three samples. It is discovered that the recycled aggregate's strengths and moduli of elasticity are lower than those of the original. Among recycled concretes, crushed aggregate concrete has the weakest characteristics because a thin mortar layer is still adhered to the aggregate contact.

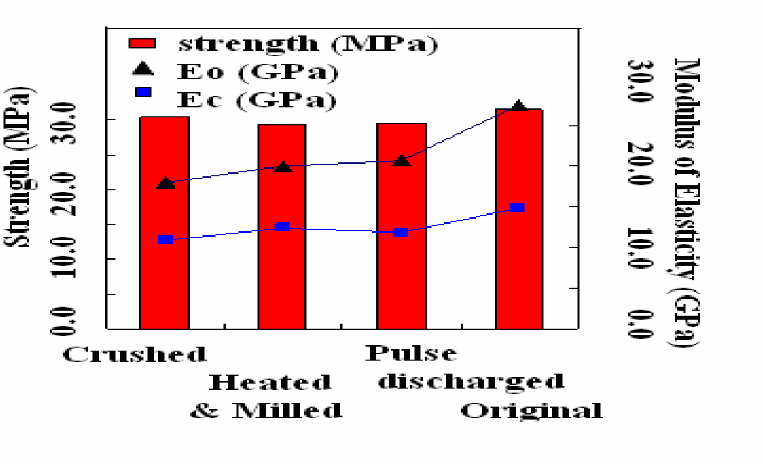

Figure 9. Strength and modulus of elasticity

According to Equation 8, the intact modulus of elasticity, E*, for each aggregate was calculated as an average.

Three samples were aged. The ratios of initial moduli E0 to intact moduli E* are then evaluated as relative damage. Figure 10 depicts the results. The agreement between the results of the AE rate process analysis and the experimental data is impressive.

As mentioned before, experimental values are only available for concrete of pulse-discharged and

Figure 11. AE activities and half-cell potentials in the acceler- ated corrosion test.

Total chloride ions were determined in depths, and chloride concentrations at cover thickness were analytically estimated by,

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original aggregates. In the figure, a mechanical property of recycle aggregate is evaluated as the relative damage. The poorest property is observed Detection of corrosionTest for accelerated corrosion

Figure 11 depicts a relationship between AE activity and half-cell potentials. The number of AE events is represented as the total of AE occurrences counted at two channels throughout one hour. Two episodes of high AE activity are noted at approximately 3 and 7 days. It is shown that half-cell potentials begin to fall after the first activity, but remain more than -350 mV around the second activity.Because a half-cell potential less than -350 mV is defined as more than 90% probability of corrosion (ASTM, 1991), the results suggest that AE activity detects corrosion in rebars more confidently than the half-cell potential.

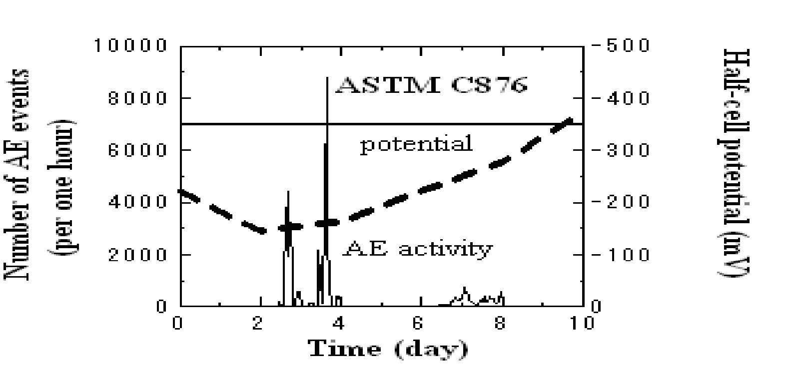

Figure 11. AE activities and half-cell potentials in the acceler-ated corrosion test.

Core samples were obtained at four stages of the procedure, testing all three specimens. Initially, chloride content was determined by compressing a standard cylindrical sample. Concrete cores were extracted from the three examples after two times of high AE activity and at the end of the process. The chloride concentrations were then tested at various cover thicknesses. Equation 12 was used to analyse these experimental values, which are displayed in Figure 12 (b), where total AE hits detected during the test are compared with chloride concentration at the rebar.

A phenomenological model of reinforcement corrosion (Melchers and Li, 2006) reports typical corrosion loss, as shown in Figure 12 (a). Corrosion begins in step one. The rate of oxygen transport determines the rate of the corrosion process. As corrosion products accumulate on the corroding surface of rebar, the flow of oxygen is eventually inhibited, and the rate of corrosion loss slows, as shown in Figure 12 (a). Under aerobic conditions, this is a nonlinear corrosion-loss-time relationship. Phases 3 and 4 of the corrosion process contain further corrosion loss owing to anaerobic corrosion. As a result, two stages of active corrosion loss are simulated. Figure 12 (b) depicts the total number of AE hits received from Figure 11. The activity of AE is matched to the concentration of chloride in rebar. The rise in total AE impacts during the acceleration test is observed to be in remarkable agreement with the normal corrosion loss in the phenome- nological model. This means that AE activity is definitely related to corrosion activity on the rebar surface. The graphic depicts two-threshold values of chloride concentration. One is the lower-bound threshold for the onset of corrosion (0.3 kg/m3 in concrete volume, 0.088% mass of cement volume), and the other is the performance-based design threshold value. To prevent corrosion, the code (JSCE, 2001) prohibits the use of concrete with a chloride content greater than 1.2 kg/m3 in concrete volume (0.35% mass of cement volume). When AE activity is compared to chloride concentration in Figure 12 (b), it is discovered that chloride concentration rises above 0.3 kg/m3 after the first AE activity and exceeds 1.2 kg/m3 after the second AE activity. This implies that chloride concentrations for corrosion phenomena at rebars reasonably match to two-stage high AE activities for corrosion initiation and corrosion cracking nucleation.

AE activity in cyclic testing

Figure 13 depicts the number of AE events and half-cell potentials during the cyclic test. The number of AE events for one hour is plotted once more. AE occurrences are observed on a regular basis, coupled with wet and dry cycles. The first strong AE activity is noticed after 40 days, but the second activity is not visible. According to the half-cell potentials, the values begin to decline after

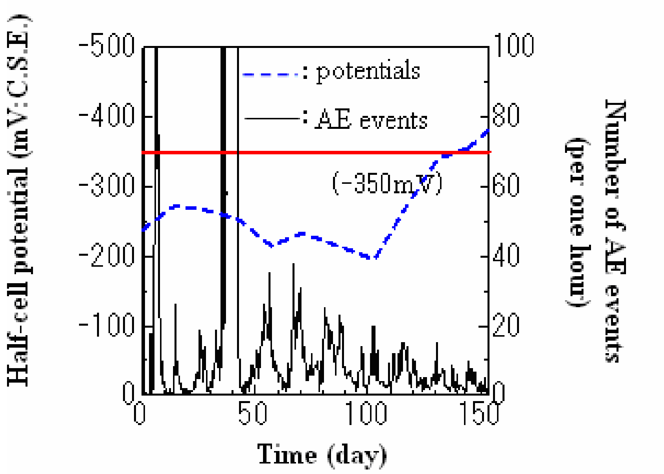

Figure 13. AE activities and half-cell potentials in the cyclic wet-dry test.

To establish the period of the 2nd AE activity, the RA values and average frequency were calculated using Equations 9 and 10, averaging the data over two weeks of wet-dry cycles. Figure 14 depicts the results. The RA value increases and the average frequency decreases during the first period, which is shown by an arrow sign. Figure 5 shows that AE sources other than tensile cracks are categorised. The increase in the RA value becomes apparent as the clock approaches 100 days. Thus, the second period is reasonably identified around 100 days after the first, when the RA values are low and the average frequencies are fairly high. Tensile cracks have must be avoided as seen in Figure 5. The first and second phases of strong AE activity are reliably detected by analysing two AE indicators of the RA value and the average frequency.

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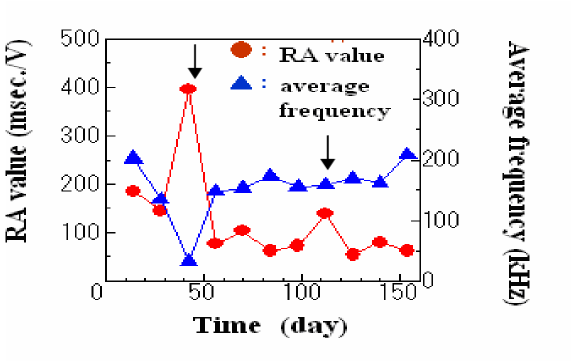
The average b-value was also obtained for each wet-dry cycle. Figure 15 shows the results. The b-value increases significantly during the first phase (upward arrow symbol), and then remains quite low. This finding indicates the formation of tiny cracks other than tensile cracks around the first period. The second period (downward arrow symbol) begins with the formation of quite substantial tensile cracks.



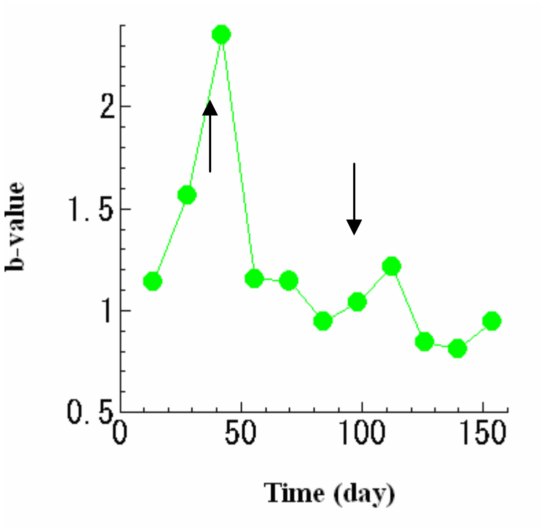


Figure 14. RA values and the average frequencies in the cyclicwet-dry test

After 40 days, the chloride concentration at rebar reached the lower-bound criterion of 0. 3 kg/m3, and after 100 days, the concentration exceeded 1.2 kg/m3. After coring the specimens at 42 and 126 days, the rebars were removed and visually inspected. Figure 16 shows that no corrosion was noticed after 42 days, but rebar was entirely corrosioned after 126 days. These findings imply that AE activities after 100days could be caused by concrete cracking caused by the expansion of corrosive products in rebars, as chloride concentrations in concrete exceeded 1.2 kg/m3. A rebar skin in the left figure of Figure 16 was analysed by scanning electron microscopy (SEM) to investigate the state of rebar at the 1st AE activity in detail. Figure 17 compares the distributions of ferrous ions when they were first received and after 42 days. Initially, ferrous ions are distributed uniformly, but by 42 days, they have vanished from specific sections of the surface.

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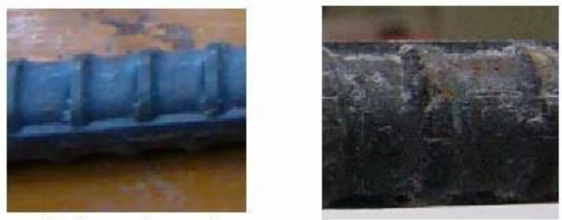
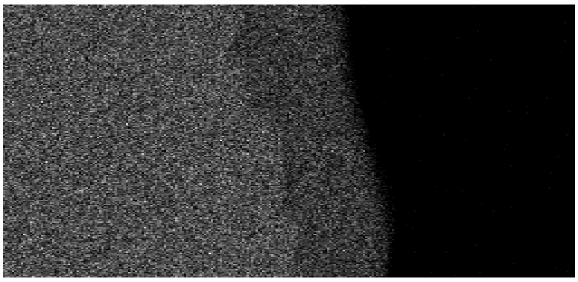


It was eventually discovered that the first high AE activity linked to the onset of corrosion in the rebars, and the second high AE activity could be caused by concrete .craking



When these findings are compared to the deterioration process depicted in Figure 1, it is reasonably established that AE monitoring can identify two important phases in the corrosion process. Small AE events of other-type cracks are actively observed at the onset of corrosion in rebar. Tensile cracks are formed during the nucleation of cracking in concrete.

5.CONCLUSIONS

The first portion of the paper proposes a quantitative evaluation of concrete damage using AE rate-process analysis and damage mechanics. The DeCAT programme was created to implement the technique. The following are our conclusions.

- The relative damage is calculated using the DeCAT analysis and the ratio of the initial modulus of elasticity to the intact modulus.
- The analysis is used to assess the mechanical properties of recycled concrete. Crushing, heating, milling, and pulse discharge were used to obtain recycled aggregate. The samples were compressed after being made into cylindrical concrete samples with similar mix proportions. The evaluated relative dam- ages are in reasonable accord with the actual deterioration degrees of recycled concrete.
- As the relative damage, the experimental value of concrete made from recycled aggregate using the pulse-discharged method was compared to that of original aggregate. It is confirmed that the relative dam- age of the analytical value, estimated by the DeCAT analysis without knowing the original aggregate value, is in striking agreement with the experimental value.

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- The application of continuous AE monitoring in the corrosion process is investigated in the second part. Because high AE activities are observed during the corrosion process, the RA value and average frequency, as well as the b-vale of the AE amplitude distribution, were estimated. Chloride ion ingress was monitored and analysed in comparison to AE results. The following are our conclusions.
- During the first period of strong AE activity, the RA values rise, the average frequencies fall, and the b-value rises. This means that as AE sources, small shear cracks are actively formed. As the second period approaches, the RA values become low, the average frequencies increase, and the b-values decrease. The fact shows that rather substantial tensile cracks are created as a result of corrosive product expansion.
- When compared to AE data, it is discovered that corrosion begins when the chloride concentration reaches the lower-bound threshold. When the chloride concentration exceeds the threshold level stated in the regulations, corrosion cracking begins.
- Once removing the rebars from the specimen, it is concluded that rebars may corrode once chloride concentration above the stipulated threshold, and AE activities after 100 days are caused by concrete.cracking owing to growth of corrosive compounds in rebars.
- A rebar skin was investigated by scanning electron microscopy (SEM) to determine the state of rebars at the first activity. It is discovered that ferrous ions have vanished. This shows that corrosion begins in rebars during the first phase of strong AE activity.
- These data show that continuous AE monitoring can identify two important stages in the corrosion process: the beginning of corrosion and the nucleation of cracking.

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PREVENTION OF CRACKS BY USING CHICKEN MESH

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ABSTRACT

Cracking is a common problem in concrete structures in real-life service conditions all over the worlds. In fact, crack-free concrete structures are very rare to find in real world. Concrete can undergo early-age cracking depending on the mix composition, exposure environment, hydration rate, and curing conditions. Understanding the causes and consequences of cracking thoroughly is essential for selecting proper measures to resolve the early-age cracking problem in concrete. This paper will help to identify the major causes and consequences of the early-age cracking in concrete. Also, this paper will be useful to adopt effective remedial measures for reducing or eliminating the early-age cracking problem in concrete. Different types of early-age crack, the factors affecting the initiation and growth of early-age cracks, the causes of early-age cracking, and the modeling of early-age cracking are discussed in this paper. A number of examples for various early-age cracking problems of concrete found in different structural elements are also shown. Above all, some recommendations are given for minimizing the early-age cracking in concrete. It is hoped that the information conveyed in this paper will be beneficial to improve the service life of concrete structures. To prevent crack in plastering work we use chicken mesh at junction of different material such between wall and column junction where coefficient of thermal expansion of different material is different and due to that chances of crack after plastering is bound to occur that's why we use chicken mesh. Chicken mesh has the same function as reinforcement does in concrete. It strengthens the plaster against forces. Mainly to avoid the crack formed due to insufficient gap filling between RCC column & Brick wall joint. Therefore, we used chicken mesh in plastering and also due to this there will a proper bond formation between finishing surfaces of RCC column & Brick wall. Chicken mesh in old plaster was used to prevent cracking and hold the plaster together should the house experience settlement. The mesh also helps fight cracks caused by the twisting of plaster laths.

KEYWORDS: Dry Shrinkage, Tensile Strength, Compressive Strength, Concrete, Chicken Mesh, Creep, Shrinkage, Thermal Expansion etc.

1.INTRODUCTION

Crack is a complete or incomplete separation of concrete into two or more parts, produced by breaking or fracturing. The crack in concrete is an inherent feature, which can't be completely prevented but can only be controlled and minimized. Concrete being a material having very low tensile strength, readily cracks when such tensile stress beyond the tensile strength of concrete occur in structure. Cracks also occur due to settlement, temperature, shrinkage effect, poor construction practice etc. In this paper, various causes for the above mentioned cracks are discussed. Modern structures are comparatively tall and slender have thin walls are designed for higher stresses and are built at a fast pace. These structures are, therefore, more crack-prone as compared with old structure which used to be low, had thick walls were lightly stressed and were built at a slow pace. Moreover, moisture from rain can easily reach the inside and spoil the finish of a modern building which has thin walls. Thus measures for control of cracks in buildings have assumed much greater importance on account of the present trends in construction.

2. MATERIALS

2.1. Cement

Ordinary Portland Cement 53 was chosen for experimentation, owing to the high initial strength and quicker setting time. The physical properties as provided by the manufacturer are tabulated in table1.

Table 1. Physical Properties of OPC 53 Cement

PHYSICAL PROPERTIES	REQUIREMENTS	OPC53
Fineness	225(min)	225
Initial setting time	300(min)	163
Final setting time	600(max)	315
Specific gravity	3.15	3.15

2.2. Coarse Aggregates

Locally available coarse aggregates having a maximum size of 20mm, and 12.5 mm size were used in this work. The aggregates were tested as per Indian Standard Specifications.

Table 2. Physical Properties of coarse aggregates

PHYSICAL PROPERTIES	VALUES
Specific gravity	2.17
Water absorption	0.163
Bulk density	1550
Fineness modulus	4.829

3. CHICKEN MESH

Table 2 Chicken wire for plaster is available in different materials, mesh size, and wire diameter

ITEMS	MESH	WIRE	ROLL	ROLL
PMCW-13	13	0.6,0.7,0.8,1.0	1,1.5,2.0,2.5	50, 100, 200m
PMCW-20	20	0.6,0.7,0.8,1.0,1.2	1,1.5,2.0,2.5	50, 100, 200m
PMCW-25	25	0.6,0.8,1.0,1.2,1.4	1,1.5,2.0,2.5	50, 100, 200m
PMCW-28	28	0.8,1.0,1.2,1.4,1.6,1.8	1,1.5,2.0,2.5	50, 100, 200m
PMCW-30	30	0.6,0.8,0.9,1.0,1.2,1.4	1,1.5,2.0,2.5	50, 100, 200m
PMCW-35	35	0.6,0.8,1.0,1.21,1.4,1.6	1,1.5,2.0,2.5	50, 100, 200m
PMCW-45	45	1.0,1.0,1.2,1.4,1.8,2.0	1,1.5,2.0,2.5	50, 100, 200m
PMCW-50	50	0.6,0.7,0.8,1.0,1.2	1,1.5,2.0,2.5	50, 100, 200m

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4. METHODOLOGY

4.1. Cement to aggregate ratio

In order to find ideal cement content, various cement content for aggregate sizes 12.5-20mm. With the size of aggregate kept constant, four different cement contents were considered with a fixed water-cement ratio and superplasticizer content. A water-cement ratio in the range of 0.27-0.30 was considered as it gives higher strength. With the usage of superplasticizer, good workability could be maintained at a lower water-cement ratio, thus, a plasticizer content of 0.17% by weight of cement content was fixed by trial-and-error method, as higher plasticizer usage led to the flow of cement paste to the bottom. The cement content used in the mixture is of great importance to yield a high strength pervious concrete. The ideal cement to the aggregate ratio for aggregates ranging from 10mm- 20mm is 1:4 to 1:4.5. The aggregate to cement ratio varied from 4.4 to 5.6. Every mix was hand-mixed using an Indian shovel, until the concrete was visibly moist, and was placed and uniformly compacted into 150 mm standard moulds. To test these mixes, cubes were tested for a 28day compressive strength as per IS 516-1959. The mix with better strength and adequate permeability was chosen for further experimentation with the optimized cement content.

The technology of plaster mesh

- The wire mesh is fixed to the connecting parts between the wall and the beam, panel and the column, and the connecting parts between the door hole and the ring beam. The width of exterior wall mesh is 200 mm, the width of interior wall mesh is more than 150 mm and the width of the wire mesh should be 200–300 mm.
- When the wall height is more than 30 m and the ceramic tile for the exterior wall is heavy we should install the steel wire mesh on the extra wall and the lap length is 100 mm.
- The lap for steel wire mesh should be smooth continuous and firm, and the lap length should be more than 100 mm. When we use the buttwelded wire panels the lap length should be more than 100 mm.
- We should smooth and straighten the steel wire mesh before attaching. The four corners are fastened on the major structure and the masonry foundation, and we should get command of the location so that the steel wire mesh can be fixed to the right location. The way to fix the steel mesh depends on the foundation.
- We could put the expansion bolts into the wire mesh or embed the steel bar with spot welding. The distance between the fixed points should be less than 300 mm–500 mm so that the steel mesh wouldn't deform. The distance is 5 mm from the foundation surface.
- The connecting of the wire mesh should be flat, continuous and firm. The length of the connecting should be more than 100 mm.
- The protruding part of the wall should be totally attached to the wire mesh because this wall is easy to crack because of the temperature.

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Plastering after installing the wire mesh

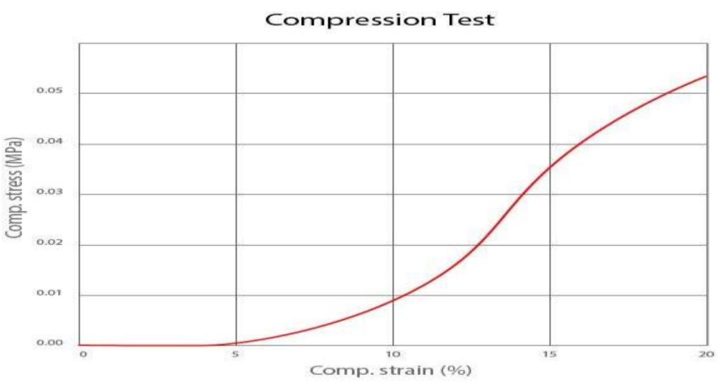
- Examining the plaster mesh is necessary and then plaster the walls.
- The connecting between the foundation and plastering layer must be firm. The cement paste and the professional mortar of 1 mm–2 mm is used to primer. We should plaster and pack it down hard in layers and make sure that there is not cavity.
- The wall wire mesh must be putted in the plastering layer. The distance between the steel mesh and the foundation should be more than 5 mm and it can prevent the steel mesh from rust.
- There is thickness standard about the plastering.
  - For the interior wall, the normal plastering thickness is 18 mm, the intermediate plastering thickness is 20 mm and the advanced plastering thickness is 25 mm.
  - For the plastering thickness of the exterior wall, the wall is 20 mm, the plinth is 25 mm and the concrete masonry plastering thickness should be within 15 mm.

5. RESULT AND DISCUSSION

5.1. Compressive strength of test (chicken mesh)

The compressive testing machine was used to test the entire concrete cylinders for crushing strength at 28 days respectively. The compressive strength for concrete grade M30(design mix) were investigated for the control mix and while (opc) cement of grade 33,43and 53. The results of compressive strength test of curing period are provided in the below table. Through the laboratory observations it was perceived that using of chicken mesh on the top layer gives some execess strength to the concrete

Grade of cement	28days compressive
33grade	34.5Mpa
43grade	46Mpa
53grade	57Mpa



Graph 1 compressive strength

5.2 Tensile strength test

The tensile strength of concrete is a very important parameter that is considered in the design. It can make a significant impact on other strengths of the structural element in flexure as it is about 10% of concrete compressive strength.

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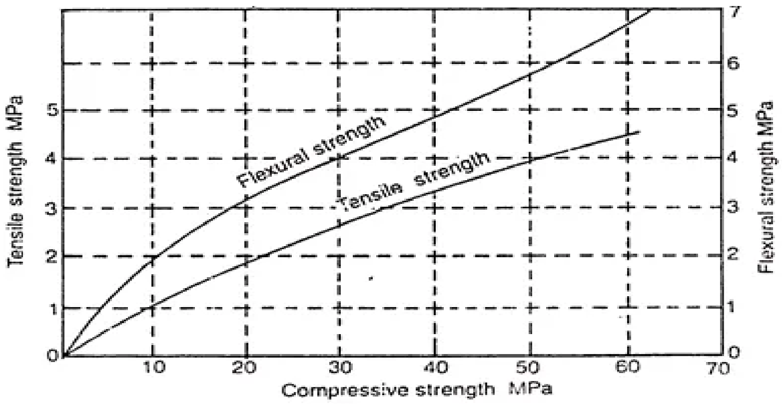
SL.NO	SUPER PLASTICIZERS	TENSILE STRENGTH(MPA)			
		C1	C2	C3	C4
1	0	1.18	1.14	0.84	0.63
2	0.5	1.45	1.35	1.10	0.93
3	1.0	2.03	1.31	1.32	1.08
4	1.5	2.63	1.36	1.10	0.99



GRAPH 2 TENSILE, FLEXURAL AND COMPRESSIVE STRENGTHS

6. CONCLUSION

Thus in the concluding paragraph, we can say cracking may occur anywhere in concrete but if above given preventions and causes are kept in ind, it may lead far beter results and much lesser visible cracks and hence a better safer and stronger structure. Cracking is overlooked may result in big and hazardous accidents also. This paper covers all the basic reasons and their preventions that need to be taken care of in construction process on a small or medium level. With the growing technology, there are many post construction methods available for the cracks removal or healing. Also they are now some special types of concretes discovered such as “Self-healing concrete” that themselves repair and heal the cracked portions, thus saving a lot of money, energy and time for post methods. There are polymer composites available to improve resistance against wearing, compressive strength, impermeability, durability as well as chemical attacks resistance. And if not above mentioned admixtures or polymers are used in initial phase then there are many repairs techniques to be followed at a later stage like stitching , sealing, routing and grouting. Though with the help of all above techniques cracks can be covered up even at later stage but again it is always focused to adopt prevention rather than looking for cures afterwards. From the above paper description and some case study we have concluded that some prevention could be taken care of during the construction process itself.

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AN EXPERIMENTAL REASEARCH ON STRENGTH PARAMETER OF CONCRETE PARTIAL REPLACEMENT CEMENT WITH LIME POWDER

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ABSTRACT

This paper represents the experimental results of a concrete using lime powder as a partial replacement. The present work is to investigate the effects of lime powder in concrete production to produce high strength concrete. The compressive strength, flexural strength and split tensile strength tests were carried out with different proportioned lime powder at different curing days, as well as finding the optimum percentages of lime powder replacements to give targeted strengths. The concrete samples were prepared by adding lime powder about 0% to 30% with an interval's of 10% as a partial replacement to cement. All these samples were cured for 7 days, 14 days and 28 days before the different tests are to be done like compressive strength test, split tensile test and flexural test were carried out. Overall of 135 specimens were casted and tested for five mixtures in their proportions so as to determine by the mechanical properties of the concrete. Total of 45 cubes were casted for determine compressive strength test with dimensions of (150mm x150mm x150mm) and 45 prisms were casted for determine flexural strength test with dimensions of (100mm x100mm x500mm) and remaining 45 cylinders are casted for determine split tensile strength test with dimensions of (100mm x300). After the test results results should be coppared.The results showed a decrease in density due to increase in lime powder content and a high strength value obtained for 30% replacement of lime powder.

KEY WORDS: Concrete, Lime powder, Cement, Compressive Strength, flexural strength, split tensile strength, M20 grade

1. INTRODUCTION

1.1 About Lime Powder

Lime Powder is a common and abundant sedimentary rock that contains high levels of magnesium and calcium magnesium carbonate or maybe dolomite, as well as minerals. Separating limestone from mines and quarries is the first step in the manufacturing process. It is possible to make hydrated lime by smashing quicklime, adding water to the smashed lime, then grouping the hydrated lime to ensure that it satisfies customer criteria before delivery.

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1.2 Why should we used lime powder in concrete?

Because lime concrete has a degree of flexibility that normal concrete does not, it is an ideal base for load bearing walls, columns, or laying under flooring. It also has a waterproofing quality that keeps subterranean wetness out of floors and walls. Lime concrete can also be created quickly and inexpensively while still producing a long-lasting substance that resists weathering and wear and tear. In the construction business, industrial and agricultural waste products are used. Lime sludge, a waste product from the paper and pulp industries, has been chemically, physically, and thermally examined in order to assess its suitability for use as a construction material. The construction industry's adoption of this waste product has concluded.

1.3 Properties of lime powder

1. It should have a high degree of flexibility.
2. It should be adaptable and simple to use. When used in mortar, it should provide the stonework more strength.
3. It should take less time to become a hard property and take less time to become a hard property.

Table 1 Physical and Chemical properties of Lime Powder

Physical appearance	**Dry white power**
C_aO	>83.3
M_gO	< 0.5
Fe_2O_3	< 2
Al_2O_3	< 1.5
SiO_2	< 2.5
SO_3	< 0.5
Na_2O	0.4 - 0.5
CO_2	< 5
$CaCO_3$	< 10
Specific gravity	2
Over 90 lm (%)	< 10
Over 630 lm (%)	0
Insoluble material	<1

Fig.1 Lime powder

Advantages of lime powder

1. A great supply of materials is available.
2. Economically cheap in coast
3. Fire resistance and good binding properties
4. It's easy to work with.
5. It has a long lifespan.
6. The structure has a lovely finish.

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2. LITERATURE REVIEW

(Namagg and Atadero) (2009) discussed the preliminary stages of a project to investigate the usage of significant quantities of high lime in concrete. Lime was employed to partially replace cement and fine aggregates by the authors. In their study, they investigated replacement percent from 0% to 50% at the International Conference on Biological, Civil, and Environmental Engineering (BCEE-2014) March 17-18, 2014 Dubai (UAE). They discovered that concrete containing 25 percent to 35 percent lime had the best compressive strength. They determined that this was due to high Lime's pozzolanic action. **(Sivaram A.v.s)** Changes in pH and Ca concentration are common in alkaline cementitious materials, which have high pH and Ca ions. In comparison to cementitious materials, demineralized or pure water has a low pH and Ca ions (for pure water, pH is around 7.00 and Ca ion is virtually zero). As a result, when cementitious materials came into contact with water, the calcium ion as well as the pH of the water increased. Using varied water to cement ratio samples, Haga et al. [20] observed pH and Ca concentration fluctuations. They discovered that samples with a greater water to cement ratio had a larger amount of Ca in the leachant during the early leaching period. For Ordinary Portland Cement, the pH and Ca concentration of the leachant (OPC) Experimental work on Split Tensile Strength, Flexural Strength, and Compressive Strength of Concrete by Dr. A. Anbuchezian et al. (A. Anbuchezian & Kumar, 2018). They replaced fine aggregate with groundnut shells and lime powder with cement in the concrete. The authors of this study have partially substituted fine aggregate with groundnut shell in percentages of 5%, 10%, 15%, and 20%, and lime powder in a general ratio of 20%. They found that groundnut shell concrete has a higher strength range of 5% to 10% than normal concrete, while lime concrete has a higher strength range of 20% than normal concrete.

3. MATERIALS

The purpose of this study was to see how lime affects the physical qualities of concrete when it is employed as a cement substitute. This module depicts the properties of the concrete used, the mixing technique, and the testing performed. The mixing was carried out in a laboratory setting. The qualities of strength and workability were studied in this investigation.

The experimental program is mainly divided into:

1. Workability characteristics
 a) Slump
 b) Compaction factor test
2. Strength characteristics
 a) Compression test
 b) Flexural strength test
 c) Split tensile strength test

3.1 CEMENT

Cement is a bonding medium with cohesive and adhesive qualities that allows it to bind together various construction components and form a compacted assembly. The 53 grade of ordinary Portland cement (O.P.C) was chosen for testing because of its strong initial strength and rapid setting time. It's a type of hydraulic cement. It is used to make concrete that has the properties of setting and hardening, and when the chemical properties react with water, O.P.C does not disintegrate in water, instead setting and hardening.

3.2 TESTS ON CEMENT

a) Field Test's

The following are field test's:

- Take a close look at the concrete. There must not be any lumps.
- Cement should be a greenish grey colour.
- Drill your hand into the cement bag and wait for it to cool down
- Rub a pinch of cement between your fingers; the texture should be smooth and grainy.

(b) Laboratory Testing

- Fineness test
- Setting time test
- Strength test
- Soundness test
- Heat of hydration test

Table 2. Physical Properties of OPC 53 Cement

Physical Properties	OPC 53	Requirement
Fineness	225	225(min)
Initial setting time	32	30(min)
Final setting time	315	600(max)
Specific gravity	3.13	3.15

3.2 Course Aggregate:

On the 4.75mm sieve, course aggregate is a material that will be kept. This study employed locally available coarse aggregates with a maximum size of 20mm and a size of 12.5 mm. The aggregates were subjected to tests in accordance with Indian Standard Specifications.

Table 3. Physical Properties of coarse aggregates

Physical Properties	Value
Specific gravity	2.16
Water absorption	0.164
Bulk density	1550
Fineness modulus	4.829

3.3 Fine Aggregate:

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Fine Aggregate is defined as aggregate that passes through a 4.75mm IS Sieve. They are responsible for filling voids in the concrete mix. The fine aggregate should have a rounded shape for enhanced workability and economy, as evidenced by the use of less cement.

Table 4. Physical properties of fine aggregates

Physical Properties	Value
Specific gravity	2.65
Water obserption	0.601
Bulk density	1529
Fineness modulus	2.8

3.4 Quality of Water

The water used for mixing and curing should be free of harmful chemicals such as alkalis, acids, oils, salt, sugar, organic materials, plant growth, and other substances that could harm bricks, stone, concrete, or steel. In most cases, potable water is sufficient for mixing. The pH of the water should not be less than 7.0.

4. EXPERIMENTAL INVESTIGATIONS

4.1 TESTS CONDUCTED FOR CONCRETE MIX

4.1.1 workability

The concrete mixture must be precise and workable in order to be correctly placed and solidified using the available processes to completely fill the forms and surround the reinforcement and other concrete items.

- Slump Cone Test
- Compacting Factor Test

4.1.2 Slump cone test

Slump Cones are used to determine the workability of a new concrete mix according to the required standards. The slump cone test is used to determine the water/cement ratio indirectly, for acceptance purposes, or to record mixture properties.

Bottom Diameter: 20 cm
Top Diameter: 10 cm
Depth=30cm

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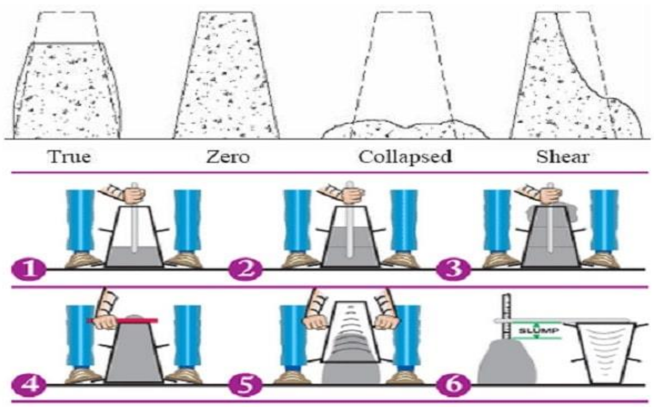
Fig. 2 Slump Cone Apparatus

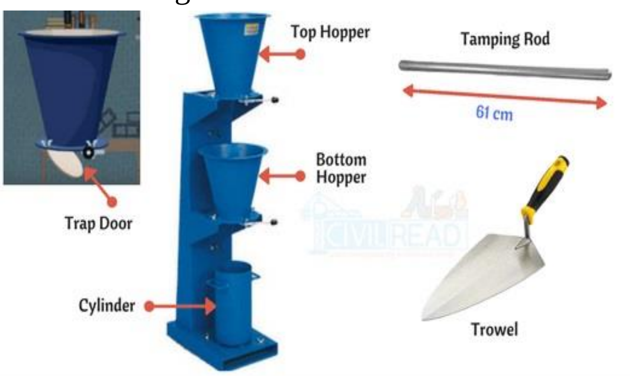
Types of slumps

- True Slump
- Shear Slump
- Collapsed Slump.



4.1.3 Compaction factor test

The compacting factor test is primarily intended for laboratory usage, although it can also be used in the field. It is more precise and sensitive than the slump test, and it is especially useful for very low workability concrete mixes. The slump test is unaffected by such dry concrete. Figure 1 shows a diagram of the device.



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$$\text{Compaction Factor} = \frac{\text{Weight of Partially Compacted Concrete}}{\text{Weight of Fully Compacted Concrete}}$$

$$\text{Compaction Factor} = \frac{Wp}{Wf}$$

W1 = Empty Cylinder Weight
Wp = Partially Compacted Concrete Weight (W2-W1)
Wf = Fully Compacted Concrete Weight (W3- W1)

4.2 specimen preparation and curing:

Cubical In the laboratory, plain cement concrete samples with dimensions of 150mm150mm150mm were made. Using a typical 2.5 kg proctor hammer, compaction should be done in three levels, with 25 blows each layer. Vibrating the sample should be done in a consistent manner. Three batches of samples were created. After 1 day in the moulds, remove them. The three batches were submerged (wet curing-WC). The process of curing lasted 28 days.

4.3 Concrete Mix

Concrete is classified into different classes based on its strength, such as M5, M7.5, M10, M15, and M20, among others. M stands for Mix, and the number represents the concrete's typical compressive strength (fck) in a 28-day direct compression test. If the proportions for M20 concrete are 1:1.5:3, then 1 part cement, 1.5 part fine aggregate (sand), and 3 part coarse aggregate (crushed stone) should be used in the mix.

grade of	nominal mix ratio
M20	1:1.5:3

4.4 Compressive strength test

Concrete has a higher compressive strength than steel, but it has a low tensile strength. According to IS 10262: 1982, the characteristic and design strength values for various grades of concrete are given for various mixes of concrete. The compressive strength of the samples manufactured in the standard mould of size 150mm X 150mm X 150mm must be tested, and the cubes must be stored for curing, and the compressive strength test was done according to IS 516: 1959 for 7days, 14days, and 28days for usual mix and partial replacement samples.

Compressive strength is defined as the force or load applied to the cross-sectional surface area at the point of failure = (P)/ (A)

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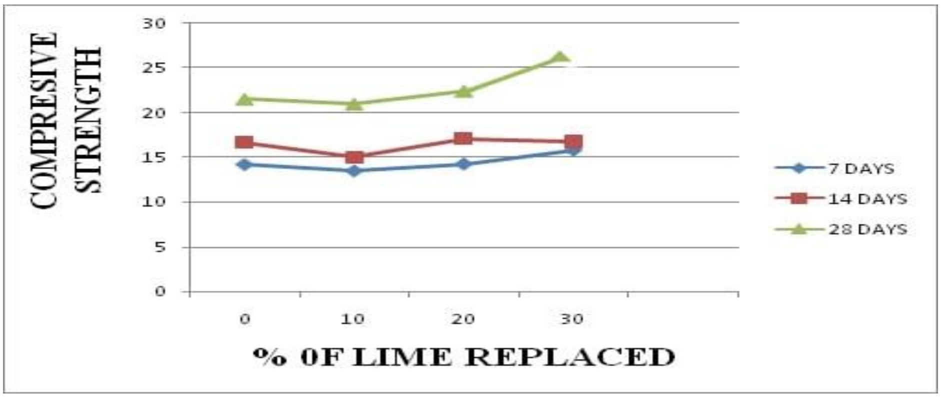
5. RESULTS AND DISCUSSIONS

The compressive strengths of all concrete mixes created by replacing cement with Lime at varying percentages are shown here. All concrete mixtures' strengths are determined after 7, 14, and 28 days of water curing. The tables that follow show all of the outcomes.

Table 5 Compressive strengths for all samples

SAMPLE NO	%LIME	COMPRESSIVE STRENGTS N/mm2		
Sample1	0	14.5	16.7	26.6
Sample2	10	13.7	15.0	20.8
Sample3	20	14.25	170.8	22.6
Sample4	30	15.9	16.73	24.4



Graph 1 Compressive strength

Showing compressive strength at various days of curing vs % of Lime Powder Discussion on Compression Value

The compressive strength of the concrete mix gradually improved as the percentage of lime added increased, up to 30% of cement being replaced by lime. As shown in the table and graphs, the concrete mix created by replacing 30% of the cement with lime has a higher compressive strength. If strong compressive strengths are required in the same grade of concrete, a mix containing 30 percent lime can be used.

6. CONCLUSION

The maximal compressive strength of the concrete is achieved by replacing 30 percent of the cement with artificial Lime powder. When 30 percent of the cement in a concrete mix is substituted with Lime powder, the slump and compacting factor values are significantly higher than in a standard mix. Finally, a concrete mix with 30% lime powder replaces cement to produce the ideal mix with great compressive strength and workability.

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ANALYSIS OF PLASTIC BRICK WALL AS LOAD BEARING CONSTRUCTION AND FRAMED STRUCTURES

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ABSTRACT

Human civilization includes the crucial part of development works as revolutionary works. Humans constructed initially, as a civil engineer, the load-bearing walls. In order to beautify the splendid of building and its sustainability besides sacrificing strength, stability, performance, the existence of the structure and environmentally fine properties, the utilization of unique eco-friendly materials is viewed in a load-bearing masonry structure. Later as an introduction of framed constructions and improvement of working stress method and limit state method has been constructed. But the modern find out about reintroduces load-bearing partitions with a plastic brick wall which will be carrying more load-bearing potential with reasonable economy when in contrast to that of the framed structure of the identical load.

Keywords: Framed structures, Plastic bricks, fly ash, Environmental, load bearing walls, Economy.

1. INTRODUCTION

Energy saving and strength efficiency of constructions are recently two of the most necessary problems in the world because of each economic and environmental worries [1]. Energy consumption in buildings accounts for about 32% of total consumption, about half of which is lost through the walls [2]. The plastic bricks are good material for building. It is usually used at various buildings and compound walls. It's very cost-effective, solid and accessible at all local building material shops. Many people have been using these hollow bricks because they reduce heat and keep the building cool. There is a need and massive scope in this country of intensifying experimental, research and study in the discipline of load-bearing masonry in order to make higher and least expensive use of this exceptional and versatile constructing material, the brick. In India, we have been making an attempt to preserve tempo to some extent with the developments taking area in other nations in regard to masonry [3]. Bricks ought to be of high strength and dense so that the moisture absorption be less, in any other case the existence expectancy of reinforcement will be lowered [4].

Plastic is a very common material that is now widely used by everybody in the world. Plastic plays a predominant role in reusable in this era, as it is compact and light in weight. Common plastic items that are used are covers, bottles, and food packages. The great problem with plastic is its decomposition. Plastic is made of polymer chemicals and they are non-biodegradable. This means that plastic will not decompose when it is placed in earth. Though plastic is a very useful material that is flexible, robust and rigid they become waste after their use and they pollute the air and land. Recycling is processing use waste materials into new products to prevent waste of potentially useful materials.

The increase in the popularity of using eco-friendly, low cost and lightweight construction materials in building industry has brought about the need to investigate how this can be achieved by benefiting to the environment as well as maintaining the material requirements and their standards. From the advantages of plastic recycling procedure is used. For the production of plastic bricks is an optimal method for controlling the problem by decomposition of plastic waste and also it costs economical for the production of building materials. In this study, plastic waste from factories will be used to incorporate with cement and sand to produce sand bricks. The bricks will then be tested to study the compressive strength, efflorescence and water absorption. In the recent past research, the replacement and addition have been done with the direct inclusion of polyethylene, polyethylene terephthalate (PET) bottles in shredded form, chemically treated polyethylene-fiber, PET in small particles form by replacing natural coarse aggregate. Most of replacements have been done by volume calculation, and showed the decreased in compressive strength as the increased plastic waste. In this study, recycled plastic waste have been introduced in the form of crushed. The replacement of plastic waste material has been done by weight.

Fig 1. Plastic polluted waste in the world

1.1 PRESENT SCENARIO OF WASTE GENERATION IN INDIA:

Growth of population has increased our urbanization as a result rising standard of living due to technological innovations have contributed to an increase both in the quantity and variety of solid wastes generated by industrial, agricultural activities, mining and domestic. Globally the estimated quantity of wastes generation was 12 billion tones in the year 2002 of which 11 billion tones were industrial wastes and 1.6 billion tones were municipal solid wastes (MSW). About 19 billion tons of solid wastes are expected to be generated annually by the year 2020. Annually, Asia alone generates 4.4 billion

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tons of solid wastes and MSW comprise 795 million tons of which about 48 (6%) MT are generated in India. MSW generation in India, is expected to reach 300 million tones and land requirement for disposal of this waste would be 169.6 km2 as against which only 20.2 km2 were occupied in 1997 for management of 48 Million tones.

As it is studied that apart from municipal wastes, the organic wastes from agricultural sources alone contribute more than 350 million tons per year. However, it is reported that about 600 million tons of wastes have been generated in India from agricultural sources alone. The Quantity of wastes generated from agricultural sources are sugarcane baggage, paddy and wheat straw and husk, wastes of vegetables, food products, tea, oil production, wooden mill waste, coconut husk, jute fiber, groundnut shell, cotton stalk etc. In the industrial sector inorganic solid waste could are coal combustion residues, bauxite red mud, tailings from aluminum, iron, copper and zinc primary extraction processes. Generation of all these inorganic industrial wastes in India is estimated to be 290 million Tons per annum. In India, 4.5 million tons of hazardous wastes are being generated annually during different industrial process like electroplating, various metal extraction processes, galvanizing, refinery, petrochemical industries, pharmaceutical and pesticide industries.

1.2 RESEARCH LITERATURE

M. T. S. Lakshmayya (2016) concluded as, having several advantages like low water absorption, high thermal insulation, high fire protection, high sound insulation and eco-friendly to environment Cellular Lightweight Concrete blocks can be used for block work constructions. From the above statements, if cost is the factor Fly Ash bricks are suggested to use since it is cheaper and readily available all over. Also suggested by many organizations and Government to use Fly Ash in construction sector since, it is available in large quantities and even eco-friendly in nature [3].Rafiq Ahmad and Mohammad Iqbal Malik (2014) concluded a brick wall failure occurs on one side of the wall through a crack formation, only the upper layer failure occurs in the case of a hollow block maceration. The concrete hollow construction of the masonry reflects a quicker building method than the brick building. Block makers use less mortar than brick labyrinth due to their thickness [5].Lingeshwaran N (2019) showed the results of the merits and demerits of the axial and lateral load reinforcement walls of different types of aspect ratios from height to width, as shown in present case studies, could give better results in the seismic performance of buildings made of macerated material with an increase in structural security and competitiveness [4].Shashank B S (2014) concluded the analysis and design carried out by using structural analysis software. By comparing the material required for the both building approximately it is noticed that the load bearing masonry structure is significantly more economical than RC framed structure [6].As in India, because of the advantages of the construction of load bearing masonry, IIM Ahmadabad is a profound example of such structures in India [3]. In this case study, the hollow brick wall as load bearing construction is compared with framed structures using some data like Clay bricks (IS 2212: 1991), Fly ash bricks (IS 12894:2002). Also, the design work data taken from Hand book on Masonry design and

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Construction (SP 20(S&T): 1991). Also using the help of some code books like Cause and prevention of cracks (SP 25: 1984), Earthquake resistant (IS 4326: 1976), Building materials (SP 21: 1983), Unreinforced masonry (IS 1905:1987) [7], and Construction practice for hollow block (IS 2572:2005).

2. MATERIALS USED

2.1. Cement

Cement is a binding agent that sets and hardness to fit onto construction units such as blocks, bricks, walls, and so on, is a large construction material. In this case, a standard 53-grade Portland K.C.P cement is used. Ordinary Portland cement is by far the most important type of cement. Prior to 1987, there were only one grade of OPC which is governed by IS 269-1976.After 1987 higher grade cements were introduced in India.

The OPC was classified into three grades, namely 33 grade, 43 grade, 53 grade depending upon the strength of the cement at 28 days when tested as per IS 4031-1988. If the 28 days strength is not less than 33 N/mm2, it is called 33 grade cement. If the strength is not less than 43 N/mm2, it is called 43 grade cement. If the strength is not less 53 N/mm2, it is called 53 grade cement. But the values of actual strength obtained by these cements at the factory are much higher than BIS specifications.

Table 1: Properties of cement

S.NO.	Physical property	Test result
1.	Compressive Strength(Mpa)	48.35
2.	Fineness (%)	6
3.	Specific Gravity	3.06

2.2. Coarse aggregate

The present study hires granite stone aggregates of 20 mm and less than 20 mm. By similar grit, sieve checking and fineness section are the different tests performed on aggregates. When they exceed a thickness of 4.75 mm, such aggregates are considered as coarse as per IS 2386-1: 1963 .

2.3. Fine aggregate

The fine aggregate used was clean river sand as per and basic gravity, sieve analysis, and fineness modulus tests were performed on the sand. In Guntur, a firm bought fine (10 mm) and fine clay aggregates. The aggregates have an incomparable thickness of less than 4.75 mm. Particulate sand must be free of clay or organic sterile as per IS 2386-1: 1963.

2.4. Water

Potable, acid-free water and impurities in aggregate should be used. Water quality and quantity must be checked obligatorily. The PH value of water should be in between 6.0 and 8.0 according to IS 456 –2000

2.5 Plastic

LDPE is defined by a density range of 0.918–0.931 g/cm^3. It is not react at room temperatures, except by strong oxidizing agents, and some solvents cause swelling. It

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can withstand temperatures of 80 °C continuously and 90 °C (194 °F) for a short time. Made in translucent or opaque variations, it is quite flexible and tough.

LDPE has more branching (on about 2% of the carbon atoms) than HDPE, so its intermolecular forces (instantaneous-dipole induced-dipole attraction) are weaker, its tensile strength is lower, and its resilience is higher. Also, because its molecules are less tightly packed and less crystalline due to the side branches, its density is lower.

2.6 Fly ash

Fly ash is generally finely divided residue ash particle resulting from the combustion of coal in the furnaces which blows along with flue gas of the furnace. Theses ash are collected with the help of electric precipitators and termed as fly ash. Fly ash is the most widely used pozzolanic material all over the world. In UK it is termed as pulverized fuel ash i.e. PFA. Although it is a residue of coal but it contain chemical components like silicon dioxide, aluminum oxide, iron oxide in major quality and apart from these substance reactive silica, magnesium oxide, sodium oxide, calcium oxide, titanium, lead oxide are also found in major quantity which marks fly ash suitable to be used in combination with cement in the production of concrete.

Fig. 2: Fly ash

2.7 Waste Plastic for Bricks

Pavement in construction is an outdoor floor or superficial surface covering. Paving materials include asphalt concrete, stone such as flag stone, cobblestone, and sets , artificial stone, bricks, tiles, and sometimes wood. Inland scape architecture pavements are part of the hard scope and are used onside walks, road surfaces, patios, courtyards. Paver block technology has been introduced in India in construction a decade ago for a specific requirement namely footpath and parking areas etc. Now paver block is being adopted extensively in different use. In this investigation various properties such as compressive strength, split tensile strength and water absorption of paver blocks consisting of plastic wastes, unconventional materials such as quarry dust and fine aggregate of various percentage replacement are used. Cement-concrete tiles and paving blocks are precast solid products made out of Cement concrete. The product

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is made in various sizes and shapes viz. rectangular, square and round blocks of different dimensions with designs for interlocking of adjacent tiles blocks.

3. EXPERIMENTAL WORK

3.1 Properties of substance

In this work, some tests have been conducted to detect the mechanical properties i.e. compressive strength of materials used according to ASTM standards. For this investigation, a mortar ratio of 1:3 was chosen. The beams are combined in line with IS 10262: 2009 [9] and IS 456: 2000 respectively [10]. With the assistance of mason, brick size walls with 1:3 of the mortar ratio of 230 mm x 105 mm x 70 mm are built. The hollow brick compressive strength was obtained from ASTM C67-11. Table 1 shows the compressive strength of brick taken from the standard ASTM.

3.2 Mix proportions

M40 concrete was produced with varying W/C of 0.5, 0.6, 0.7, 0.8 and 0.9 respectively. The targeted mean compressive strength was 45MPa and a workability of 25mm-100mm.

The concrete was produced for mild exposure and ACI 211.1-91 mix design proportioning method was utilized for designing the concrete mixture (Day et al., 2002).

The fresh concrete was allowed to cure for 24hrs before it was demolded and kept in water to undergo further curing for 7, 14, 21, and 28days respectively (ASTM C 192, 2002). All the aggregates were utilized in their surface saturated condition (Ejiogu et al., 2017).Five specimens were produced for each test and the average results were taken. A total number of 240 samples of concrete were produced for the work.

3.3 Design Mix Proportion for the Fresh Concrete Mix

Table 2: Design Mix Proportion for the Fresh Concrete Mix

S.N	W/	Cement (CMT)	Water content	Sand Content	Course aggregate
1	0.5	520	280	501.08	1087.4
2	0.6	520	336	501.08	1087.4
3	0.7	520	393	501.08	1087.4
4	0.8	520	453	501.08	1087.4
5	0.9	520	501	501.08	1087.4

3.4 Fabrication of beams

Deflections in the beam is principally due to bending. The forces mounted on the beam effects in impact forces at the beam assist levels. The standard has an effect on of all the masses appearing on the beam is to create bending moments inside the beam and shear forces, in turn, set off inner stresses, strains, and deflections of the beam [11]. The dimensions taken for the beams are 230 x 230 mm of 1500 m length is designed as per code IS 456:2000 [10].

3.5 Detailed reinforcement of beam

All the four (for beams) are reinforced with 16 mm and 8 mm diameter of Fe 500 grade high yield strength deformed steel bars confirmed to IS 1786: 1985. Table 3 informs the beam detailing of reinforcement and the cross-sectional details of beam are shown in Fig. 3.

Table 3: Brick strength properties

S.N.	Materials	Proportion of brick	Average
1	Compressive strength of	ASTM C109-11	9.58 N/mm^2

Table 4: Detailing of reinforced beams

Specimen	Longitudina	Reinforceme	Shear
Beam (1-	Top	Bottom	10No-8 mm

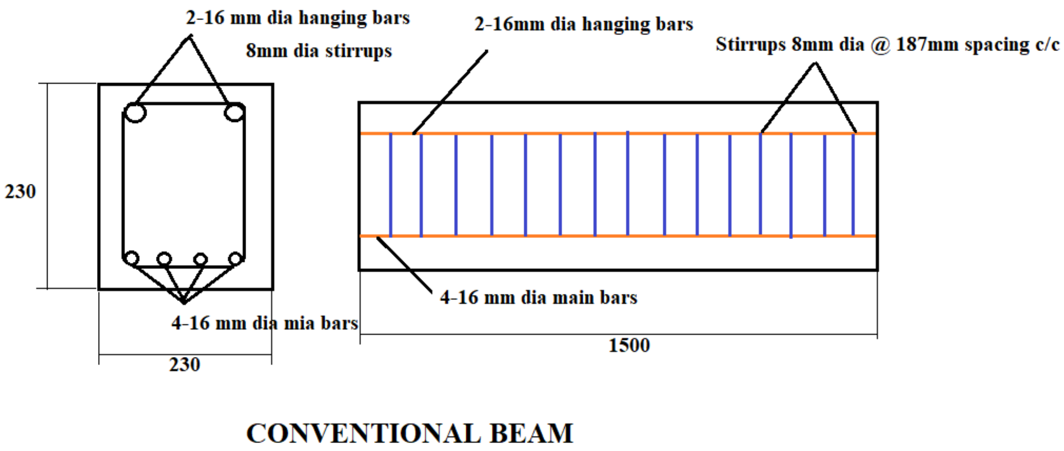

Fig 3: Beam Brick

3.6 Phase of bar bending

Steel bars are used here for the construction of conventional beams for flexural reinforcement, i.e. for main reinforcement and hanging bars, as well as for stirrups. The bar diameter is 16 mm and 8 mm. The steel is to be cut by length according to the measurement of the design. After positioning the main bars and the hanging bars, the distance between the strands should be indicated by means of a jack and put along the line. Using the binding thread to connect all the main bars, hanging bars and strands. The phase of bar bending is done in steel stock yard from.

3.7. Casting of the beam

Four beams have been casted for hollow brick wall and framed structure wall, which is positioned bottom and pinnacle of the wall support. The beams have been casted into a mold dimension of 230x230x1500 mm.

3.8. Wall construction using hollow brick

The brick units have to be attached to cement mortar to create a hollow brick wall. For the construction of wall, English bond will be taken into account. This bond in truth consists of alternating courses of headers and stretchers. A quoin nearer is used

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at the beginning and give up of the wall after the first header to wreck the continuousness of joints.

3.9 Loading frame test for both walls

Loading frame checking out normally makes use of an excessive stiffness assisting structure in opposition to which the check forces can react. The load body includes of two columns, a base beam and a moving crosshead that is outfitted with fixtures are successful of measuring specific mechanical properties that are associated to displacement and power. The constructed wall is now positioned between the two beams and placed on the loading frame machine Using compressive loading cell, the load used to be utilized on both the walls and measured and LVDT was positioned at the aspect face of the hollow brick wall and framed structure wall which is precisely at the core to the wall and at the factor of member displacement is measured.

4. RESULTS AND DISCUSSION

In this work, Experimental analysis was carried out with the measure of load vs deflecting curve on hollow brick wall and framed structure wall.

4.1 For Plastic brick wall

From this unreinforced hollow brick wall, the load is applied to determine some crack failure patterns Discussion: The first crack resisted at 198kN and the load deflection curve has acquired. The crack deflection reaches up to a maximum load of 388kN. The graph values obtained are shown in Fig.4.

4.2. For framed structure wall

The crack failure patterns of framed structure are shown in Fig.5. Discussion: In this wall, the first crack resisted at 225kN and the load deflection curve has acquired. The crack deflection reaches up to a maximum load of 365kN.

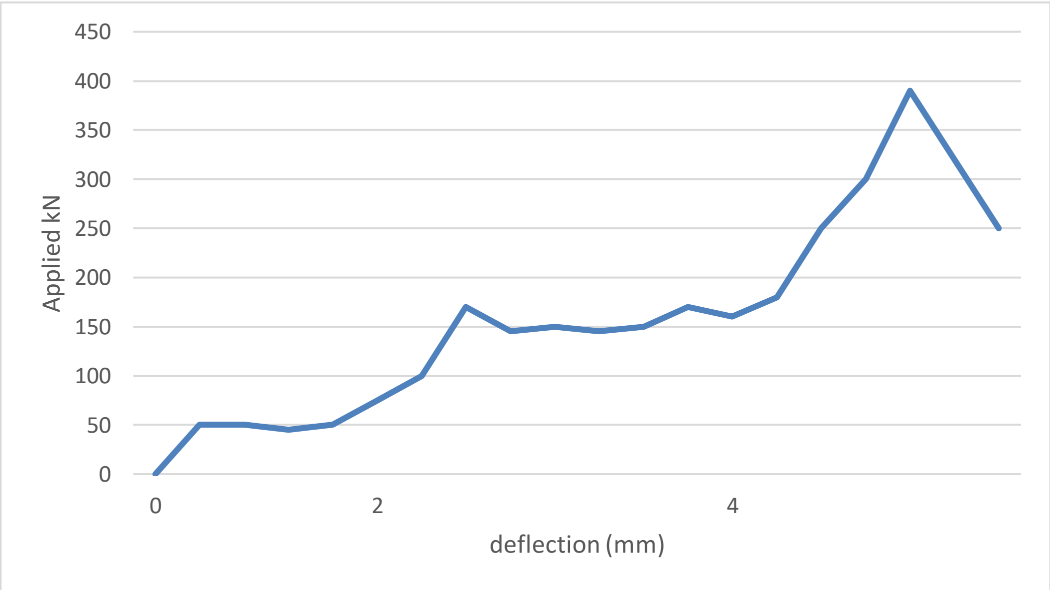

Fig 4: Load deflection curve for Plastic brick wall.

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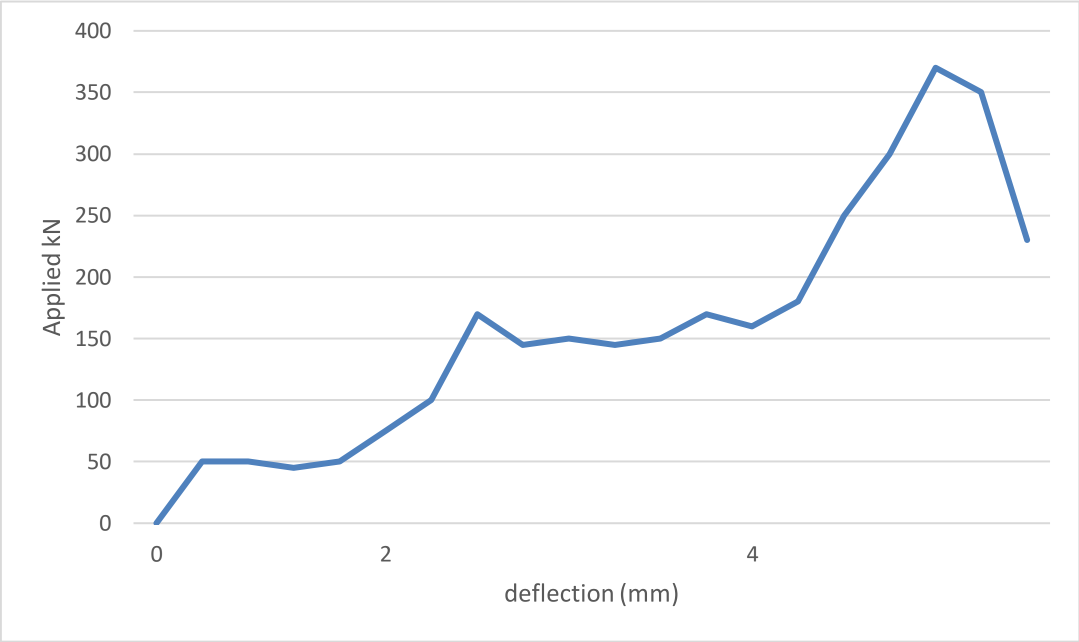

Fig 5: Load deflection curve for framed structure wall.

5. CONCLUSION

As per the results, the flexural capacity is more for framed structure wall while comparing with hollow brick wall. The comparison among conventional framed structure to that of plastic brick wall determines that, in the strength point of view plastic brick wall is very much suitable for economical point of view than framed structure. Since the cost pertained per unit for plastic brick wall is less when compared to that of framed structure. It results in improved structural efficiency of macerated buildings with a boost in both construction safety and competitiveness.

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INTEGRITY APPROACH ON NET ZERO ENERGY BUILDING FOR INDIAN SCENARIO

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ABSTRACT

In current years, there had been a developing variety of tasks and tasks to sell the improvement and marketplace creation of low and internet 0 electricity sun houses and communities. These tasks combine lively sun technology to distinctly green homes to gain very low ranges of internet electricity consumption.

Zero Energy Buildings are environmental pleasant home, and bring tons electricity then it is honestly consumed, seems quite traditional like every other house. Zero Energy Buildings are financial, low-cost homes and construct for own circle of relatives with regular earnings and really healthful too. Now-a-days international is targeted on fee and financial construction. At the give up of the 12 months those homes produce extra electricity than utilized by occupants.

In this paper, we use a pattern of cutting-edge era low electricity homes to discover the idea of 0 electricity: what it means, why a clean and measurable definition is needed, and the way we've improved closer to the ZEB Goal

KEYWORDS: Optimization, Low and Net Zero Energy Homes, Cost powerful design.

1. INTRODUCTION

Amid developing issues approximately growing strength prices, strength independence, and the effect of weather change, facts display homes to be the number one strength customer within side the U.S. This truth underscores the significance of focused on constructing strength use as a key to lowering the nation's strength consumption. The constructing quarter can considerably lessen strength use via way of means of incorporating strength-green techniques into the layout, production, and operation of recent homes and project retrofits to enhance the performance of current homes. It can similarly lessen dependence on fossil gasoline derived strength via way of means of growing use of on-web website online and off-web website online renewable strength sources.

The idea of a Net Zero Energy Building (NZEB), one that produces as a good deal strength because it makes use of over the path of a year, these days has been evolving from studies to reality. Currently, there are simplest a small variety of rather green homes that meet the standards to be called "Net Zero". As a end result of advances in production technologies, renewable strength structures, and educational

studies, growing Net Zero Energy homes is turning into an increasing number of feasible.
While the precise definitions of metrics for "internet 0 strength" vary (that is mentioned below), maximum agree that Net Zero Energy Buildings combine's

 Exemplary constructing layout to limit strength requirements.
 Renewable strength structures that meet those decreased strength wishes.

In idea, a internet ZEB is a constructing with significantly decreased strength wishes thru performance profits such that the stability of the strength wishes may be furnished via way of means of renewable technologies. Despite our use of the phrase "0 strength," we lack a not unusual place definition—or a not unusual place understanding—of what it means. In this paper, we use a pattern of contemporary era low-strength homes to discover the idea of 0 strength—what it means, why a clean and measurable definition is needed, and the way we've got improved towards the ZEB goal.

2. LITERATURE REVIEW

The following is a evaluate of literature associated with ZEB definitions and studies tasks. There regarded literature is split into some of essential critical subjects for the dialogue of ZEB definitions.

1. ***Energy attention:*** Total power call for within side the constructing is a sum of thermal and energy call for; however, many research attention most effective on one call for neglecting the other. This difficulty is raised with the aid of using Able, (1994): "Many low-power constructing tasks appear to be primarily based totally at the idea 'lower warmth deliver at any cost'. In a few cases, this has resulted in 'zero-power buildings' which, it's far true, do now no longer want any warmth deliver however do, instead, in a roundabout way want energy, e.g., to function the warmth pump covered within side the system."

2. Energy Supply system*:* The clinical courses attention both on off-grid ZEBs or on-grid ZEB. The essential distinction among the ones processes is that, the off-grid ZEB does now no longer have any connection to the power infrastructure, as a consequence it does now no longer buy power from any outside sources, and the bounds for the stability calculations are within side the constructing. The on-grid ZEB, within side the literature additionally named "internet zero" or "grid related", is the power generating constructing related to at least one or greater power infrastructures; energy grid, district heating and cooling system, fueloline pipe network, biomass and bio fuels distribution networks. Therefore, it's far has an opportunity for each shopping for and promoting power from/to the software grid. This department is likewise properly major within side the ZEB definitions

3. Renewable power options: In a ZEB definition it's far vital to outline the deliver-facet of the renewable power sources. According to Torcellini, et al. (2006) there are options: on-web website online deliver or off-web website online deliver. Within the on-web website online deliver authors distinguish constructing footprint and

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constructing web website online. Within the off-web website online deliver the constructing both makes use of RES to be had off-web website online to provide power on-web website online, or buy off-web website online RES. issue.

3. METHODOLOGY

3.1NZEB concept
3.2 Design steps of NZEB
3.3 Feasibility and case studies
3.4 advantages and disadvantages
3.5 compare with normal buildings

3.1 NZEB concept:

In large its miles assumed that the NZE building is installed to the grid and that energy flows to and from the grid over the course of a normal day. Rather than have an energy storage device on-internet internet site on line, the grid is used due to the fact the storage device. The following are severa variations of the definition of NZE houses with the useful resource of the usage of the U.S. National Renewable Energy Laboratory (Torcellini, Pless, Deru and Crawley 2006; Malin and Boehland 2005):
Involves - Zero net annual site energy, zero net annual source energy, zero annual energy cost, zero net annual emissions
According to the NREL, the NZEB is expressed by these 4 steps -Net Zero Site Energy
Net Zero Source Energy
Net Zero Energy Costs
Net Zero Energy Emissions

3.2 Design steps of NZEBs

Building and designing less costly 0 power houses includes 12 incorporated steps that make use of usually to be had constructing substances and device at the side of easy-to-research constructing techniques.

- start with smart design
- use energy modelling
- Super- Seal the building envelope
- super -insulate the building envelope
- heat water wisely
- use highly insulated Windows and doors
- use the sun for solar tempering
- Create an energy efficient , fresh air supply
- select an energy-efficient heating and cooling system
- install energy efficient lighting
- select energy efficient appliances and electronics
- use the sun for renewable energy
- onsite and offsite energy sources

3.3 Feasibility and Case Studies

Feasibility

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The NREL additionally studied the technical feasibility of industrial ZEBs. The primary query decided with the aid of using the observe became to what volume a photovoltaic device can offer for a constructing's power needs. Based on EnergyPlus simulations of numerous homes and current and projected technology to 2025, the observe discovered that 62% of homes should attain internet zero (Griffith, 2007). Concurrently, 47% of constructing ground area should attain internet zero. The observe additionally discovered, assuming exportation of extra strength from PV structures, new homes should, on common, devour simplest 12.2 kBtu/ft2, which became an 86% discount from modern-day stock. Office homes, while in comparison to ASHRAE Standard 90.1-2004, required 67% in power financial savings to attain the ZEB aim.

A zone evaluation confirmed that workplace homes have an underneath common danger of attaining internet zero, due in large part in element to excessive plug and method masses and constructing height. man or woman technology cap potential to attain the ZEB aim, the ability to lessen internet-web website online EUI became maximum for thermal insulation, observed with the aid of using lighting, plug and method masses, HVAC, dynamic windows, daylighting, and passive solar. The evaluation concluded that attaining a ZEB aim became greater potential than usually assumed.

Cause study:

The Buildings and Thermal System Center on the NREL studied six excessive overall performance homes over a 4 yr length to apprehend the problems within side the layout, construction, operation, and assessment of low power homes with a purpose to decide first-rate practices that have to be implemented to destiny homes to attain the ZEB aim (Torcellini et al, 2006a). The observe discovered cost became preferred over price and a whole-constructing layout technique became a great manner to decrease power and price. However, the homes used greater power than expected within side the layout and simulation stage. The better-than-expected power use resulted from better-than-expected plug masses, PV device degradation, and unpredictable occupancy behavior. Each of the homes stored 25% to 70% in power decrease than code. Energy tracking supplied precious comments in keeping green overall performance of constructing structures with a purpose to attain layout goals. A set of first-rate practices were advanced from the observe to be implemented to destiny designs of low power homes and ZEBs. Further info of the first-rate practices may be discovered within side the literature.

Building in India (most popular) :

Fig. 1 Indira Paryavaran Bhavan

Energy Efficient Design Features

Summary

Location New Delhi
Geographical coordinates 28° N, 77° E
Occupancy Type Office (MoEF)
Typology New Construction
Climate Type Composite
Project Area 9565 m2
Grid Connectivity Grid connected
EPI 43.75 kWh/m2/yr

3.4 Advantages and Disadvantages of NZEB

Advantages

- Isolation for constructing proprietors from destiny power charge increases.
- Increased consolation because of greater-uniform indoors temperatures (this could be tested with comparative isotherm maps).
- Reduced requirement for power austerity.
- Reduced general price of possession because of stepped forward power performance decreased general internet month-to-month price of living.
- Reduced hazard of loss from grid blackouts.
- Improved reliability – photovoltaic structures have 25-12 months warranties and rarely fail throughout climate problems – the 1982 photovoltaic structures at the Walt Disney World EPCOT Energy Pavilion are nevertheless operating nice today, after going thru 3 latest hurricanes.
- Extra price is minimized for brand new production in comparison to an afterthought retrofit better resale cost as capacity proprietors call for greater ZEBs than to be had deliver the cost of a ZEB constructing relative to comparable< traditional constructing have to boom each time power fees boom.
- Future legislative restrictions, and carbon emission taxes/consequences can also additionally pressure pricey retrofits to inefficient buildings.
- Contribute to the extra advantages of the society, e.g. offering sustainable renewable power to the grid, lowering the want of grid expansion.

Disadvantages

- Initial fees may be better – attempt required to understand, apply, and qualify for ZEB subsidies, in the event that they exist.
- Very few designers or developers have the essential competencies or revel in to construct ZEBs
- Possible declines in destiny application agency renewable power fees can also additionally reduce the cost of capital invested in power performance.
- new photovoltaic sun cells system era charge has been falling at more or less 17% in step with 12 months – It will reduce the cost of capital invested in a sun electric powered producing system – Current subsidies could be phased out as photovoltaic mass manufacturing lowers destiny charge.
- Challenge to get better preliminary fees on resale of constructing, however new power score structures are being delivered gradually.

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 While the person residence can also additionally use a median of internet 0 power over a 12 months, it could call for power on the time whilst top call for the grid occurs. In this kind of case, the ability of the grid have to nevertheless offer strength to all loads. Therefore, a ZEB might not lessen the desired strength plant ability.
 Without an optimized thermal envelope the embodied power, heating and cooling power and aid utilization is better than needed. ZEB with the aid of using definition do now no longer mandate a minimal heating and cooling overall performance stage for that reason permitting outsized renewable power structures to fill the power gap.
 Solar power seize the usage of the residence envelope handiest works in places unobstructed from the sun. The sun power seize can not be optimized in north (for northern hemisphere, or south for southern Hemisphere) dealing with shade, or wooded surroundings.

3.5 Netzero Energy Building Vs Normal Building

NET ZERO ENERGY BUILDING	NORMAL BUILDINGS
Here we use solar energy and wind Energy	Here we use electrical energy
Here to reduce energy consumption we uses passive	Here we are not using any passive and active
energy needs are from renewable sources	Energy needs are from non-renewable sources
Overall energy balance is zero because	Overall energy balance is not zero
generation is peak and consumption is also peak	because generation is not peak and
NZEB are Environmental friendly home	These are not environmental friendly home
Economic and Affordable houses	These are not Economic and Affordable houses
Energy consumed by the habitants is less	Energy consumed by the habitants is
compared to the energy produced	more when compared to the energy
Natural sources are protected for further	Natural sources are not protected for further

4. CONCLUSION

With the development in renewable technology, NZEB are the future. Many governments have framed ZEB laws. Few governments also are offering subsidies to people and agencies for developing ZEB. But the intention of ZEB might now no longer be fulfilled until the time all of the human beings don’t recognize their duty and make contributions toward lowering strength consumption. The preliminary price of nzeb is better however via way of means of nzeb the full price of dwelling may be minimized. The strength performance of nzeb is better than the regular building. In nzeb’s we're the use of renewable reassets subsequently we're saving the herbal resources. Also via way of means of building nzeb the pollutants also can be reduced due to the fact we aren't the use of embodied strength materials.

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STRENGTH PROPERTIES OF CONCRETE BY PARTIAL REPLACEMENT OF FINE AGGREGATE WITH GLASS AND RUBBER POWDER

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ABSTRACT

Use of waste material in concrete achieves a new height in the present construction world. In this Investigation glass and Rubber powder is partial replace with fine aggregate. The methods are conducted in this experiments of compressive and split tensile test with different mix proportions of M20 grade of concrete. 150 * 150 * 150 mm cube and 150*300 mm cylinders are casted of M 20 grade of concrete for 7, 14 and 28days curing. Both Compressive strength and Split tensile strength values are improved when adding glass powder and rubber powder.

Keywords: Concrete, Glass Powder, Rubber powder, Fine aggregate.

1. INTRODUCTION

Concrete is a rigid material with high compressive strength and weak in tensile strength. Reinforcing bars are used to improve the tensile strength. In addition to that these powders can make the concrete more homogeneous and can improve the tensile response, particularly the ductility. The various types of powders added to concrete are rubber powder, glass powder etc. The process of selecting suitable ingredients of concrete and determining their relative amounts with an objective of producing a concrete of required strength, durability, and workability as economically as possible is termed as concrete mix design. Here we are doing concrete mix design of M20 grade by adding glass and rubber powders and get more strength as well as it's become economical mix design as far as cost is concern.

The principle reason for incorporating these powders into a concrete as partial replacement of sand is to increase the toughness and tensile strength and improve the cracking deformation characteristics of the resultant composite. For FRC to be a viable construction material, it must be able to compete economically with existing reinforcing system. The glass powder and rubber powders gives more strength to the concrete.

In this report Glass powder and rubber powders are used as partial replacement of sand in concrete and compare with conventional concrete. Objective of this study is to add the Glass powder and rubber powder in to the concrete as partial replacement of fine aggregate and to study the strength properties of concrete with the variation in fiber content. i.e. to study the strength properties of concrete (M20 Grade) for powder content of 0.33%, 0.67% and 1% at 7,14,28 days.

2. LITERATURE REVIEW

Camille A. Issa, George Salem in 2013 have discussed in his paper as waste continues to accumulate and availability and capacity of landfill spaces diminish, agencies are increasing application and use of recycled materials such as crumb rubber from tires in construction. The basic building materials in concrete construction are primarily aggregate and cement. The educated use of recycled materials can result in reduced cost potentials and may enhance performance; however, not all recycled materials are well suited for concrete construction applications. The two main reasons for not utilizing a reclaimed material are (1) addition of material is a detriment to performance, and (2) excessive cost. In this study, the performance of recycled materials crumb rubber as valuable substitute for fine aggregates ranging from 0% to 100% in replacement of crushed sand in concrete mixes is investigated. An acceptable compressive strength was obtained with up to 25% by volume replacement of fine aggregates with crumb rubber. Wang Her Yung a, Lin Chin Yung et.al in his study used waste tire rubber as a recycled material and replaced part of the fine aggregate by waste tire rubber powder filtered through #30 and #50 sieves to produce self-compacting rubber concrete (SCRC). Part of the fine aggregate was replaced with waste tire rubber powder that had been passed through sieves at volume ratios of 5%, 10%, 15% and 20%, respectively, to produce cylinder specimens and obtain the optimal replacement value. Replacing part of the normal sand with waste tire rubber powder of different degrees of fineness at different ratios is discussed. The results showed that when 5% waste tire rubber powder that had been passed through a #50 sieve was added, the 91-day compressive strength was higher than the control group by10%.Additionally, the shrinkage was higher with an increase in the amount of waste rubber, and reached its maximum at 20%. The ultrasonic pulse velocity decreased when more powder was added, and the 56-day electrical resistance exceeded 20 kX-cm and was increased with the addition of more powder. Meanwhile, both the ultrasonic pulse velocity and the electrical resistance were in a favorable linear relationship with the compressive strength. The addition of 5% waste tire rubber powder brought about a significant increase in anti-sulfate corrosion. Using waste tire rubber powder can enhance the durability of self-compacting rubber concrete.

3. MATERIALS INVOLVED

3.1 Ordinary Portland cement

Cement is a material which is used to bind solid bodies together by hardening from a fresh or plastic state. In this research work locally available ordinary Portland cement was used.

3.2 Coarse Aggregate

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The coarse aggregate was air dried to obtain saturated surface dry condition to ensure that water cement ratio was not affected. Few characteristics of aggregate that affect the workability and bond between concrete matrixes are shape, texture, gradation and moisture content. In this study crushed aggregates from quarry with the nominal size 5-10 mm were used in accordance to BS 882-1992.

3.3 Fine Aggregate

Fine aggregate; Fine aggregate is commonly known as sand and should comply with coarse, medium, or fine grading needs. The fine aggregate was saturated under surface dry conditions to ensure the water cement ratio is not affected.

3.4 Rubber powder

Rubber powder is one of the major byproduct of waste tire recycling. Rubber powder has large number of use in the different section of the industry. Rubber tyres are reused, reprocessed or hand crafted into new products, the end result is that there is less waste and less environmental degradation as a result and physical properties as shown in table1.

3.5 Glass powder

Glass powder is a waste material and it becomes granulated by sieving by means of sieves after they are crushed in the breaker and milled. It is used for surface treatment by blasting, reinforcement of synthetic resins, and path lines. Physical properties of glass powder as shown in table 2

Table 1. Physical Properties of Rubber Powder

PROPERTIES	RUBBER POWDER
Density	0.83
Size	80µm - 1.6mm
Elongation	420
Rate of steel fiber	0%

Table 2 Chemical Properties Glass powder

COMPOUND	CLEAR GLASS	COLOR GLASS	OPC	WASTE CLASS
Sio2	68.1	68.7	22.8	68
Al2O3	0.9	1.0	5.9	7
Fe2o3	0.6	0.9	3.5	<1
Ca0	14.5	12.0	63.0	11
Mg0	1.8	1.8	1.5	<1
K20	12.2	1.0	1.0	<1
Na20	0.4	13.3	0.1	12
So3	-	0.1	2.0	-
LOI	-	-	1.5	-

4. TESTS ON CONCRETE

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The property of fresh concrete which is indicated by the amount of useful internal work required to fully compact the concrete without bleeding or segregation in the finished product. Workability is one of the physical parameters of concrete which affects the strength and durability as well as the cost of labor and appearance of the finished product. Concrete is said to be workable when it is easily placed and compacted homogeneously i.e., without bleeding or Segregation. Unworkable concrete needs more work or effort to be compacted in place, also honeycombs &/or pockets may also be visible in finished concrete. Two tests basically have done for workability namely slump test and compaction factor test with fresh mix.

4.1 Compressive Strength test:

The testing of concrete cubes is required:

- To verify the strength of concrete to mix is used in actual construction.
- To verify the strength of trail mixes as in the case of design of mixes. Is code has specified the Strength of cubes150x150x150mm.

Fig .1 Compression test on cubes

4.2 Split Tensile Test Oncylinder:

The tensile strength of 150 mm diameter and 300mm height cylinder of M20 grade concrete with 5%, 10%, and 15% of fine aggregate replaced with Glass powder and Rubber powder for 7days and 28days is done in laboratory

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were examined and the corresponding tensile strength values of different proportions of replacement of Rubber and Glass powders in concrete are tabulated and represented graphically. Finally the comparative tensile strength variation of M20 grade concrete with partial replacement of Glass and Rubber powder in Fine aggregate is obtained.

Fig.3 Split tensile test on cylinder

5. RESULTS AND DISCUSSIONS

5.1 Compressive Strength test:

The compressive strength of 150x150x150 mm cubes of M20 grade concrete containing Glass powder and Rubber powder with 5%, 10%, and 15% replacements for 7days, 14days, and 28days is examined. These results are compared with conventional concrete and the corresponding compressive strength values of different proportions of replacements arc given in tabular form and represented graphically. Finally the comparative strength variation of M20 grade concrete with partial replacement of Glass powder and Rubber powder of concrete is demonstrated**.**

Table 3 compressive strength of conventional concrete

S.NO	AGE OF CONCRETE(DAYS)	AREA(MM^2)	COMPRESSIVE STRENGTH(N/MM^2)
1.	7	22500	13.56
2.	14	22500	20.93
3.	28	22500	24

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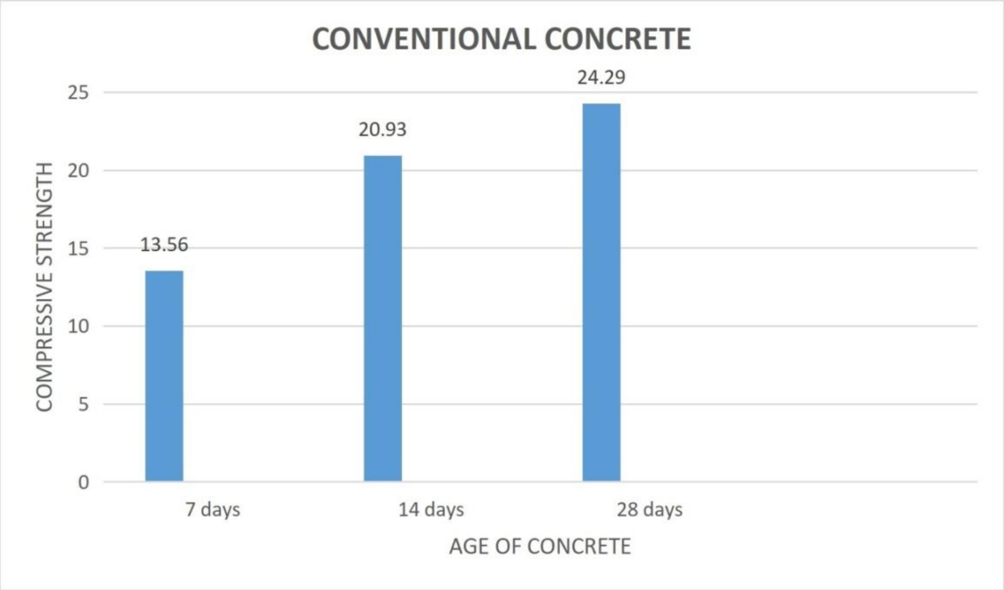
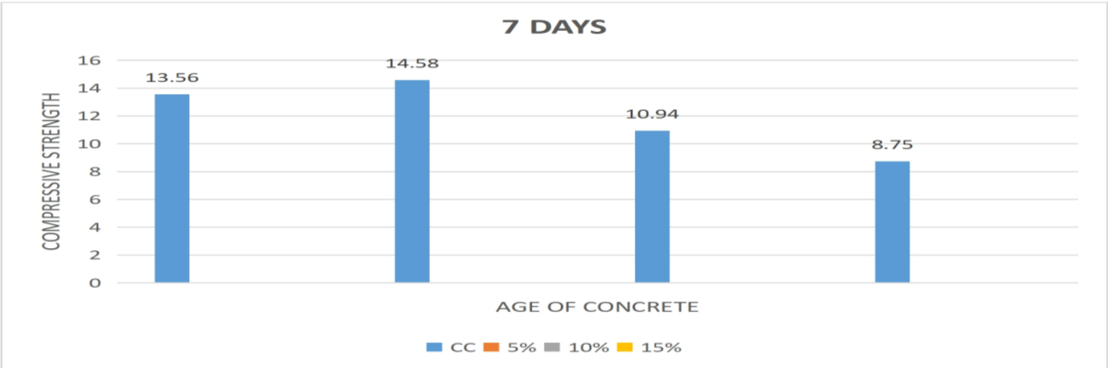
Graph: 1 compressive strength of conventional concrete



The above bar graph shows the compressive strength of conventional concrete. The compressive strength of concrete will be calculated after 7, 14 and 28 days of curing in water.

Table 4 Compressive strength of 150mm concrete cube containing Glass and Rubber powder with (5%,10% and 15%) replacement after 7 days of curing with CC.

S.NO	Percentage of glass and	7days compressive
1.	CC	13.56
2.	5%	14.58
3.	10%	10.94
4.	15%	8.75



Graph 2 compressive strength of 150mm concrete cube containing Glass and Rubber powders with (5%, 10%and15%) replacements after 7 days of curing with CC.

The above graph shows the compressive strength of concrete containing glass and rubber powder with conventional concrete. The compressive strength may be varying

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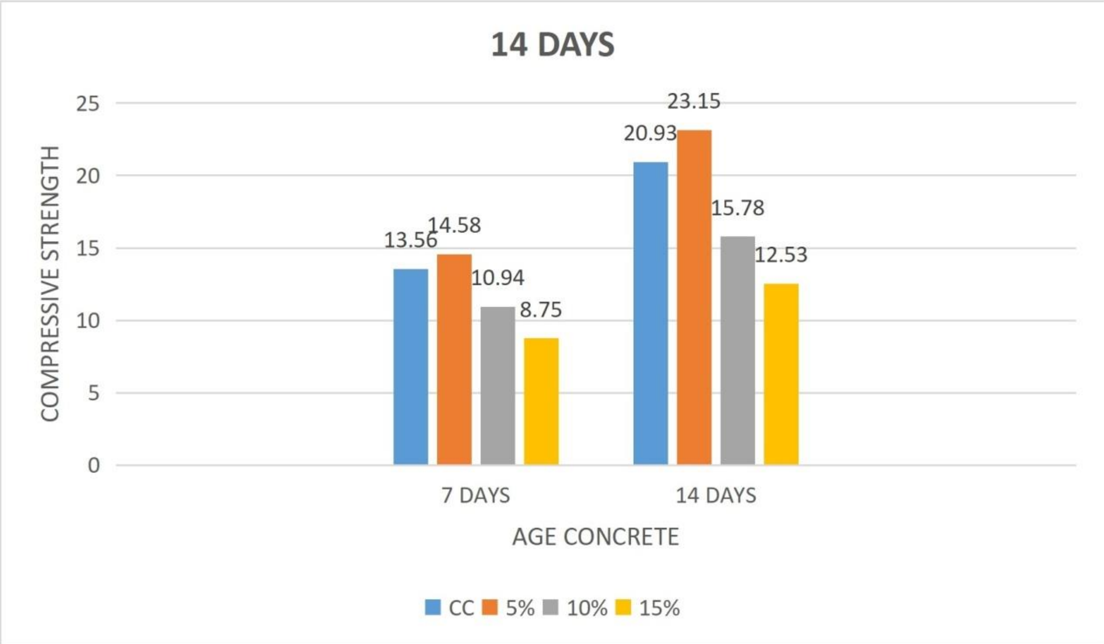
for different proportions like 5%, 10%, and 15%.The above graph shows the compressive strength of concrete after 7 days of curing in water. The compressive strength will be increased when compared to conventional concrete.

Table 5 Compressive strength of 150mm concrete cube containing Glass and Rubber powder with (5%,10% and 15%) replacements after 7,14 days curing with

S.NO	Percentage of	7 days	14 days
1.	CC	13.56	20.93
2.	5%	14.58	23.15
3.	10%	10.94	15.78
4.	15%	8.75	12.53



Graph: 3 Compressive strength of 150mm concrete cube containing

Glass and Rubber powder with (5%, 10% and 15%) replacements after 7, 14 days curing with CC

The above graph shows the compressive strength of concrete containing Glass and Rubber powder with conventional concrete. The compressive strength may be varying for different proportions like 5%, 10%, and 15%.The above graph shows the compressive

Strength of concrete after 7 days, 14 days of curing in water. The compressive strength will developed up to 5 % after adding Glass and Rubber powder the compressive strength of concrete will be reduced.

Table 6 Compressive strength of 150mm concrete cube containing Glass and rubber powders with (5%,10% and 15%) replacements after 7,14,28 days of curing withCC

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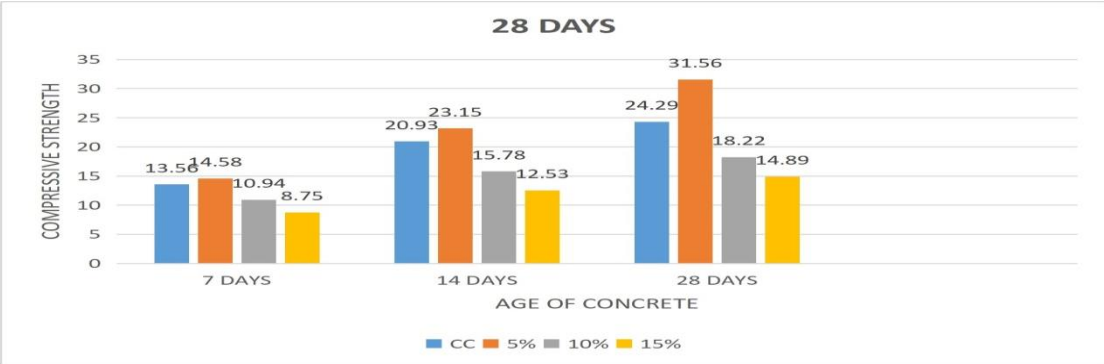
S.NO	Percentage of	7 days	14 days	28 days
1.	CC	13.56	20.93	24.29
2.	5%	14.58	23.15	31.56
3.	10%	10.94	15.78	18.22
4.	15%	8.75	12.53	14.89



Graph 4 Compressive strength of 150mm concrete cube containing Glass and rubber powders with (5%,10% and 15%) replacements after 7,14,28 days of curing withCC

The above graph shows the compressive strength of concrete containing Glass and Rubber powders with conventional concrete. The compressive strength may be varying for different proportions like 5%, 10%, and 15%. The above graph shows the compressive strength of concrete after 7 days, 14 days, 28 days of curing in water. The compressive strength will developed up to 5 % after adding Glass and rubber powders the compressive strength of concrete will be reduced.

5.2 SPLIT TENSILE TEST ONCYLINDER:

The Tensile strength of 150 mm diameter and 300mm height cylinder of M20 grade concrete with 5%, 10%, and 15% of fine aggregate replaced with Glass and rubber powders for 7days, 14days and 28days is done in laboratory. The corresponding tensile strength values of different proportions of replacement of Glass and rubber powders in concrete are tabulated and represented graphically. Finally the comparative tensile strength variation of M20 grade concrete with partial replacement of Glass and rubber powders in concrete is obtained.

Table 7 Tensile strength of conventional concrete cylinders

S.NO	Age of	Area(mm^2)	Tensile strength(N/mm^2)
1.	7	17671.46	1.59
2.	14	17671.46	2.37
3.	28	17671.46	2.68

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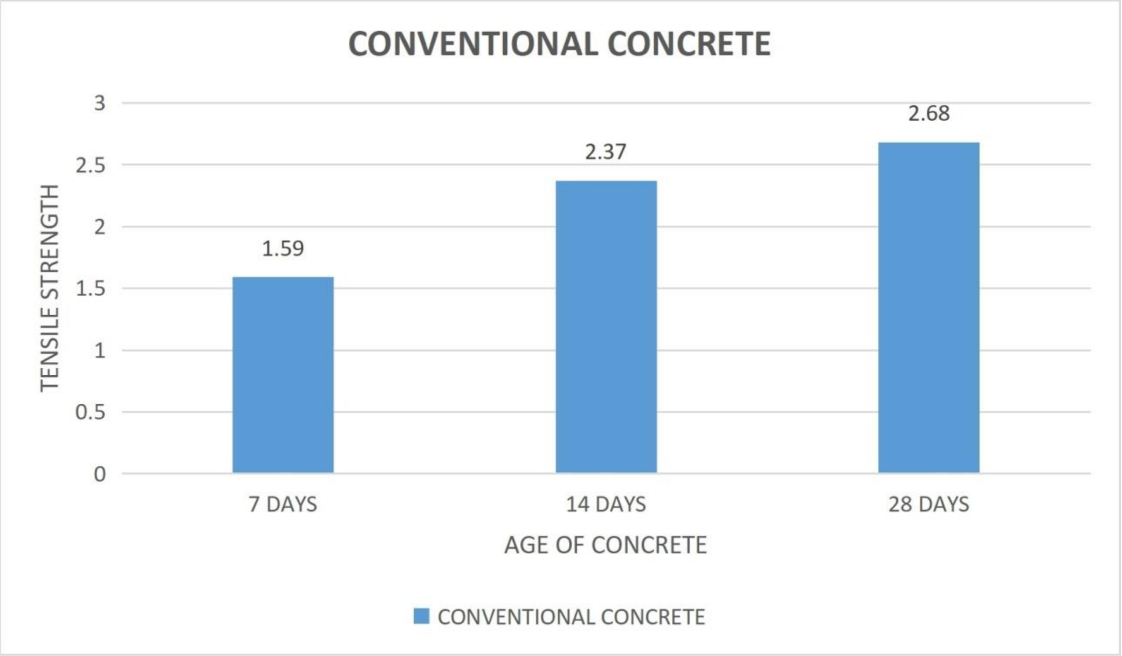
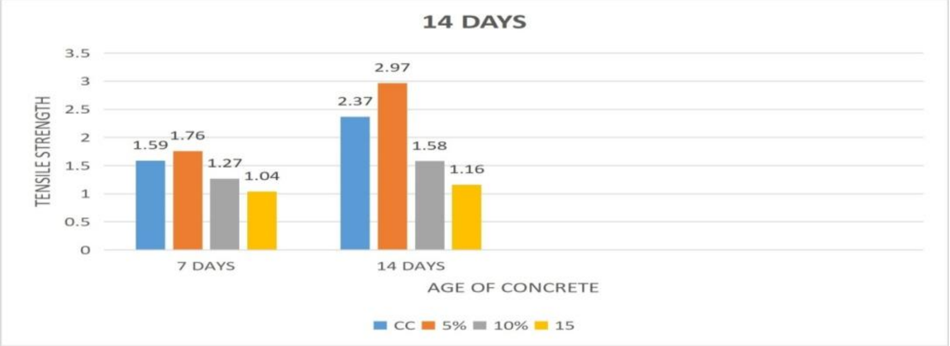


Graph 5: Tensile strength of conventional concrete cylinders

The above bar graph shows the Tensile strength of conventional concrete. The Tensile strength of concrete cylinders will be calculated after 7, 14, and 28 days of curing in water.

Table 8: Tensile strength of concrete cylinder containing Glass and Rubber powder with (5%, 10% and 15%) replacements after 7 days of curing with CC.

S.NO	Percentage of replacements	7 days Tensile strength in
1.	CC	1.59
2.	5%	1.76
3.	10%	1.27
4.	15%	1.04



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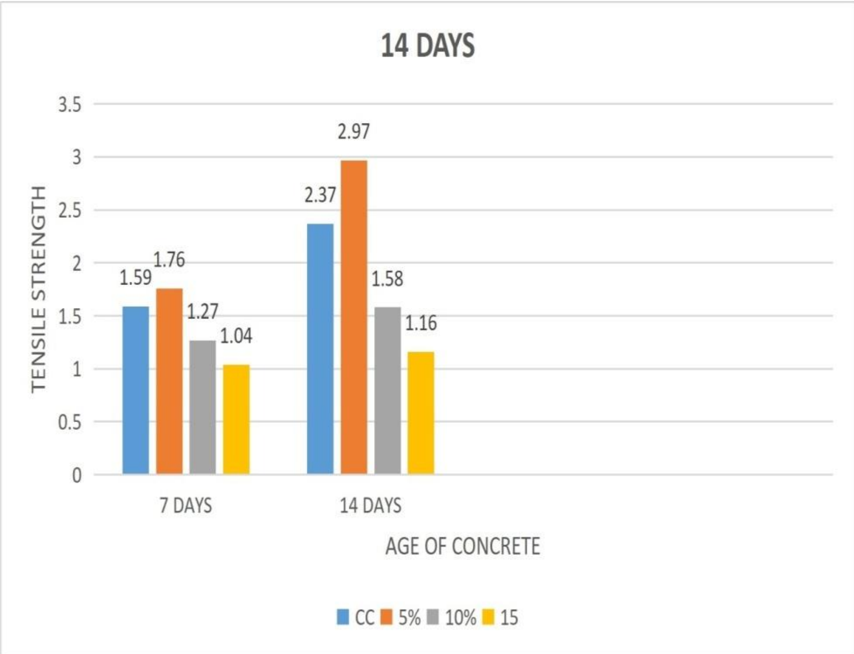
Graph 6 Tensile strength of concrete cylinder containing

Glass and Rubber powder with(5%,10% and 15%) replacements after 7 days of curing withCC.

The above graph shows the tensile strength of concrete containing Glass and rubber powder with conventional concrete. The tensile strength may be varying for different proportions like 5%, 10%, and 15%. The above graph shows the tensile strength of concrete after 7 days of curing in water. The tensile strength will developed up to 5 %after adding Glass and rubber powders the tensile strength of concrete will be reduced.

Table 9 Tensile strength of concrete cylinder containing Glass and Rubber powders with(5%,10% and 15%) replacements after 7,14 days of curing withCC.

S.NO	Percentage of replacements	7days tensile strength in	14 days Tensile strength in
1.	CC	1.59	2.37
2.	5%	1.76	2.97
3.	10%	1.27	1.58
4.	15%	1.04	1.16



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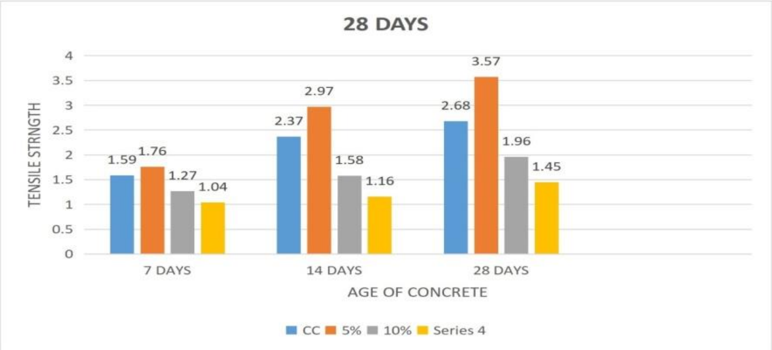
Graph 7: Tensile strength of concrete cylinder containing

Glass and Rubber powders with (5%, 10% and 15%) replacements after 7,14 days of curing with CC.

The above graph shows the tensile strength of concrete containing Glass and rubber powder with conventional concrete. The tensile strength may be varying for different proportions like 5%, 10%, and 15%. The above graph shows the tensile strength of concrete after 7 days, 14 days of curing in water. The tensile strength will developed up to 5 % after adding Glass and rubber powder, the tensile strength of concrete will be reduced**.**

Table 10 Tensile strength of concrete cylinder containing Glass and rubber powders with (5%, 10% and 15%) replacements after 7,14,28 days of curing with CC.

S.NO	Percentages of	7 days tensile	14 days tensile	28 days tensile
1.	CC	1.59	2.37	2.68
2.	5%	1.76	2.97	3.57
3.	10%	1.27	1.58	1.96
4.	15%	1.04	1.16	1.45



Graph 8 Tensile strength of concrete cylinder containing

Glass and rubber powders with (5%,10% and 15%) replacements after 7,14,28 days of curing with CC.

The above graph shows the tensile strength of concrete containing Glass and Rubber powder with conventional concrete. The tensile strength may be varying for different proportions like 5%, 10%, and 15%. The above graph shows the tensile strength of concrete after 7 days, 14 days, 28 days of curing in water. The tensile strength will developed up to 5 % after adding Glass and rubber powders, the tensile strength of concrete will be reduced

6. CONCLUSION

An analysis was made on the strength characteristics by conducting the compressive tests and tensile tests on concrete containing Glass powder and rubber powder. The results revealed that up to 5% replacement values will shows that the concrete will have more strength when compared to the conventional concrete. The percentage replacement was increased up to 15%. For 10% replacement we will observe that the values will falling down, for 15% replacement also we will see that strengths of concrete will gradually decreases when compared to conventional concrete. Increase in percentage of Glass powder and rubber powder will results the decrease in strengths. Graphs and Tables will shows the compressive, tensile strengths of concrete containing Glass powder and rubber powder with different replacement proportions. These values are compared with conventional concrete.

In the 5% replacement, the compressive strength of concrete at 28days is 31.56Mpa, at the same time the conventional concrete will gives the compressive strength at 28days is 24.29Mpa this shows the increase in strength, whereas in the 15% replacement, the compressive strength of concrete at 28 days is 14.89Mpa,this Shows the gradual decrease in strength when compared to conventional concrete and 5% replacements.

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FIBER REINFORCED POLYMER COMPOSITES IN STRENGHING REINFORCED CONCRETE STRUCTURE

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ABSTRACT

Fiber-reinforced polymer (FRP) composites continue to give designers the potential to deliver creative and clever solutions to tackle infrastructure's ever-growing ageing concerns. Since the introduction of FRP materials to the construction industry more than 50 years ago, this paper provides a current review of historic and recent developments of FRP in strengthening and rehabilitation of civil engineering applications. This study focuses on some of the classic and recent experimental, numerical, and analytical investigations related to the incorporation of FRPs into buildings and other structures. The topic offered below attempts to cover the application of FRP systems in reinforced concrete structural members, as well as the performance of FRPs (including bonding agents) in extreme situations such as high temperatures, saltwater environments, and freezing and thawing cycles. This study also provides a collective viewpoint on the constraints, problems, and research needs connected with the successful, sustainable, and long-term adoption of FRPs in civil infrastructure.

FRP; reinforcement; concrete; earthquake; fire; environmental exposure.

1. BEGINNING

Fibre reinforced polymers (FRP) are a type of material known as a composite. Composites are created by combining two or more constituent (parent) elements to create an upgraded compound with better qualities that are functionally superior to its parents [1-3]. FRP materials are made up of high strength continuous fibres embedded in a polymer matrix (resin). The main reinforcing elements are the embedding fibres, while the polymer matrix functions as a binder, protecting the fibres and facilitating load transfer to and between these fibres. E-, S-, and Z-glass fibres, aramid fibres (aromatic polyamides, Kevlar 49), and carbon fibres (ultra-high modulus, high modulus, and high-strength) are the three primary types of fibres used in the construction sector [1-3]. Polymer matrices (resins), on the other hand, are divided into two groups: thermosetting and thermoplastics. The thermosetting matrices include vinylesters, epoxies, and polyesters. Thermosetting matrices are polymers that have been crossed-linked by addition or condensation polymerization. They are created by heat and, once made, do not melt or soften when reheated or dissolved in solvents.

Thermosetting resins, which are increasingly commonly utilised because to their superior mechanical performance, provide greater impregnation and fibre adhesion qualities. Unlike thermosettings, thermoplastics like polyethylene, polyvinyl chloride, polypropylene, and polyurethane are more expensive to manufacture and very sensitive to climatic conditions.

Resins can be made of polymers, metals, or ceramics in general. The polymer matrix is the most commonly used material because to its simple manufacturing technique and low production costs. Carbon FRP (CFRP), glass FRP (GFRP), aramid FRP (AFRP), basalt FRP (BFRP), and some newly created polythylene naphthalate (PEN) and polyethylene terephthalate (PET) composites have all resulted from the coupling of matrix and fibres [1-4]. The behaviour of FRP materials can vary greatly depending on the type of fibre and polymer matrix used, particularly in terms of mechanical qualities.

FRPs were first offered to the aerospace, automotive, and marine industries as lightweight materials with high modulus and strength [1-3]. FRPs were not practicable for use in civil applications due to their high cost and production complexity, hence unreinforced concrete was used instead.

Composites, which were less expensive to process, were used as cladding and finishing materials in non-structural applications. However, as modern technology has advanced, FRPs have emerged as an appealing alternative for retrofitting and strengthening concrete structures due to a number of advantages they offer over traditional construction materials such as concrete and steel [5]. Because of recent improvements in FRP material properties such as corrosion resistance, environmental durability, and inherent tailorability, the use of FRP has expanded beyond the rehabilitation of existing buildings and, to some extent, into the strengthening of large infrastructure and the construction of new facilities. FRP materials, for example, are used in the retrofitting of reinforced and unreinforced masonry walls, the seismic retrofitting of bridges and buildings, the repair and strengthening of concrete structures, metallic and timber beams, girders, and slabs, and the rehabilitation of unique structures such as chimneys, historic monuments, and offshore platforms [1-3]. The building industry has recently emerged as one of the world's leading consumers of polymer composites [5-10]. In the majority of the above-mentioned applications, FRPs are primarily used as "externally bonded" systems to improve the flexural, shear, torsional, and axial sectional capacity of reinforced concrete structural elements, as well as to provide additional confinement and improve structural member stability and serviceability. In general, there are two types of strengthening systems: those that use FRP plates and/or sheets and those that use near-surface mounted (NSM) bars. FRP plates and sheets are only applied to concrete surfaces after they have been thoroughly cleaned.

Grinding, sandblasting, or high-pressure water jetting are methods of preparing the external surface of concrete. This external strengthening method is simple and quick to implement.

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2. FRP STRENGTHENING SYSTEM AND PRODUCT TYPES

FRP materials are produced in a variety of products and are divided into two categories: constant cross-sectioned and pultruded sectioned. Constant cross-sectioned FRP composite structural shapes are frequently manufactured for usage in the construction industry, specifically in buildings and bridge applications, whilst pultruded sections are mostly employed in highway bridge decks and pedestrian passages. Furthermore, FRP products can be divided into those designed for use in new structures and those designed for strengthening and retrofitting existing structures. There are three types of FRP reinforcements for new structures: (1) FRP bars for internal reinforcement, (2) FRP tendons for prestressed concrete (PC) elements, and (3) stay-in-place FRP formwork for reinforced concrete. “Retrofitting” refers to the use of FRP materials to reinforce and/or restore load-bearing structural parts in existing structures. Retrofitting applications can be divided into two categories. The first category is “strengthening,” in which the structure’s initial strength or ductility must be increased to accommodate new services or levels of loading. This increase may be required to make the structure compliant with existing building codes, or it may be desired due to changes in the structure’s intended use. The third sort of FRP retrofitting is called “repairing.” In the second situation, FRPs are used to repair an existing and deteriorated structure in order to restore its load-carrying capacity, ductility, or stability to the level that it was designed for.

In any case, the most typical FRP items are prefabricated plates, bars, sheets, and anchorages. Table 1 shows the mechanical parameters of various types of FRP composite materials [1-4, 33-37] used in the building sector. Prefabricated FRP parts are often rigid, making them difficult to bend or employ as internal reinforcement (stirrups). In contrast, FRP fabric is supplied in continuous uni- or bi-directional sheets that may be easily adjusted to meet any geometry and wrapped around complex features. To boost flexural strength, FRP fabrics can be attached to the tension side of structural elements (e.g., slabs or beams). Applications of FRP Strengthening in Reinforced Concrete Structures

Because of the superior properties of these composites, the integration of FRP strengthening systems has increased during the previous three decades. The amount of research and published material has adequately recorded this in the open literature. This section tries to highlight some of the noteworthy experimental, numerical, and analytical studies conducted in recent years. Studies on flexural, shear, torsional, axial, and seismic strengthening are presented in particul

3. ADAPTIVE APPLICATIONS

Attaching externally bonded FRP plates, strips, or fabrics at the soffit of simply-supported beams can improve the flexural capacity of plain and reinforced concrete (RC) elements (see Fig. 2). When RC beams and slabs were externally reinforced with

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FRP laminates, several failure mechanisms were discovered experimentally. Steel yielding followed by rupture of FRP laminates, FRP debonding from adjacent concrete surface, and concrete cover separation (cover delamination) are common failure mechanisms of strengthened RC members under flexure with FRP laminates, according to current ACI 440.2R-08 [38] design requirements. If the strain in the FRP achieves its ultimate strain before the concrete in the top compression fibre reaches its crushing strain, the externally bonded FRP laminate will rupture. Debonding of FRP Debonding of FRP laminates is typically triggered by flexural and/or flexural-shear cracks around the maximum moment region of the strengthened element and progresses throughout the length of the FRP through the bonding agent (epoxy adhesive or cement). Matrix). Under loading, such cracks open and widen, causing high levels of shear stress at the interface between the FRP sheets/plate and concrete substrate, resulting in FRP debonding. Concrete cover separation (cover delamination) is another type of debonding brittle failure mechanism that is usually begun by the creation of a crack near the end (curtailment) of a FRP laminate. The crack will then spread to and along the level of flexural steel reinforcement, causing the concrete cover to separate. The creation of a crack near the plate end causes the concrete cover to fail. The fracture spreads to and then along the level of the steel tension reinforcement, causing the concrete cover layer to separate from the rest of the RC beam or slab. Figure 3 depicts the various failure modes of externally reinforced RC flexural members with FRP laminates.

Alternatively, near-surface mounted strips (NSM) or rods with fiber direction parallel to the member longitudinal axis can also be utilized [9, 37]. This use of externally bonded plates and NSM CFRP systems to strengthen RC beams in flexure has been well studied over the past three decades [1-3] and some of these studies are highlighted herein. In an early study by Ritchi et al.
[39] in 1991, strengthened RC beams with adhesively bonded GFRP and CFRP plates were tested to failure. The tested beams were 2.75 m long and were subjected to dominant flexural effects. Results of this investigation revealed that strengthened beams achieved 17 to 95% increase in

stiffness, and 40-97% increase of ultimate strength when compared to similar unstrengthened control beams.

FRP has also been 146ehavior as a reinforcing material to increase the shear capacity of RC beams. In such cases, FRP strengthening systems can be used in a variety of ways, including side bonding of FRP sheets and/or plates, as well as the NSM approach (see Fig. 5). Individual and relatively narrow sheets/plates are bonded and spaced at the external sides of the RC beam to act in parallel to resist shear stresses, similar to internal steel stirrups. Chajes et al. [86] conducted one of the early research that studied shear response of FRP-sided bonded RC beams. Chajes et al. conducted experiments on a set of twelve unreinforced concrete T-beams. The study's findings prompted further research into the usage of significantly broader FRP sheets covering both sides and soffit of RC beams in a process known as "U-wrapping." Carolin and Taljsten [87] and

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El-Maaddawy and Chekfeh [88] demonstrated that CFRP shear strengthening restored RC beam shear strength. These researchers and others [89-90] also reported that using correct end anchors delayed or prevented CFRP debonding, which boosted shear strength gain substantially. Chennareddy and Taha [91] demonstrated in a more recent work that combining NSM with U-wrapping of RC beams can greatly improve shear and flexural capacity. However, using such a hybrid strengthening system has changed the failure mode of the tested beam from debonding of NSM bars.

This problem has received limited attention in the literature [92-94] when it comes to the 147ehavior of solid RC deep beams enhanced with FRP composites. According to Islam et al. [92], up to 40%

The adoption of an externally bonded CFRP system improves the shear strength of deep beams. In contrast to Zhang et al. [93], who found that CFRP shear strengthening of deep beams resulted in a 46% increase in shear capacity. Unfortunately, there isn't enough data on the 147ehavior of RC deep beams with "cut-off" or apertures reinforced in shear with FRP composites. El-Maaddawy and Sherif [94] published one of the few experimental tests in the literature. They demonstrated the efficiency of upgrading shear capacity by applying CFRP shear strengthening around web openings. El-Maaddawy and Sherif similarly reported a 35-73% increase in shear strength. In a companion work, Hawileh et al. [95] investigated these tests further using FE simulation. The numerical analysis's findings reflected recommendations made in a comprehensive review study by Ahmed et al. [96] to perform additional research to better understand the 147ehavior of RC beams with apertures reinforced with externally bonded FRP materials.

Few researchers [97, 98] also briefly reported in the literature on the viability of using externally bonded CFRP composite systems to improve the shear 147 ehavior of shallow RC beams with openings. For example, Pimanmas [97] demonstrated that externally inserted diagonally to the beam's axis inclined NSM composite rebars beside the opening cut-off and over the whole beam depth can entirely restore shear capability of RC beams with web openings. According to El-Maaddawy and El-Ariss [98], adding CFRP sheets around the opening can enhance both shear capacity and overall beam stiffness.

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Shear strengthening of RC beams has been demonstrated in the preceding investigations by connecting FRP plates or sheets to the beam's sidewalls. However, due to accessibility limitations, unique geometry, and other factors, beam sides may not always be accessible for strengthening upgrades in 148ehavior. Few researchers have investigated the contribution of FRP flexural reinforcement on the shear strength of RC beams [99-101] to overcome such challenges. Sobuz et al. [99] were one of these researchers, and they examined four flexurally deficient beams strengthened with one, two, and three layers of CFRP laminates glued to the tension side of the beam (bottom soffit). All specimens were tested under four-point bending, and the strengthened specimens outperformed the control specimens by 54-85%.

. Nawaz et al. [100] conducted similar experimental and analytical research. In their tests, strengthened beams demonstrated a 13 to 138% improvement in shear capacity due to the installation of thin FRP sheets along the beam's soffit. It should be mentioned that a great number of research have recently been conducted to study various parameters influencing shear strengthening of RC beams such as inclined bonded sheets, FRP material kinds, and loading configuration. Table 3 summarises some of these investigations. Several researchers [64, 68, 69] used the finite element method to model and study the 148ehavior of shear deficient beams reinforced with externally bonded FRP sheets and laminates. Haddad et al. [64] investigated the performance of heat-resistant materials using nonlinear FE.

To predict the shear 148ehavior of FRP-strengthened RC components, a FE model was constructed by altering the RC softened membrane model. By predicting the monotonic responses of ten FRP reinforced RC panels subjected to pure shear loads, the derived model was validated. The experimental and analytical results were in good accord. Godat et al [69] simulate and analyse the 148ehavior of RC beams strengthened in shear with externally bonded FRP laminates using various models. They used three distinct types of interface elements, which changed the numerical predictions of FRP shear-strengthened beams significantly.

4. APPLICATIONS FOR TORSION

FRP is frequently utilised as an external reinforcing material and system to increase the strength requirement linked to flexure and shear in RC beams and columns. However, as evidenced by the small number of published studies, strengthening of members subjected to torsion is the least researched area. This is because beams are primarily

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susceptible to flexural and shear effects, and most codal regulations prefer to ignore torsion effects when beams have sufficient shear reinforcement [106]. Furthermore, the

complicated test setup required to conduct torsional tests is a barrier to such research efforts. In general, torsional strengthening of beams follows flexure and shear strengthening, in which beams are strengthened using traditional methods.

Salom et al. [107] conducted an experimental and analytical programme to address the torsional behaviour of six fully wrapped strengthened spandrel beams using CFRP composites, one of the few research papers published in this subject. According to the results of these tests, all six beams attained a 50% improvement in overall ultimate torsional strength but suffered from general FRP debonding and severe concrete crushing. Khalaf and Bayer [108] conducted yet another set of experiments to assess the torsional strength of externally bonded CFRP sheets to RC beams. Sheets were wrapped in two ways: totally wrapped and partially wrapped. In these tests, fully wrapped beams obtained double the ultimate torque of the reference beam. beam that has not been reinforced. The entirely wrapped beams also enhanced confinement conditions, which increased concrete strength and avoided fracture widening. Khalaf and Bayer also observed that adequate anchorage in the U-jacket sheets considerably increased overall response.

5. APPLICATIONS INVOLVING AXES

One of the first applications of FRP materials was to strengthen bridge piers and columns after earthquakes [1-3]. FRP sheets are typically employed in such applications, while some recent research have advocated the usage of NSM reinforcement as well [116]. Lateral confinement of concrete columns by spirally wrapping FRP composites onto the concrete surface, as shown in Fig. 6, can boost compressive strength and prevent longitudinal steel reinforcement buckling. Fardis and Khalili [117] pioneered and presented the use of FRP materials in concrete columns in one study. Yamamoto [118] conducted experimental experiments in the early 1990s to evaluate the viability of using FRP materials as reinforcing and confinement systems for concrete columns in another study. Yamamoto looked into the effect.

Yamamoto looked into the impact of FRP addition on uniaxial concrete strength and shear-flexural behaviour of RC columns. The results of these tests revealed that the ultimate strength of strengthened columns increased by nearly three times their original capacity.

6. APPLICATIONS INVOLVING COMBINED LOADING (SEISMIC)

While most research has focused on the static and monotonic behaviour of FRP-strengthened structures, the seismic response of such

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strengthening systems has also been studied. Because FRP was primarily developed as an efficient retrofitting tool, particularly for seismically damaged buildings and bridges, the cyclic behaviour of

FRP-strengthened structures was thoroughly investigated. Barnes and Mays [138] conducted one such investigation, reporting cyclic (fatigue) testing on two RC beams and three RC beams strengthened using CFRP plates. These tests revealed that the beams broke in a primary flexural mode, with no discernible variations in behaviour

between the reinforced and non-strengthened beams. Papakonstantinou et al. [139] investigated this as well.

A secondary failure mechanism was the reinforcing and debonding of GFRP sheets.

Several researchers have recently investigated beams under cyclic loading [140-143]. Tanarslan et al. [140] used cyclic loading to test seven identical defective RC cantilever T-beams. The beams evaluated in this experiment were reinforced using FRP systems that were side bonded, U-wrapped, L-shaped, U jacketed, and double L-shaped jacketed. Tanarslan et al. demonstrated that using two and three layers of CFRP strips increased the failure load by 5.31% and 14.38%, respectively. In a related work, Sakar et al. [141] studied the behaviour of RC beams externally strengthened in shear using NSM GFRP rods both experimentally and statistically. A total of five RC cantilever beams were tested experimentally.

Reinforcing and debonding of GFRP sheets was a secondary failure mechanism.

Several researchers have recently studied beams subjected to cyclic loading [140-143]. Tanarslan et al. [140] tested seven identical faulty RC cantilever T-beams using cyclic loads. The beams tested in this experiment were reinforced with side bonded, U-wrapped, L-shaped, U jacketed, and double L-shaped jacketed FRP systems. Tanarslan et al. found that utilising two and three layers of CFRP strips increased failure load by 5.31% and 14.38%, respectively. In a related study, Sakar et al. [141] investigated both experimentally and statistically the behaviour of RC beams externally strengthened in shear with NSM GFRP rods. Five RC cantilever beams were experimentally tested.

7. CONCRETE STRUCTURE PERFORMANCE UNDER VARIOUS ENVIRONMENTAL CONDITIONS

While FRP materials perform admirably under most conditions, the fact remains that composites can be significantly influenced by their surroundings. This section examines selected experimental and numerical investigations in which FRP strengthening systems were subjected to difficult circumstances such as high temperatures (fire), salty environments, and freeze-thaw cycles. It should be emphasised that, due to the increased usage of FRP in RC structure strengthening, the majority of reported studies studied the performance of FRP materials and FRP-strengthened concrete structures under harsh conditions. Unfortunately, the performance of FRP-strengthened MTMG

structures in harsh environmental conditions has received less attention and is rarely reported. It is overdue.

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UTILIZATION OF AGRICULTURAL AND INDUSTRIAL WASTE AS REPLACEMENT OF CEMENT IN PAVEMENT QUALITY CONCRETE

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ABSTRACT

Over the years, supplementary cementations materials (SCM) have been successfully utilized in concrete buildings, but they have been rarely exploited in concrete pavements. In recent years, due to the growing importance of concrete pavements, researchers have begun studying the performance of various types of SCMs from pavement perspective. The overview herein assesses the existing research associated with utilizing different kinds of silica-rich waste as SCM. For this purpose, five agricultural waste (AW) comprising rice husk ash (RHA), rice straw ash (RSA), corn cob ash (CCA), palm oil fuel ash (POFA), sugarcane bagasse ash (SBA) and three industrial by-products (IB), i.e., fly ash (FA), ground granulated blast fur- nace slag (GGBFS) and microsilica (MS), were selected. Their effects on various properties of concrete were exhaustively reviewed. This study also furnishes reasons for limited literature on SCMs utilization in concrete pavements. Moreover, this review accentuates the previous studies' gaps, which require further research, such as the need for dedicated standard codes for AW utilization in concrete pavements. The guidance for future research to further enhance the properties of pavement quality concrete is also given.

Keywords: *Concrete pavement • Supplementary cementitious material • Agricultural waste • Industrial waste • Pavement quality concrete*

INTRODUCTION

Pavements are crucial for the development of a country (Li et al., 2021a). They help reduce poverty by providing access to social services, employment, health and education (Pandey and Kumar 2020a). In India, around 70% of the goods and 80% of the passengers use pavements for transportation purposes (Gupta and Sachdeva 2019). The total length of pavement infrastructure (including all types) in the world is around 16.3 million km, out of which 5.6 million km is in India (which is the 2nd most extensive road network in the world)(MoRTH Report 2016; Plati 2019). The total road length in India (categorized into surface types) is shown in Table 1. In India, the entire length of national highway is only 1.8% of the total road network. However, the traffc on national highway is approximately 40% of the total trafc (MoRTH 2018). Therefore, the Government of India launched "Bharatmala Pariyojana" (estimated cost=5.35

trillion Indian rupees) on 24 October 2017 to overcome this massive defcit between the "Supply and Demand" (Press Information Bureau MoRTH, 2017). People responsible for pavement design prefer fexible pavements over concrete pavements (CP) as their construction is easy and cheaper. Ninety per cent of the Indian national highways are fexible pavement, and the service life of most of them is about to end (Gupta and Sachdeva 2019).

Recently, the Government of India has sanctioned CP as the primary mode of national highway and expressway construction (due to its distinct advantages over the fexible pavement) (Pandey and Kumar 2020a). Therefore, with such an ambitious road development project on the anvil and to make CP the frst choice for construction, it is advised to somehow reduce its construction cost without afecting its properties.

The rise in population and growth in the global economy has resulted in a significant amount of pollution in the form of solid waste. These wastes are generated by anthropogenic, commercial and industrial activities and are dumped in landfills, drainage ditches and water bodies, which are unhealthy and toxic for plants, animals and humans (Yao et al. 2015). The practice of dumping toxic waste on the grounds surrounding human habitations is mainly followed in developing countries. In contrast, developed countries pay greater attention to the problem of pollution and solid waste. In the UK, when cement manufacturing industries used 20% industrial by-products as raw materials, the total amount of waste materials in landflls was reduced by 3 million tons (Jamshidi et al. 2017). Even though a massive amount of waste is generated throughout the world, there is a negligible amount of its utilization in CP. The incorporation of these wastes in CP will not only reduce its cost and bring it at par with that of fexible pavement but will also reduce the pollution caused by industrial processes associated with the production of pavement materials (which is responsible for approximately 21% of the global emission of greenhouse gases) (Plati 2019). This review focuses only on the efect of partial/complete cement replacement by supplementary cementitious material (SCM) on concrete properties, while the impact of replacing natural aggregates with waste aggregates was outside the scope (even though using waste aggregates helps in maintaining an ecological balance by avoiding fast depletion of their natural resources) (Hilal et al. 2020; Prasad et al. 2021; Singh et al. 2022). It was because the availability of recycled aggregates is significantly less in India, which reduces its credential. Also, the effect of hydrated cement paste on concrete properties is more dominant and influential than that of aggregates (Shetty 2010).

NEED FOR REVIEW

Concrete is the most versatile construction material and the second most consumed material globally (Monteiro et al. 2017). In India, cement production (an essential component of concrete) was 550 million tons in 2020 (IBEF 2019). By 2025, India is expected to become a major exporter of cement to other developing countries. Apart from causing several environmental damages (mainly CO2 emission due to fuel combustion and limestone calcinations), cement production consumes a massive

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amount of energy (lower than only steel-making and aluminum production) (Tayeh 2018). Given that cement consumption is on the rise, different SCMs are being researched to decrease or even abolish cement production due to its adverse environmental impacts. The usage of SCMs in CP will help reduce its carbon footprint and reduce its construction cost because most of the SCMs are either agricultural waste or industrial by-products. Moreover, it eliminates any chances of environmental problems associated with their disposal (Raheem and Ikotun 2020).

Also, pavement quality concrete (PQC), engineered and specialized with SCMs, could be considered one of the most sustainable approaches for highway development. The only problem is that there is a lack of research studies and guidelines on the efects of diferent SCMs on the engineering properties of PQC that gave the urge for this review.

Category	Total length (km)	Surfaced	Bituminous	Un-surfaced (km)
National highways	101,011	0	101,011	0
State highways	176,166	2,550	167,687	5,928
District roads	561,940	25,100	508,392	28,447
Urban roads	509,730	41,706	354,752	113,272
Project roads	319,109	39,567	70,160	209,382
Rural roads	3,935,337	682,640	1,508,339	1,744,358
Total	**5,603,293**	**791,563**	**2,710,341**	**2,101,389**

Table 1 Length of the Indian road network in 2015–2016 (MoRTH Report 2016)

SCOPE OF THE REVIEW

Past studies related to conventional concrete (CC) have been analyzed in this review to understand the effects of differ- ent SCMs on mechanical and durability properties of PQC because there is no any major difference between CC and PQC of the same grade. They are just a name for the formu- lation of product based on the desired requirement of each type of concrete, in terms of workability, placement, waiting time, strength, etc. Also, both types of concrete require simi- lar curing techniques. However, PQC requires more strin- gent measures for protecting the fresh concrete because CP usually occupies the large surface area than its thickness. However, there are few minor differences between CC and PQC, one of them being that PQC requires low workability (slump ≈ 25 mm to 50 mm). In contrast, the workability of CC depends on the procedure for procurement, production, placement and curing. The usual criterion for the quality of CC is compressive strength. However, in the design of PQC, the flexural strength is considered more important, as the stresses induced in CP are mainly flexural. PQC can also be designed based on its compressive strength, but that does not necessarily satisfy durability requirements unless examined under a specific context. Another minor difference is the maximum nominal size of the aggregates. In PQC, the maximum nominal size of the aggregates is limited to 31.5

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mm, while it goes up to 40 mm in case of CC. PQC Also requires a little more cement as compared to CC. Based on the above discussion, the authors reviewed an exhaustive number of past studies (coupled with intense research and concurrent assessment) and prepared the blueprint for find- ing the suitable cement replacement in PQC. It was based on the hypothesis that the mechanism by which SCMs influ- ence the properties of CC, in the same way, they affect the properties of PQC also.

The descriptions covering every aspect of SCMs have been mentioned in this study: availability in different countries, dependency on production approach, user- friendliness, etc. Also, the material properties of each SCM have been discussed in detail. It should be noted that any mention of SCM percentage in this study, for example, 30% SCM, signifies that 30% of cement has been partially replaced by an equal weight of SCM unless stated other-wise. Ultimately, the recommendations and suggestions have been given for future research that are important to SCM reinforce utilization in PQC.

SUPPLEMENTARY CEMENTATIONS' MATERIAL

SCMs are those materials that have very little or no cemen- titious value. However, when they are used in combination with cement and moisture, cementitious compounds are formed. Usually, the Ca/Si ratio in the hydrated cement paste is between 0.6 and 2.0 mol/mol (Maddalena et al. 2019). But when SCM having a low Ca/Si ratio is utilized as a partial substitute for cement, silica (from SCM) reacts pozzolanically with portlandite (from cement hydration) and forms denser C-S–H gel (secondary) which results in swelling of the reaction products (Kawashima et al. 2013; et al. 2014; Aprianti et al. 2015). Primarily, Bae SCMs (in appropriate amounts) improve the workability, strength, durability and fluidity of concrete (Alaloul et al. 2020). They also decrease the alkali-silica reaction, permeability and heat of hydration (Khan et al. 2014). The improvement ratio generally depends on numerous factors like silica content, particle size and shape, etc. (Tayeh et al. 2021b). The main factors which typically govern the consequences of incorporating SCMs are pozzolanic action, acceleration of cement hydration, filler effect and dilution effect.

The finer particle size of SCM (compared to cement) Significantly affects the mortar and concrete properties (Tayeh et al. 2020). These types of SCMs increase the cement hydration by their nucleation site effect (Li et al. 2019). The fine particles segregate larger pores present in the cementitious paste into smaller pores. Therefore, an increase in the number of pores provides additional nucleation sites for the precipitation of hydration products. It increases the compactness of the pore structure of con- crete (Li et al., 2021a, b, c). The filler effect of these SCMs also improves the packing density. They fill in the gaps among the relatively coarser cement particles and reduce the water-to-binder ratio (w/b) at the interfacial transition zone (ITZ) around coarse aggregates and bring it at par with the rest of hardened cement paste (Taher et al. 2021). Many researchers have reported progressive improvement in various properties of concrete with an increase in the SCM ratio. However, beyond the optimum level of cement substitution, the properties

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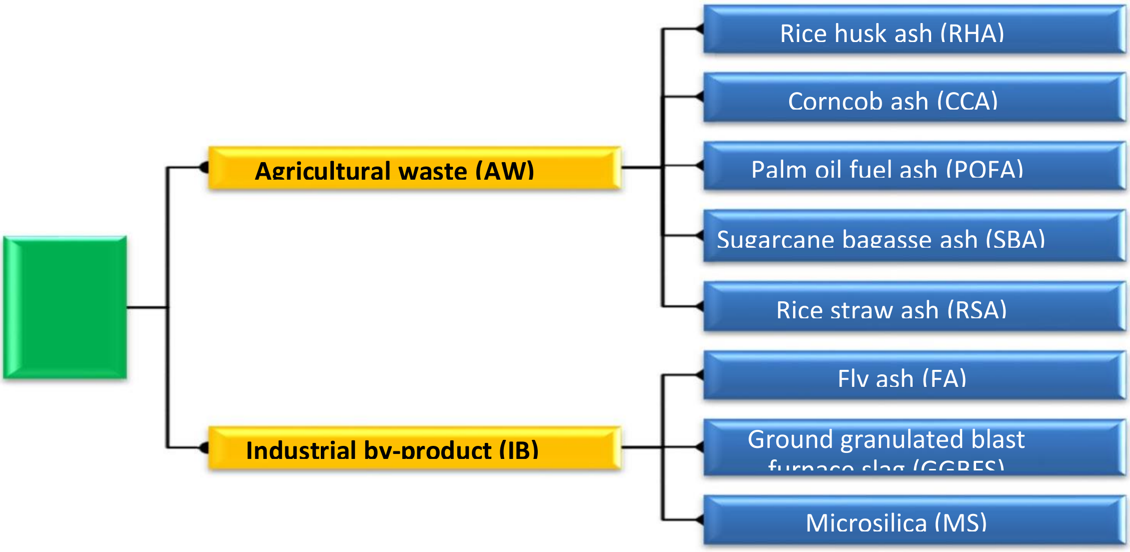
start to degrade with further replacement due to cement's dilution effect. The increase in the amount of cement replacement by SCM reduces the formation of Ca(OH)2, thereby affecting the pozzolanic reaction. In this study, SCMs were broadly divided into agricultural waste (AW) and industrial by-products (IB). Different types of AW and IB, whose performances have been scrutinized, are shown in Fig. 1.



Has Agriculture and the chores associated with agriculture are the principal sources of income for over 70% of the world populace. This gives an idea of the enormous amount of agro-residues produced in the world. Globally, the annual production of agro-residues is around 140 billion tons (Bimbraw 2019). Usually, agro-residues are classified into field residues and process residues (wikipedia 2020). Field residues are the leftovers obtained from the harvesting of crops, e.g. stalk, straw, etc. In contrast, process residues are obtained from the processing of crops into a final or usable product, e.g. husk, bagasse, etc. Most of the farmers do not realize the economic value of field residues. Therefore, after harvesting season, they treat them as waste materials and usually leave them on the fields. To ready their fields for the next batch of cultivation and get rid of the field residues, they exercise a cheaper and environmentally unfriendly option, i.e. field burning. Apart from the emission of environmentally harmful soot particles and greenhouse gases, open-air burning of field residues leads to loss of plant nutri- ents like nitrogen, phosphorous, potassium and sulphur in the soil (Domínguez-Escribà and Porcar 2009). On the other hand, process residues are dumped in the open area (after necessary processing) and left unattended, which results in their rotting. In India, the combined annual production of field and process agro-residues is around 500 million tons, out of which roughly 92 million tons are burnt (Devi et al. 2017). It has been divulged in numerous studies that when an agro-residue is burnt, the resulting ash is highly pozzolanic because structurally stronger crops have high silica content (Currie and Perry 2007).

Agro-residues are considerably cheaper, which increases the possibilities of

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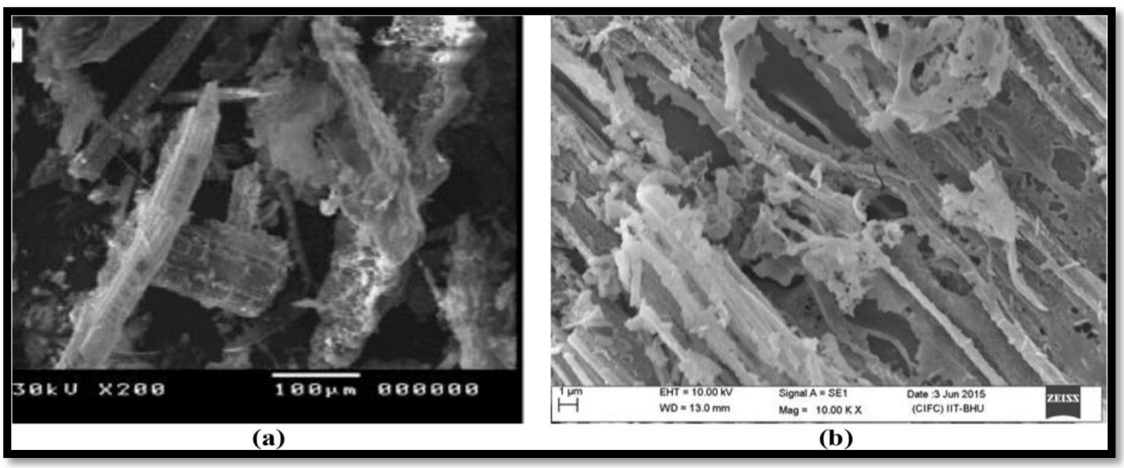
significantly inexpensive SCMs. Table 2 gives the amount of different agro products and residues produced in different countries and the amount of ash generated by burning these agro-residues (based on previous studies). The countries given in Table 2 have been chosen because they are one of the most populous and agriculturally active countries on their continent.

Rice husk ash (RHA)

The India is the 2nd largest producer of rice in the world. Rice production in India and Asia is 20% and 90%, respectively, of the total rice produced in the world (IARI 2012). RHA is produced by burning rice husk, a waste by-product of the rice milling industry. Approximately 120 million tons of rice husk is produced in the world in a year (Abbas and Ansumali 2010). Its major components are hemicellulose, cellulose lignin (Huang and Lo 2019)

MATERIAL PROPERTIES

The raw SBA consists of fine, coarse and completely/par- tially burnt particles. They are either stored in large silos or discarded as waste in the open fields (Bahurudeen et al. 2015). In the past, raw SBA was either burnt or ground, even in the absence of adequate knowledge about the effect of these processes on SBA material properties. Bahurudeen et al. (2015) investigated different pretreatment techniques of raw SBA, such as sieving, chemical activation, grind- ing, burning and combination of all. They concluded that the most efficient process involves oven-drying raw SBA at 105 to 110 °C for 24 h, followed by passing it through the sieve of size 300 µm and further grinding it to the size of 0.3 m2/g using a ball mill. Other studies also adopted a similar treatment procedure (Kazmi et al. 2017; Moretti et al. 2018). Praveenkumar et al. (2020) applied the same tech- nique with the additional steps of oven drying and grinding SBA for the 2nd time, as shown in Fig. 8. Arenas-Piedrahita et al. (2016) adopted a low-energy consuming process for the treatment of raw SBA. They passed the oven-dried SBA through a 75-µm sieve to attain requisite fineness.



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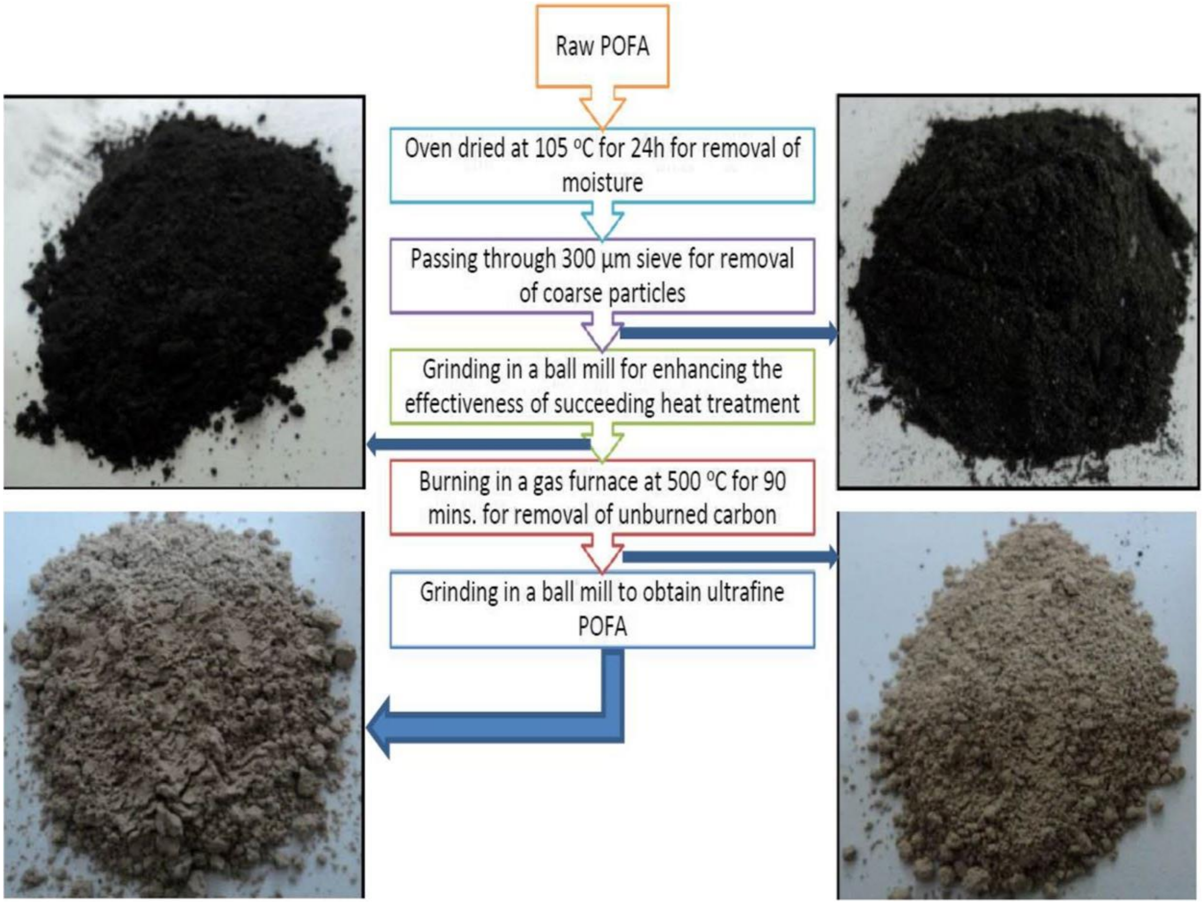

Fig. 2 Treatment of raw POFA for production of ultrafine POFA along with colour transformation at each step (Zeyad et al. 2017)

CONCLUSION

There is a growing concern among the scientific com- munity about the ill effects of conventional concrete. One way for sustainable and viable concrete produc- tion is optimum utilization of AW and IB as an SCM. The SCM utilization can be the breakthrough needed for the construction of environmentally conscientious CP. The multifaceted values of SCM usage are (1) uti- lization of waste materials from landfill, (2) reduction in cost associated with the cement, (3) production of concrete with higher durability and (4) environmentally friendly and carbon-conscious concrete. The main con- clusions derived from this exhaustive review study are as follows:

1. GGBFS has the lowest silica content, followed by CCA and FA. However, they have high CaO content as com- pared to other waste materials. As a result, they also show hydraulic activity apart from pozzolanic activity. The silica content and mean particle size of each AW is dependent on their origin, burning temperature and production approach. Therefore, to obtain better results from AW, they need to be carefully and adequately pro- cessed. Comparatively, the material properties of IBs are less dependent on the processing approach. The fea- tures of processed AW are equivalent to that of IBs. MS has a minuscule mean particle size (0.15 to 0.60 µm).

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The analysis of morphological characteristics of AW revealed that they are primarily porous, having an irreg- ular shape (RHA, SBA), needle shape (RSA) or angu- lar shape (CCA, POFA). But IBs have a comparatively smoother surface with a spherical shape (FA, MS) or random geometry (GGBFS). The mineralogical analysis revealed that MS is highly amorphous, while others are partially amorphous and partially crystalline.

2. The hydration heat decreases with an increase in SCM content because a reduction in cement content stead- ies the hydration reaction and reduces the amount of heat released during the hydration process. However, MS shows contrary results. Few studies (related to MS) observed an increase in cumulative hydration heat liber- ated in 1 day and a reduction at other curing age.

3. RHA and RSA reduce the slump and workability of con- crete due to the high quantity of carbon content, and therefore, additional water is required for a silica-lime reaction. Meanwhile, other SCMs cause both reduction and increment in the concrete workability (depending on the amount of superplasticizer present and w/b). The increment in workability is due to the ball-bearing effect, lubricating effect and excellent surface characteristics of MS, GGBFS, FA, SBA, POFA and CCA.

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MECHANICAL BEHAVIOR ON PARTIAL REPLACEMENT OF COARSE AGGREGATE WITH SEASHELL IN CONCRETE

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ABSTRACT

This paper represents the experimental results of a concrete using seashell as a partial replacement. The present work is to investigate the effects of seashells in concrete production to produce high strength concrete. The compressive strength, flexural strength and split tensile strength tests were carried out with different proportioned seashells at different curing days, as well as finding the optimum percentages of seashell replacements to give targeted strengths. The concrete samples were prepared by adding seashells about 0%, 6%, 9%, % and 11% as a partial replacement to coarse aggregate. All these samples were cured for 7 days, 14 days and 28 days before the compressive, split tensile and flexural test were carried out. A total of 135 specimens were casted and tested for five mixtures in their proportions so as to determine the mechanical properties of the concrete. It should be noted that no additives were added to the mix except seashell as a partial replacement coarse aggregate. A total of 45 cubes were casted for compressive strength test with dimensions of (150mm x150mm x150mm) and 45 prisms were casted for flexural strength test with dimensions of (100mm x100mm x300mm) and remaining 45 cylinders casted for split tensile strength test with dimensions of (100mm x200). After these tests were carried out, the results were used to compare with those of the control experiment. The results showed a decrease in density due to increase in seashell content and a high strength value obtained for 20% replacement. It was noted that implementing seashells in the concrete mix can be used to produce a lightweight concrete with high strength.

Keywords: Coarse aggregate, Seashells, compressive strength, flexural strength, split tensile strength.

I. INTRODUCTION

In this research work properties of structural concrete when seashells are used as coarse aggregate replacement were studied. Most of the waste materials are non-biodegradable and may remain on the environment for hundreds or even thousands of years. These non-biodegradable materials cause waste disposal crises leading to environmental problems. The problems of waste materials accumulation is everywhere around the world and mostly affect high density areas. According to research from (Waste Management., 2007) use of these industrial and marine waste products can be of great advantages in the construction industries. Utilizing seashells reduces the storage of marine waste, also reducing exploitation of quarried aggregates and has benefits in adding different materials to a concrete mix design for improved performance (Richardson & Fuller, 2013). The aim of this research work is to.

• To make an investigation on the workability of freshly mixed concrete. This will be achieved by carrying out slump test and compaction factor test.

• To make an investigation on the durability of hardened concrete using the compressive, tensile and flexural strength test

II. MATERIALS AND METHODOLOGY OF EXPERMENTAL WORK

A.Materials

Cement is a material which is used to bind solid bodies together by hardening from a fresh or plastic state. In this research work locally available ordinary Portland cement was used.

The coarse aggregate was air dried to obtain saturated surface dry condition to ensure that water cement ratio was not affected. Few characteristics of aggregate that affect the workability and bond between concrete matrixes are shape, texture, gradation and moisture content. In this study crushed aggregates from quarry with the nominal size 5-10 mm were used inaccordance to BS 882-1992.

Fine aggregate; Fine aggregate is commonly known as sand and should comply with coarse, medium, or fine grading needs. The fine aggregate was saturated under surface dry conditions to ensure the water cement ratio is not affected.

The chemical reaction between water and cement is very significant to achieve a cementing property. Hydration is the chemical reaction between the compounds of cement and water yield products that achieve the cementing property after hardening. Therefore, it is necessary to that the water used is not polluted or contain any substance that may affect the reaction between the two components, so tap water will be used in this study

Table 1: Physical properties of ordinary Portland cement

s.no	Test conducted	Result obtained	RequirementsAsperIS:12269-
1	**Fineness Modulus**	2.33%	10% maximum
2	**Initial setting time**	35 minutes	30 minimum
3	**Final setting time**	400 minutes	600 maximum
4	**Specific gravity**	3.15	2.99-3.15
5	**Standard Consistency**	30%	-

Table 2. Specific gravity of coarse aggregates

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PARTICULARS	TEST1	TEST2	TEST3
Weight is empty pycnometer (w1gram	620	620	620
Weight of pycnometer 1/3rdoffineaggregates(W2)grams	1060	1070	1070
Weight of pycnometer + 1/3rd of fine aggregates+water(W3)grams	1740	1770	1770
Weight of pycnometer+water(W4) grams	1490	1490	1490
Specific gravity G=(W2-W1)\((W2-W1)-(W3-W4)	2.56	2.64	2.69

III. TESTS ON CONCRETE

The property of fresh concrete which is indicated by the amount of useful internal work required to fully compact the concrete without bleeding orsegregationinthefinishedproduct.Workabilityisoneofthephysicalparametersof concrete which affects the strength and durability as well as the cost of labor and appearance of the finished product. Concrete is said to be workable when it is easily placed and compacted homogeneously i.e., without bleeding or Segregation. Unworkable concrete needs more work or effort to be compacted in place, also honeycombs &/or pockets may also be visible in finished concrete. . Two tests basically have done for workability namely slump test and compaction factor test with fresh mix.

Table 3.

Seashell content (%)	Slump value (mm)
0	45
3	39
6	32
9	29
11	23

Sea shell content (%)	Compaction factor value (mm)
0	0.879
3	0.825
6	0.796
9	0.798
11	0.736

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IV.MECHANICAL PROPERTIES

COMPRESSIVE STRENGTH TEST

TABLE NO :- 9 COMPRESSIVE STRENGTH RESULTS

Concrete Mixes	Compressive Strength (N/mm^2)		
	7 days	14 days	28 days
Sea shells (0%)	29.45	Sea shells (0%)	29.45
Sea shells (3%)	24.59	Sea shells (3%)	24.59
Sea shells (6%)	32.82	Sea shells (6%)	32.82
Sea shells (9%)	23.88	Sea shells (9%)	23.88
Sea shells (11%)	23.15	Sea shells (11%)	23.15

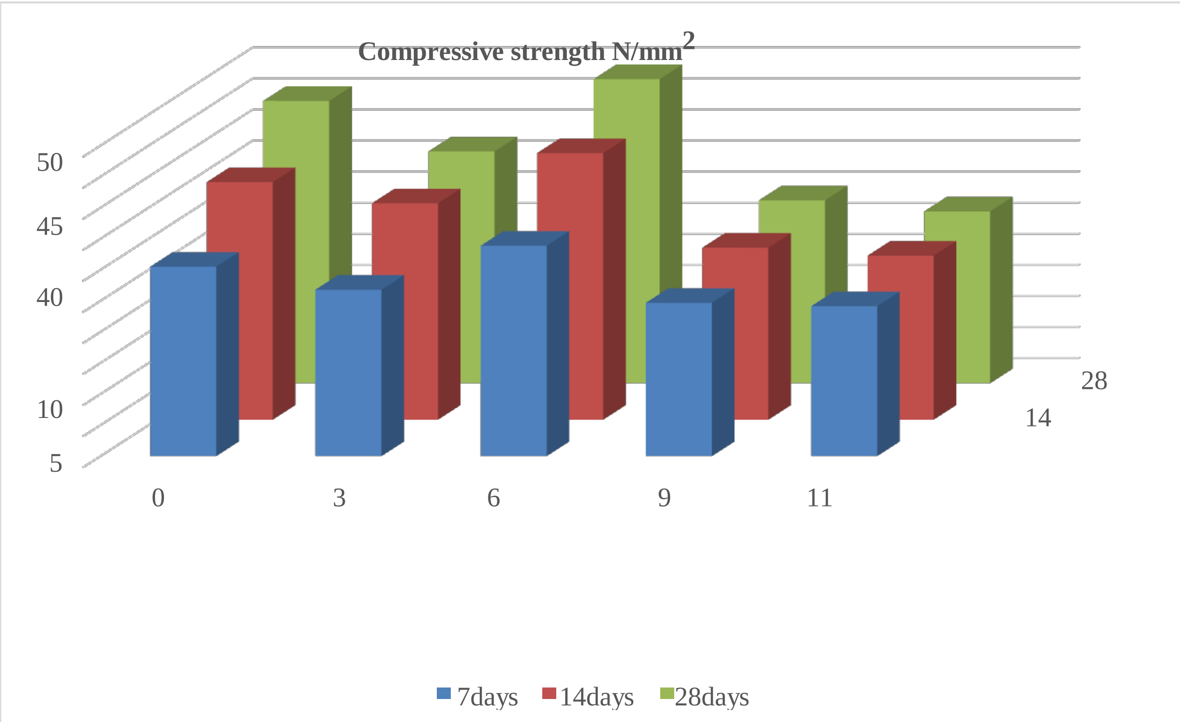

FIG NO 12:- GRAPH FOR COMPRESSION

Flexural strength test

TABLE NO :- 10 FLEXURAL TEST RESULT

Concrete Mixes	**Flexural strength(N/mm^2**		
	7 days	**14 days**	**28 days**
Sea shells (0%)	5.45	5.76	6.2
Sea shells (3%)	4.89	5.22	5.74
Sea shells (6%)	5.56	6.39	7.95
Sea shells (9%)	4.55	5.28	5.86
Sea shells (11%)	4.45	5.22	5.76

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GRAPH OF FLEXURAL TEST

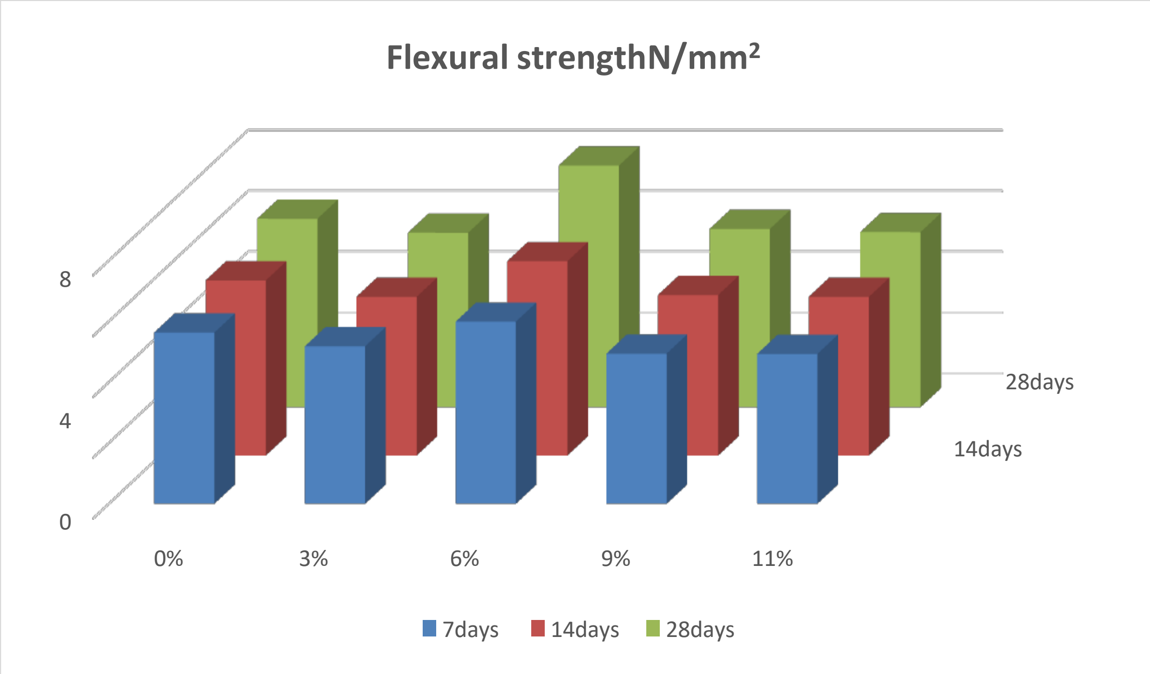

FIG NO :-12 GRAPHFOR FLEXURAL TEST

SPLIT TENSILE TEST

CONCRETEMIXES	SPLIT TENSILE TEST (N/MM^2)		
	7days	14 days	28 days
seashells(0%)	5.63	seashells(0%)	5.63
seashells(10%)	5.18	seashells(10%)	5.18
seashells(20%)	5.99	seashells(20%)	5.99
seashells(30%)	4.94	seashells(30%)	4.94
seashells(40%)	4.93	seashells(40%)	4.93

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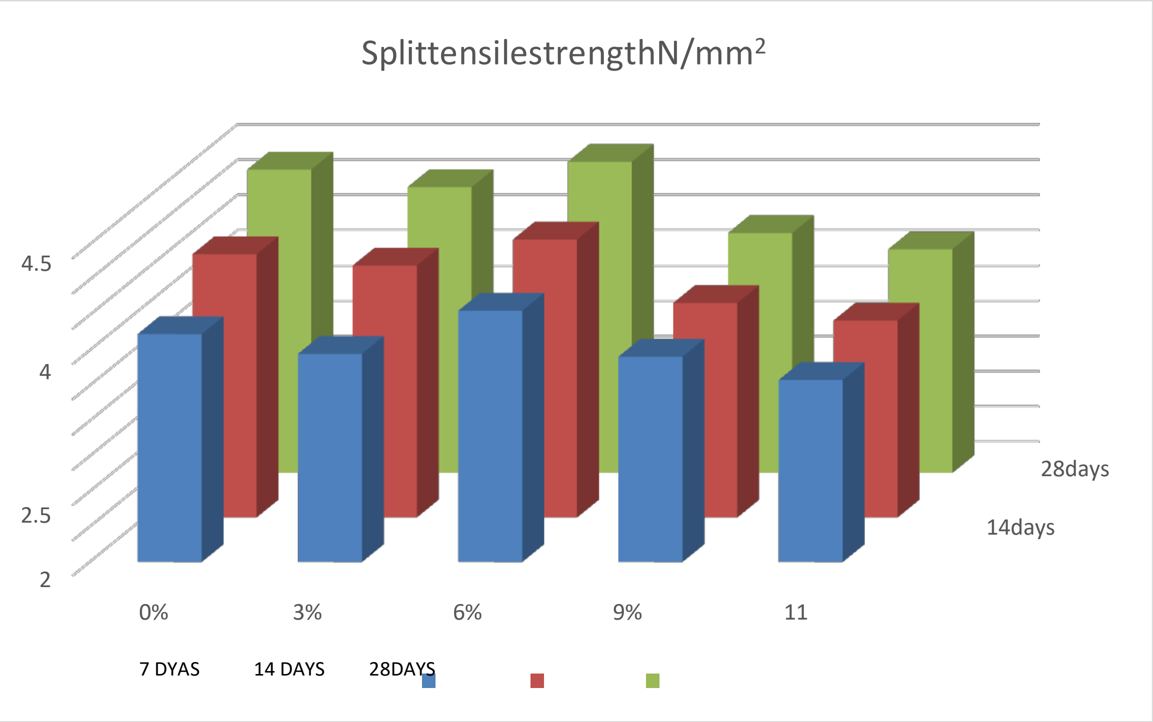
FIG NO 13 :- GRAPH FOR SPLIT TEST RESULTS



CONCLUSIONS

Generally using seashells as partial replacements in concrete is very good, as it reduces the depletion of natural resources like sand and granite, it also reduces accumulation of waste marine materials on rivers or seabeds and banks. From the study the following conclusions were brought forth

- In early stages of t e analysis, it was found that adding and increasing the seashells as partial replacement reduces the workability of concrete.
- The density of the concrete was observed to be decreasing as the content of seashells was increased from0%to11%. Atday28 the samples that contained seashells showed densities between 2144 kg/m3 - 2284/m3 and that of concrete with a highest value of2307kg/m3.
- As the percentage of seashells was increased from 0% to 11%, it was observed that maximum strength was observed at 11% replacement in all compressive, flexural and split tensile tests.

ACKNOWLEDGMENT

The preferred spelling of the word “acknowledgment” in American English is without an “e” after the “g.” Use the singular heading even if you have many acknowledgments. Avoid expressions such as “One of us (S.B.A.) would like to thank ” Instead, write “F. A. Author thanks ” Sponsor and financial support acknowledgments are placed in the unnumbered footnote on the first page.

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HIGHWAY CONSTRUCTION ON WEEK SOIL USING EPS GEOFOAM AND GEO MEMBARANCES

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ABSTRACT

This paper mainly concentrates on the uses and applications of EPS geo-foams and geomembranes in construction industry like Bridges and Embankments over weak soil (compressible soils). If any external load is acting on weak soil, it will undergo settlement and the soil will be compressed. To overcome these settlements and compression of the weak soils, in this research we suggest EPS geo-foams. The EPS means "Expanded Poly Styrene", it is a light weight material which is 1% weight of soil and it is less than 10% weight of other light weight materials and it is available in different densities. It has high compressive resistance and it reduces settlement of weak soil. It is generally used as a soil fill replacement material. If the soil contains any moisture content, the geo membrane acts like a water barrier for the geo-foam material. Geo-membrane is a thin continues polymeric sheets and it is a geo synthetic material, it is generally used in construction industry and geotechnical applications. If we place different types of densities of EPS geo-foam blocks and geo-membranes over weak soil in bridges and embankments, the soil behaviour is changing and attaining stability. Finally based upon the behaviour of weak soil we conclude that, at which density of the EPS blocks the soil attain more strength and how other strength parameters has been related to density by conducting the different tests. Keywords: EPS Geo-foam, Geo-membrane, Weak soil, compressive resistance, settlement, soil fill replacement.

1. INTRODUCTION:-

Now a days all countries are developing more rapidly in the construction side. To construct any structure on weak soil, if the soil is not suitable for construction, then there is a need to go for alternative materials [3]. Especially while the construction of the structures like Brides and Embankments, it is mandatory that the soil should have enough strength (Bearing capacity) to with stand the external loads and when we required to construct heavy structures like bridges and embankments on weak soils one need to increase the strength and stability of the soil. Stabilizing of soils is not economical and it requires more time [7, 8]. In this research we suggest the best alternative material is EPS geo-foam means "Expanded Poly Styrene" generally called as "Thermocol" is used in the weak soils to get more stability [10]. It contains 95% of air and the strength of EPS is related to the density of EPS geo-foam. In foreign countries they were used these EPS blocks in the construction of Bridges and embankments to increase the strength and stability of the weak soils and to decrease the

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settlements of the soils under loading. The usage of these EPS geo-foams in Bridge abutments is best economical alternative than a piled.

embankment inside the abutment. We can use different qualities of EPS geo-foams based on the requirement in the soils .Generally by placing different densities over weak soil and comparing the behavior of weak soil based on the results obtained [11].

2. MATERIALS AND PROPERTIES

2.1. EPS Geo-foam EPS Geo-foam blocks means Expanded Poly-Styrene Geo-foam blocks, which is a geo-synthetic material generally used for packaging and insulation purposes over compressible soils, but now a days it is also used in the construction field [6]. The EPS geo-foams can be used in the bridge abutments and the construction of embankments to increase the strength and stability of the weak soils. The use of EPS geofoam over weak soils was best suggestion because it was found to be the most economical geotechnical solution for the project [5]. EPS geo-foam blocks were therefore used to make up the filling inside the abutments and the embankments while the extension of highways. The EPS geo-foam weight is very less, it can carry easily without any special equipment and can be available in different shapes and densities.

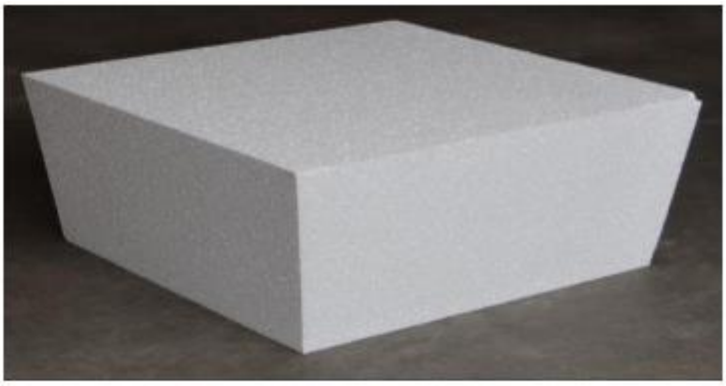

Fig: 1 EPS Geo-foam

2.2 **Geo-membrane**

A geo-membrane is a very less permeable membrane, it will not allow water through it and act like a barrier for other material which is placed over geo membrane [4]. It is majorly used over weak soil and it is

Fig: 2 Geo-membranes

Table: 2 Properties of Geo membrane

Property	Value
Thickness	12-100 miles
Specific gravity	0.9 -1.6
Tear resistance	4-32 pounds
Impact resistance	0.5-13 ft-lb
Puncture resistance	10-100 pounds

act like a barrier between soil and EPS geo-foam. The main purpose of these geo membranes is to hold the EPS geo-foam blocks on the soil and to minimize the passage of the water through it. And by placing these geo membranes on the side fills we can mitigate the settlement and sliding of the soil.

2.3. Compressible soils

Weak soils generally called as “compressible soils” such as clay or silty clay soil having low bearing capacity. When loads act on this type of soils it undergoes easily settlement [2]. To increase the properties of weak soil instead of stabilizing, if we place geo-foam members over weak soil it will give best results more than stabilizing techniques and the cost of the usage of these EPS blocks in the soils is very less compared to the stabilization of the soil by using any stabilizing materials [9]. The below figure shows the properties of weak soil.

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Fig: 3 Compressible soil

3. Test Results and Comparison

Table: 3 Properties of soil

Property	Value
Liquid limit	62%
Plastic limit	41%
Plasticity index	22%
Specific gravity	2.34

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3.1Density

EPS geo-foam densities are taken as 10, 12, 14, 16, 18, 20kg/m3 and comparing the stability of soil at various densities. The stability of soil depends upon the compressive strength and shear strength values. The test results are shown in the following graph. The below graph shows the variation between different density values of EPS geo-foam to the other strength parameters of EPS geo-foam after placing over weak.

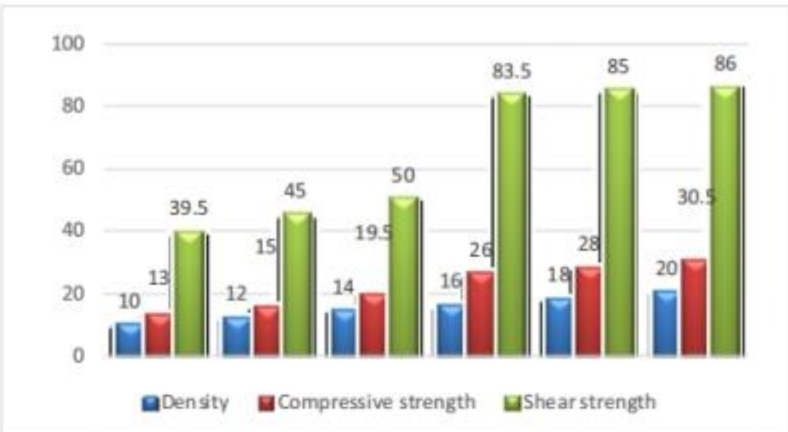

Fig 4: Comparing of Compressive strength, shear strength values with different density values of EPS geo-foam.

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3.2.**California Bearing Ratio Test**

The CBR test is generally used for evaluating the sub grade strength of the roads and pavements.

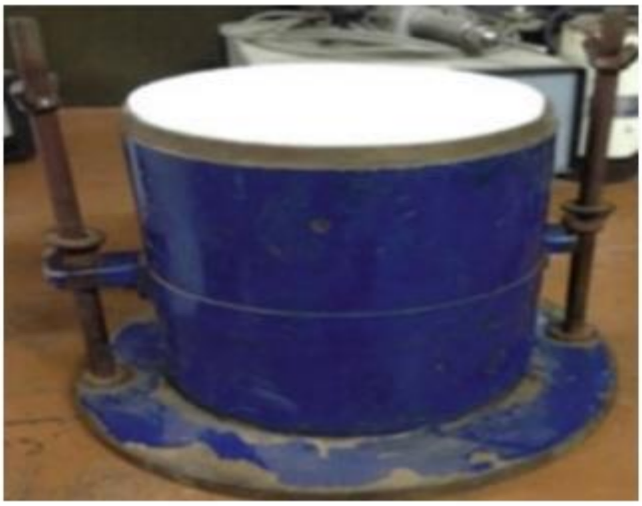

Fig: 5 CBR test specimen

But in case of construction of structures over weak soil by placing EPS geo-foam, we need to perform CBR ratio test on geo-foam to find the penetration strength [1]. CBR ratio test has been performed on different densities of geo-foam as 10, 15, 20, 25 kg/m3. By placing EPS geo-foam in cylindrical sections of CBR mould. The CBR test

is penetrated into EPS geo-foam with a standard rate of 1.28 mm/min as per ASTM D1883 [12]. This test is performed on different densities and obtained different CBR ratio values. Finally graph is drawn between density and CBR ratio values as shown as below.

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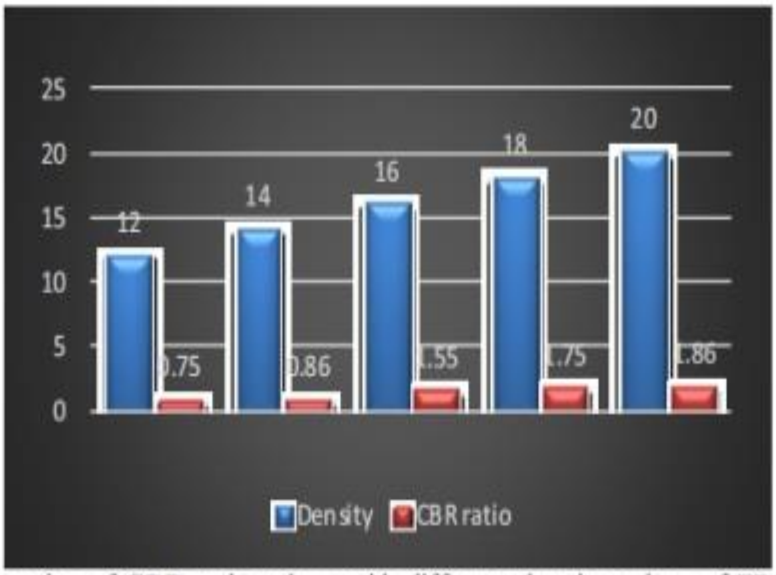

Fig 6: Comparing of CBR ratio values with different density values of EPS geo-foam

3.4Shear Strength

Shear strength is the maximum internal resistance to shearing stresses and a consequent tendency for shear deformation. It has been tested over different densitiesas 14, 16,18,20 kg/m3 of EPS geofoam under tri axial testing. EPS geo-foam blocks with shear strength of 45 kpa at 5% deformation constituted large part of the filling. Higher strength blocks were also used at selected sections and these had a strength of 62 kpa at 5% deformation. Below figure shows the test result values.

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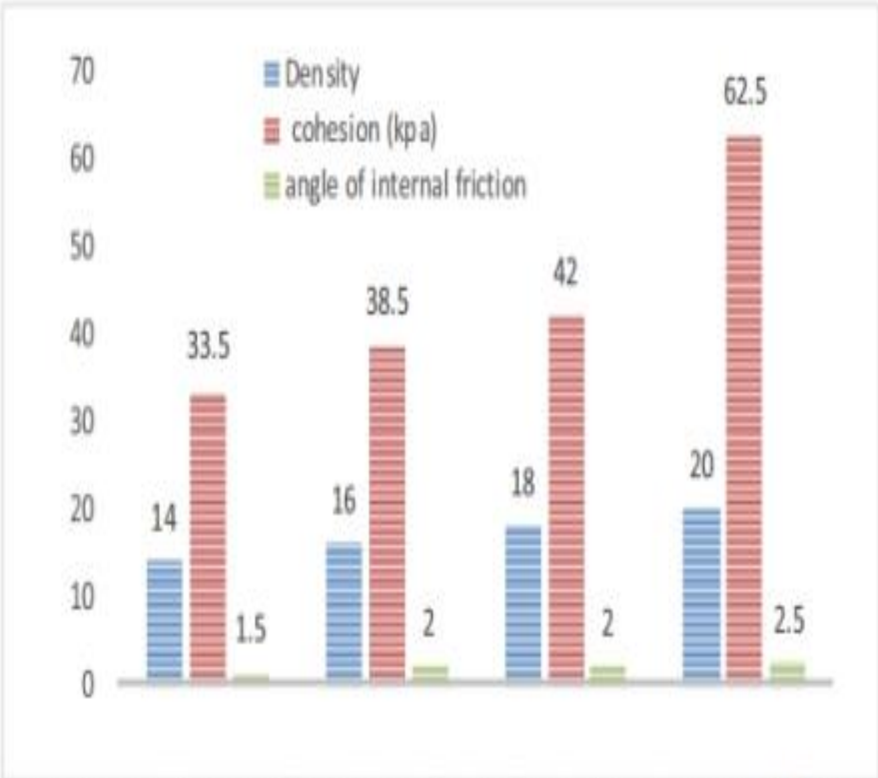

Fig 8: Comparing of strength parameters with different density values of EPS geo-foam.

CONCLUSION

The following are the list of the conclusions drawn from the above investigation,

Based upon above results, we can conclude that the weak soil can get strength by using these EPS Geo-foams and Geo membranes. This technique is more economical compared to the stabilization of soil by using stabilized materials, because the cost of Thermocol is very less compared to the stabilizing materials.

Behavior of weak soil depends upon the different density values of geo-foam used in the construction. It is clear that from the above test results, density of EPS Geo-foam should be not less than 15.If the density of Geo-foam is less than 15 then there is no effect of these EPS Geo-foams in the strength properties of the soil. A full pledge inspection of the embankment during construction plays vital role in the quality checking. Overall, the lightweight fill in bridge abutments and embankments are safe with regard to settlement and stability concerns. Construction of bridge abutments and highway embankments over soft soil using expanded polystyrene (EPS) block (geo-foam block) to decrease consolidation settlement is a recent technology and has been implemented by various countries around the world.

By using EPS blocks, bridge abutments, infrastructural embankments and extension of highways can now be done cheaply and quickly without unnecessary embankment slopes. This was implemented in the southeast of the Netherlands. If the density value is less than 15 the strength will not increase more, if the value is more than 20the compressive strength, shear strength and CBR ratio values increases and it is best for any type of construction.

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PROPARATION OF LIGHT WEIGHT AGGREGATE CONCRETE BY BTHE PARTIAL REPLACEMENT OF FINE AGGREGATE WITH PLASTIC LIMIT

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ABSTRACT

The inclusion of an artificial aggregate manufactured using plastic waste to develop a light-weight concrete was studied. Five separate mixes were designed, progressivelyincreasing the amount of artifificial aggregate and measuring the fresh and hardened concrete properties, and it was found that the slump and density of the concrete decreased as the amount of artifificial aggregate in the concrete increased. Both the compressive and the tensile Then the mix that was most suitable to the requirements of the study in terms of density and compressive strength was chosen for further investigation in stage two. Fifteen percent of the natural aggregate by weight was replaced in this optimal mix, which equals more than thirty-seven percent of the volume given the lower density of the manufactured aggregate compared to natural aggregate. A larger number of specimens and more detailed testing was undertaken for stage two when compared to stage one, including establishing the compressive stress-strain relationship and the modulus of elasticity of the newly developed concrete mix. The results indicated that plastic aggregates manufactured following shredding, palletisation and extrusion processes can be used to obtain a lightweight concrete (1800 Kg/m3) while having relatively good compressive strength properties (20 MPa at 28 days). These results were higher than other results previously reported in the literature on the replacement of coarse aggregate with plastic, but were marginally lower than results reported in the literature for studies where fifine aggregate was replaced with plastic.. It was concluded that the concrete mix reported herein can be used for a wide spectrum of applications such as non-structural facades and sound barriers for highways.

Keywords: Concrete, plastic waste, manufactured aggregate, light-weight concrete, Sustainability

1. INTRODUCTION

Concrete is the most common construction material in the world and is com posed of four basic ingredients: water, cement, gravel as coarse aggregate, and sand as fifine aggregate. Aggregate resources are the most extracted mineral resource in the world, and the global construction market consumed the equivalent of USD 360 billion in 2018 alone [1]. The "mining of sand and gravel is the most disastrous activity as it threatens the very existence" of rivers and other natural environments [2], and can have signifificantly adverse societal effffects in the community or in the region [3]. As an

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example, 4.1 million cubic metres of concrete were produced in New Zealand in 2018, which resulted in approximately 5.1 billion tons of aggregate if 1250 Kg of aggregate per cubic meter of concrete is assumed [4]. Reducing the amount of virgin aggregates being mined is critical if natural ecosystems are to be preserved for future generations. Plastics are ubiquitous in society in almost every fifield and the production of plastic products, especially single-use plastic products, has strikingly increased during the 20th century and in the fifirst two decades of the 21st century. In 2017,64.4 million tons of plastic were produced in Europe and 348 million tonnes were produced worldwide, with 60% of that amount being used by only two market sectors, being the packaging industry and the building and construction industry [5]. Plastic waste can be processed following three methods, which are recycling, incineration (often combined with an energy recovery process), and landfifilling, in order of preference [6]. In the same year of 2017, 27.3% of the plastic waste collected in Europe was disposed of in landfifills [5] and in the USA the situation is far worse, where in 2015 there was 35.4 million tons of plastic produced of which 75.4% fifinished its useful life in landfifills [7], and with the reporting of such data subsequently discontinued with the change of US Government administration in 2016. On a global scale, only 9.5% of all the plastic ever produced up to 2015 has been recycled and 79% of this plastic is in landfifills, although the amount of plastic waste currently going into landfifills has reduced to 58%[8]. Most types of plastics are non-biodegradable and are chemically unreactive to the environment, so these plastics can remain in the environment for decades or even centuries. Some types of plastic can also release toxic elements into the environment, such that dumping plastic waste into landfifills is not a viable solution. While incineration of plastic waste completely eliminates the waste and can be a source of power, this process typically releases carbon dioxide and other poisonous chemicals and produces toxic flfly ash and bottom ash. Recycling is therefore the best solution to treat plastic waste, with one of the most commonly used methods being the reuse of plastic waste into the construction and building industry. Research on the use of plastic waste in cement mortar and in concrete is extensive [9, 10, 11], with various reviews of the topic having been compiled recently [12, 13, 14, 15]. The inclusion of other waste materials in concrete for sustainability purposes has also been intensively investigated, such as flfly ash [16, 17], geopolymer aggregates made with fly ash [18], waste glass [19], or biochar [20], but the focus of the research reported herein was on plastic waste. The most common method to introduce plastic waste into concrete mixes requires the plastic to be categorised by the diffferent types, and to be cleaned before being shredded into particles of diffferent shapes and sizes [13, 21, 22]. The commonly reported result of incorporating plastic into concrete as an aggregate replacement is the reduction of workability, density and mechanical performance of the resulting concrete mix, without signifificantly improving the durability of the material [23, 24, 25]. An improvement in abrasion resistance was reported in the past when using PET plastic as an aggregate replacement due to the more rough texture of the plastic particles compared to the texture of natural aggregates [13, 26]. The increment in water absorption of concrete with plastic waste as an aggregate replacement was widely reported as a result of the elevated air content that is entrained during mixing, with the

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increment in entrained air caused by inadequate blending of the natural and artifificial aggregates due to difffferences in density, where the plastic waste aggregate typically flfloated in the cement paste while the natural aggregates sank [27, 28, 29, 30]. Finally, the use of plastic aggregate increased drying shrinkage due to the lower restraint provided by the plastic aggregate when compared to that of the natural aggregate, and increased the resistance to chloride ion penetration [31, 32, 33, 34]. The main source of the problems associated with incorporating plastic waste into concrete is the chemical incompatibility between plastic and cement paste, given that plastic is hydrophobic and cannot chemically bind with the cement paste, and therefore the bond strength between the plastic surface and the cement paste is low [14]. This behavior results in key properties decreasing as the amount of plastic incorporated within the concrete mix is increased [14].The majority of the reported research existing in the literature has focused on introducing plastic waste into the concrete mix by fifirst sorting, cleaning and shredding the plastic waste but without further altering this plastic waste via processes such as heating or chemical treatments. Only one product comparable to that used in the current study has been found in the literature, that was developed using 30% cleaned, sorted and shredded liner low-density polyethylene (LLDP) as a binding matrix combined with 70% virgin sand [35, 36, 37], whereas the product used in the current study is made of 100% plastic waste without the addition of any virgin material. The aggregate product used in this study was made of 100% plastic waste, with the manufacturing process involving shredding, extrusion and pelletization of the plastic waste. The mechanical and physical properties of the plastic waste were altered through this manufacturing process to produce the resultant aggregate, with the appearance and mechanical properties of the manufactured aggregate being distinctly difffferent from those of typical smooth plastic. All seven grades of plastic as defifined by ASTM D7611 [38] were used during the manufacturing of the artifificial aggregate, but always using 80% of polyolefifins and 20% of the other types, with the mechanical and physical properties of the manufactured aggregate found to be consistent regardless of the proportions of plastics grades used. The fifinal product has a specifific gravity of 0.85 kg/m3 and negligible water absorption. The concrete mixes developed with the material used in this study resulted in a compressive strength of 19.7 MPa using an aggregate made with 100% plastic waste, while the results reported by Alqahtanietal indicate a maximum compressive strength of 12 MPa using an aggregate made with 30% plastic waste. Therefore, the material used in this study was novel when compared to other materials reported in the literature.

2. RESEARCH MOTIVATION AND OBJECTIVE

The objective of the study reported herein was to obtain a concrete mix with a density of 1800 kg/m3 , a 28 days compressive strength of 20-25 MPa, and al1-day compressive strength of 10 MPa. The reason for targeting a relatively high compressive strength at an early age was to accelerate the production of precast concrete panels and other precast concrete elements, which was the main market being targeted. The installation of non-structural concrete elements such as shade panels, façade panels and highway sound barriers is streamlined when using light weight concrete, improving the

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construction effiffifficiency and reducing the demands on foundation and anchoring elements. The targeted concrete mix was not to be used for structural or infrastructure applications

Table 1. Physical properties of Portlan cement

Specific surface area (m^2/kg)	339
Initial setting time (min)	115
Final setting time (hr:min)	2:38
Soundness (mm)	1.3
SO_3 (%)	2.5
Specific gravity (g/cm^3)	3.15

3. MATERIALS AND METHODS

3.1. Cement

Concrete test specimens were made using the same materials used in a local ready-mix plant, with a maximum nominal greywacke aggregate size of 19 mm. Portland cement Type GP as defifined by NZS 3122 [39] was used. The physical properties of the cement are reported in Table 1. Silica fume, with a silica content of 93% and surface area of 23 m2 /g was also added as a supplementary cementitious material.

3.2. Natural aggregate

Two types of natural coarse aggregates were used, being greywacke Kaipara Brookby (KB) 13 (defifined as having 86% of the aggregates passing between 13.2 mm and 19 mm and in accordance with the New Zealand standard of concrete production [40], and greywacke KB 07 (also known as Premium All Passing 7 or PAP7). One fifine natural aggregate was used, commonly referred to as McCallum's Offffshore natural sand (MC 01). The sieve analysis carried out in compliance with the New Zealand standard for testing of water and aggregates [41] for both PAP7 and MC 01 is reported in Figure 1. Both aggregates comply with the gradingrequirements specified in the New Zealand standard [42]. The specific gravity of the KB aggregates is 2680 Kg/m3 and the specifific gravity of the MC 01 sand is 2650 Kg/m3 , as obtained using the corresponding standards [41]. 3.3. Artifificial aggregate The aggregate is manufactured in two broad sizes, being a coarse aggregate and a fifine aggregate, with a picture of both materials being reported in Figure 2. A sieve analysis (also known as gradation test) was performed in accordance with the New Zealand standard [41] to understand the fifineness of both the coarse and the fifine aggregates. The sieve analysis curve for the fifine aggregate is reported

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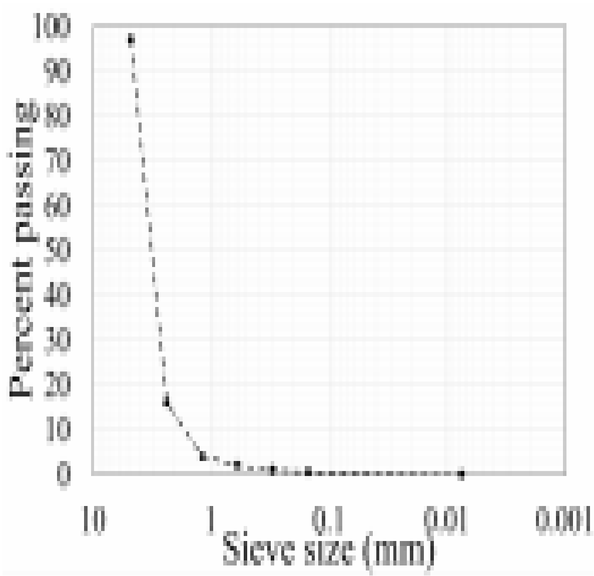

Fig. 3. Sieve analysis of the artificial fine aggregate

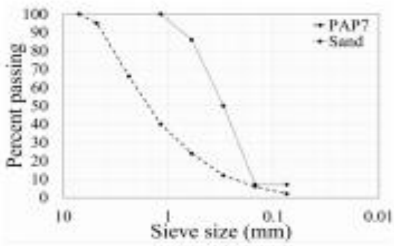

Fig. 1. MC01 sand and PAP7 sieve analysis

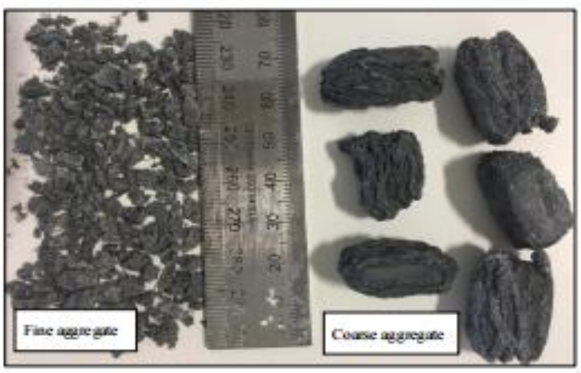

Fig. 2. Pictures of the manufactured aggregate

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in Figure 3. The size of approximately 80% of the fifine aggregate was between 2.36 mm and 4.75 mm. Of the remaining 20%, the size of over 12% was between 1.18 mm and 2.36 mm and the rest was relatively evenly spread, which indicated that the fifine aggregate was relatively coarse and that the aggregate featured a poor grading distribution. The size of 80% of the coarse aggregate was between 13.2 mm and 19.0 mm, which was similar to the size grading distribution of the 13mm natural aggregate (KB13) and in compliance with the New Zealand standard [41]. Appropriate concrete mixes need a widely distributed fifine aggregate for the concrete to be workable, which was not the case for the fifine artifificial aggregate.

3.4. Chemical admixtures Standardised offff-the-shelf air entraining agent, superplasticizer and water reducer chemical admixtures were used in the mixes.

4. Trial Mixes

A total of fifive mixes were designed and batched according to the New Zealand Standard on Concrete Production [40], and various fresh and hardened properties were investigated following the New Zealand Standard for testing of concrete[43, 44]. The ingredients used in each mix are reported in this section, together with the results from the investigated properties of the trial mixes.

4.1. Recipes The ingredients used in each trial mix are reported in Table 2, together with the quantity of each ingredient. The water cement ratio and the amount of coarse natural aggregate were kept constant at 0.405 and 320 kg. The mass amount of PAP7 and sand was progressively reduced while increasing the mass amount of artifificial aggregate (both coarse and fifine aggregate in the ratios described in Table 2) until the maximum replacement level of natural aggregate by artifificial aggregate was 15% by mass (for mix 5). Given that the density of the artifificial aggregate was smaller than 0.25 times the density of the artifificial aggregate, the volume of artifificial aggregate was 37.1% of the total volume of aggregate for mix5. Both the superplasticizer and the water reducer were maintained constant at 2 litres and 0.9 litres respectively.

4.2. Fresh concrete properties

Yield and slump tests were undertaken on the fresh concrete for the 5 mixes in accordance with the NZS 3112.1 standard[43], with the results being reported in Table 3. The relationship between artifificial aggregate content, slump and entrained air are visually represented in Figure 4. The objective was to obtain a fresh mix with a slump of at least 100 mm, but when more artifificial aggregate was included in the fresh concrete the workability of the fresh mix decreased, as previously observed by others[14]. This effffect could be exacerbated by the narrow particle size distribution of the artifificial fifine aggregate. Altering the water to cement ratio was not a desired option, because a higher ratio would compromise the strength of the concrete. A decision was made to include an air entraining agent, given that the maximum amount of superplasticizer and water reducer before excessive bleeding could be expected had already been added. The air entraining agent stabilised the percentage of entrained air to 10% for mix 5. Extensive research has been conducted on the effffect of introducing pieces or fifi-bres of plastic in the concrete mix, with a thorough review recently being published [14]. The main conclusion from the review study was that there is high variability depending on the type and shape of plastic included in the mix. However, the product used in the current study diffffered because the water absorption increasedas a result of the manufacturing process, which reduced the slump. This slumpreduction could be partially mitigated by using chemical additives significantly below the limits suggested by the suppliers, as shown in Figure 4. A similar behavior was observed in the only study with a material similar to that used in this project [37].4.3. Hardened properties Cylinders of a nominal radius and length of 100 mm and 200 mm respectively were tested in compression according to the NZS 3112.2 standard[44] using auniversal testing machine with a capacity of 300 kN and a prevision of 0.01%

Table 2. Mix recipes

Material	Density (kg/m^3)	Mix number 1	2	3	4	5
Cement (kg)	3150			400		
Water (kg)	1000			162		
w/c	-			0.405		
Fume silica (kg)	2100			20		
KB13 mm (kg)	2680			320		
PAP7 (kg)	2680	410	410	360	360	320
MC01 Sand (kg)	2650	495	495	445	445	405
Coarse artificial aggregate (kg)	800	30	75	60	100	120
Fine artificial aggregate (kg)	800	30	25	60	60	65
Artificial aggregate (% of total aggregate by weight)	-	4.7	7.5	9.6	12.5	15.0
Artificial aggregate (% of total aggregate by volume)	-	11.6	18.6	23.7	30.9	37.1
Water reducer (l)	1000			2		
Super-plasticiser (l)	1000			0.9		

Table 3. Fresh concrete properties for the trial mixes

Mix	Artificial aggregate (%)	Slump (mm)	Entrained air (%)
1	4.7	130	5.8
2	7.5	170	3.5
3	9.6	110	6.5
4	12.5	110	9.5
5	15.0	110	10.0

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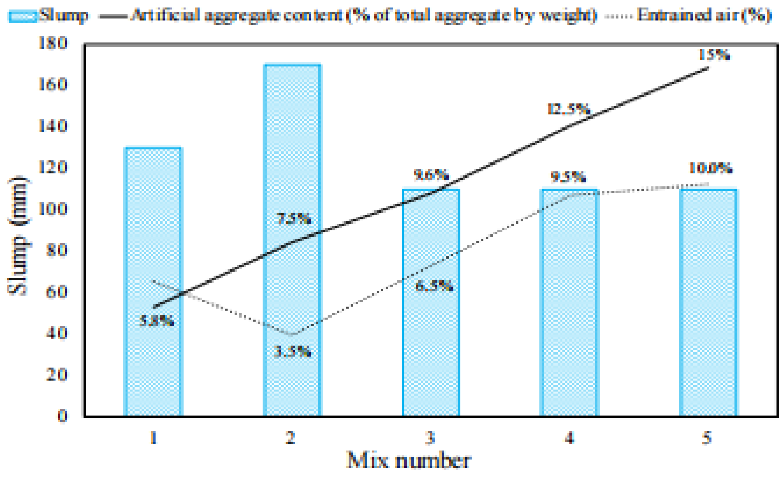

Fig. 4. Relationship between artificial aggregate content, slump and entrained air

(0.03 kN). Similarly, beams with a square cross section of 100 mm per side and a length of 500 mm were tested in the same machine using the four point bending test described in the same standard[44]. Three cylinders and one beam for each mix were tested at each time period. The compressive and the flflexural strength were measured at 1, 7 and 28 days after being stored in a water bath at 21±3 degrees elsius, in compliance with the standard. The results are reported in Table 4 together with the quantity of artifificial aggregate content (Agg.) expressed as a mass percentage of the total aggregate weight, and the dry density in kg/m3 . A visual representation of the relationship between compressive strength, amount of artifificial aggregate, and density is reported in Figure 5, with the standard deviation represented by whisker lines.The density decreased as the amount of artifificial aggregate was increased and as the quantity of entrained air increased. This reduction of density was accompanied by a reduction of strength but the strength was stabilised for mixes 3 to 5 while steadily increasing the amount of artifificial aggregate and keeping the density around the target of 1800 kg/m3 . While the addition of air entraining agents was necessary to obtain a workable fresh mix, the extra entrained air reduced the strength of the hardened concrete. The objective was therefore to fifind the balance

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Table 4. Hardened concrete properties for the trial mixes

Mix	Agg. (%)	Density (kg/m^3)	Compressive strength (MPa)			Flexural strength (MPa)		
			1 day	7 days	28 days	1 day	7 days	28 days
1	4.7	1927	12.0	23.3	27.2	2.4	4.6	4.9
2	7.5	2116	13.2	26.3	36.5	2.5	4.6	5.6
3	9.6	1885	11.6	21.4	22.8	2.4	4.1	4.2
4	12.5	1925	10.6	19.5	22.6	2.0	4.0	4.4
5	15.0	1812	10.0	19.0	22.2	2.2	4.1	4.5

between density, which decreased as more artifificial aggregate and entrained air was included in the mix, and mechanical properties, which also decreased when more artifificial aggregate and entrained air was used. This balance was achieved in mix 4 and especially in mix 5, with both mixes having similar mechanical properties but with mix 5 having slightly more artifificial aggregates, less entrained air, and lower density than mix 4. The fifinding from several past studies were extracted from a previous review to compare the results obtained in this research with those from previous studies [14]. The comparison, reported in Figure 6, was delineated by studies that replaced coarse aggregate (marked with a circle) and those that replaced fifine aggregate (marked with a triangle). The results from the current study (marked with a cross) were generally superior to those where only the coarse aggregate was replaced, but the replacement of only the fifine aggregate resulted in higher strength concrete, as for example the studies by Ravindrarajah [45] and Juki et al [25]. The strength of the coarse aggregate had a more signifificant effffect of the compressive strength of the concrete because the fracture line is more likely to cross the coarse aggregates than the fifine aggregates. Therefore including plastic waste as fifine aggregate has a more limited effffect on concrete strength. The relationship between aggregate content, density and flflexural strength can be seen in Figure 7, similarly to Figure 5. A key fifinding was that the flflexural strength increased with respect to the compressive strength when more artifificial aggregate was used. For example, the compressive strength of mix 5 was 82% of that of mix 1, but the flflexural strength of mix 5 was 92% of that of mix 1. This behaviour indicated that the artifificial aggregate had a signifificant inflfluence on the flflexural strength, and could potentially increase the tensile strength. A possible solution to further increase the mechanical properties while maintaining or even reducing the density and without compromising the mechanical properties of the

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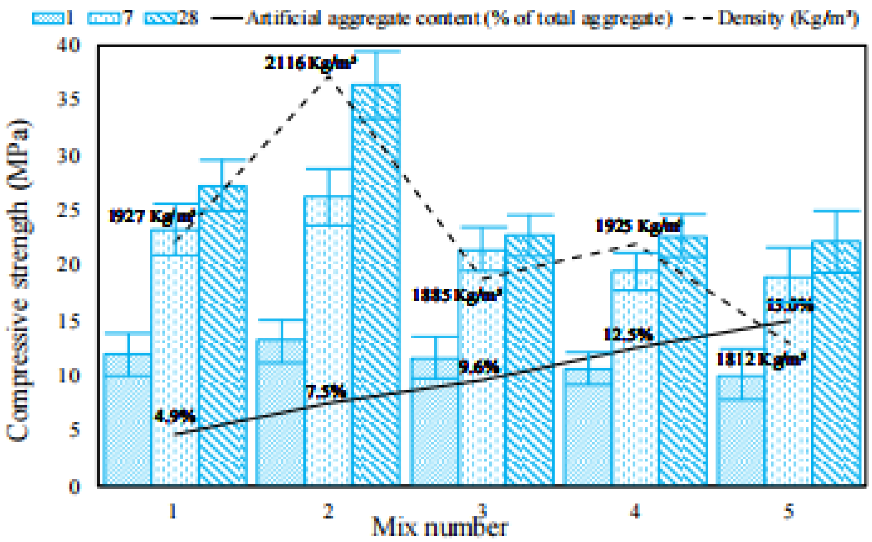

Fig. 5. Compressive strength for the five trial mixes

concrete could be to create a more densely graded fifine aggregate (i.e. greater variation in particle size) that would help with the flflowability of the concrete, so that less or no air entraining agent would be necessary. The evolution over time of the mechanical properties is reported in Figure 8 for the compressive strength and in Figure 9 for the flflexural strength. The strength evolution over time was similar to that of typical concrete without artifificial aggre gates, and no effffect on the time evolution could be found between the density of the mix or the amount of recycled aggregate or entrained air.

4. FINAL MIX

The results show that mix 5 used the largest amount of plastic aggregate while satisfying the product requirements. The volume of aggregates replaced by the plastic aggregate in mix 5 was 37.1%. More than 19 million tons of virgin aggregate would not be mined if mix 5 was used for only 1% of the concrete produced in New Zealand in an average year [4]. Given the low density of plastic, approximately 9 million tons of plastic could be recycled per year to occupy the same volume as 19 million tons of aggregate. After studying the results from the trial mix, mix

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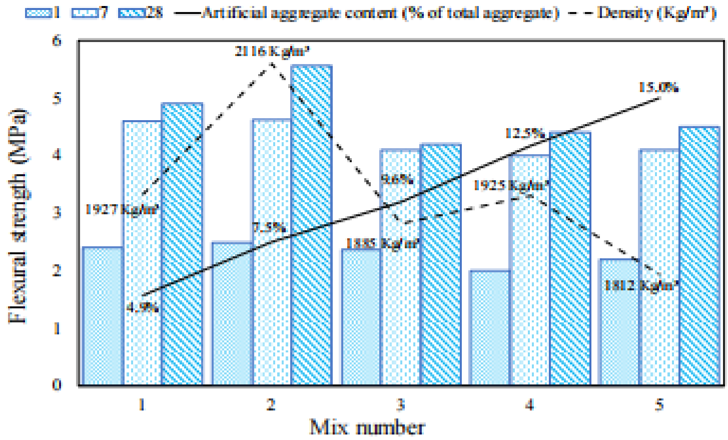

Fig. 7. Flexural strength for the five trial mixes

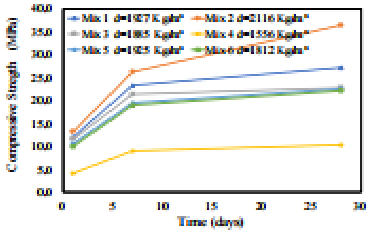

Fig. 8. Evolution of the compressive strength of the trial mixes

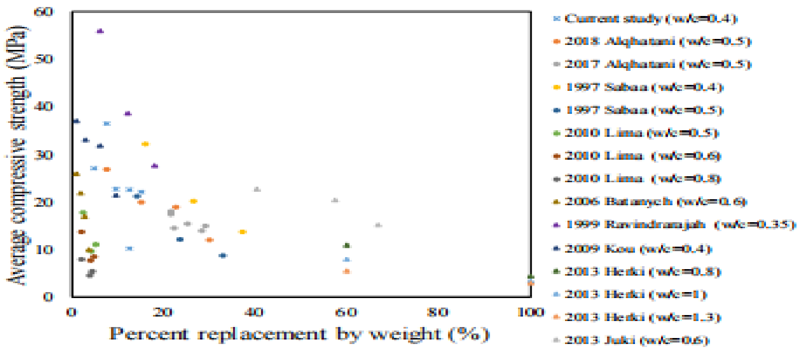

Fig. 6. Comparison between the current study (crosses) with previous studies on replacement of coarse aggregate (circles) and fine aggregates (triangles)

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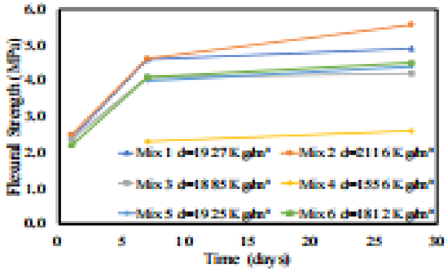

Fig. 9. Evolution of the flexural strength of the trial mixes

Table 5. Hardened concrete properties for the final mix

Age	1 day	7 days	28 days
Compressive strength (MPa)	9.2 ±0.38	17.7 ±0.59	19.7 ±1.58
Split tensile strength (MPa)	1.9 ±0.06	2.3 ±0.12	2.3 ±0.15
Flexural strength (MPa)	2.4	3.6	4.3

5 was selected to undertake a more detailed study on the mechanical properties of the hardened concrete.

5.1. Hardened propertiesA number of cylinders and beams were prepared using the mix 5 recipe asdetailed in Table 2. Five cylinders were tested in compression and fifive cylinders were tested in split tension at an age of 1 and 7 days, and twenty cylinders were tested in compression and twenty in split tension at an age of 28 days. Similarly, one beam was tested at an age of 1 and another at 7 days, while 3 beams were tested at an age of 28 days. The average results are reported in Table 5 together with the standard deviation for the compressive and split tensile strength.Examples of the failures observed during testing are reported in Figure 10. The fracture plane was observed to not cross any piece of the artifificial aggregate, either in compressive, in split tensile or in flflexural testing. Occasionally, the fracture plane was coincident with the surface of the artificial aggregate. Both observations were in accordance with the behaviour of typical concrete, where the aggregate is typically stronger than the cement paste and the fracture plane does not cross the aggregate but coincides with its surface. A point of difffference with typical concrete was that pieces of the artificial aggregate prevented the crack that

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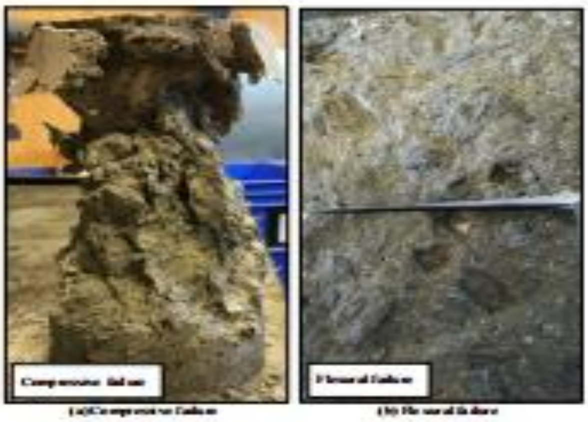

Fig. 10. Pictures of the failure observed during testing

defifined the fracture plane from opening beyond a certain width, and the cylinder remained cohesive until considerable damage was observed. Even when the typical hourglass shape took form, after large deformation was applied into the cylinder, small pieces of concrete were still attached to the main body of the cylinder by pieces of aggregate, as can be seen in Figure 10a.

5.2. Statistics The results of the compressive and tensile strength of the forty cylinders tested at an age of 28 days are reported in Table 6. The purpose of testing twenty specimens for each test at an age of 28 days was to obtain the specifified strength value, in addition to the average strength value and any other statistical value that could be useful, as reported in Figure 11. The specifified strength value is typically defifined as the lower bound characteristic value or 95 percentile value, which means that 95% of the strength values (or nineteen out of twenty) should be above that specifified value. Hundreds or even thousands of data points would be obtained in a typical scenario when developing a new concrete mix by a ready mix plant for commercial use, but that was not a feasible option for this study and therefore twenty specimens were tested instead. A normal distribution can be assumed, given that normal distribution is often assumed in testing of concrete strength. The specifified value would then be calculated as the average value minus 1.645 times the standard deviation, which results in a specifified compressive strength of 17.1 MPa. This result was consistent with the results from Table 6 and Figure 11, as only one value was below 17.1 MPa.

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Table 6. Details of compression and split tension tests

Compressive	19.4	20.9	21.2	21.8	19.8	18.1	16.4	17.1	18.2	18.7
strength (MPa)	19.8	19.9	21.7	20.4	19.9	18.6	18.4	22.3	19.7	21.8
Split tensile	2.2	2.1	2.1	2.5	2.3	2.3	2.3	1.9	2.3	2.2
strength (MPa)	2.3	2.1	2.5	2.2	2.4	2.1	2.5	2.5	2.2	2.1

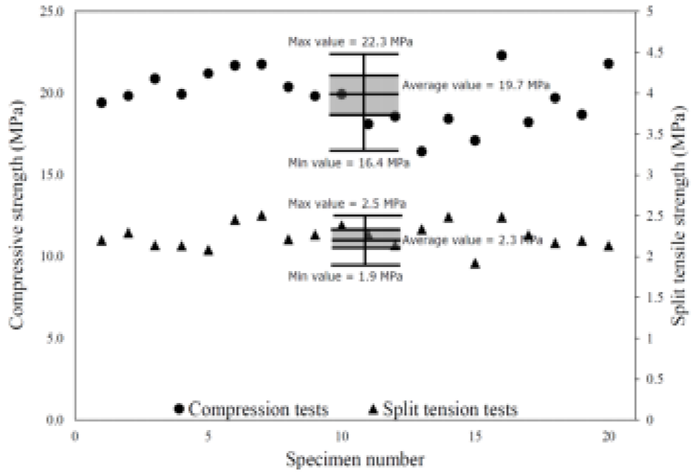

Fig. 11. Statistical values of the cylinder testing at 28 days

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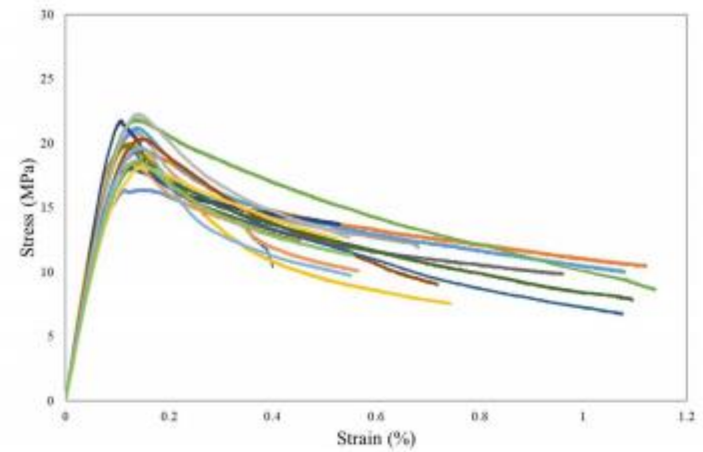

Fig. 12. Full stress strain response for concrete compressive cylinders of the final mix design tested at 28 days

5.3. Stress strain relationships

The stress-strain relationship in compression is reported in Figure 12. The strain at peak stress was similar to what can be expected with typical concrete, but the concrete

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exhibited a less brittle failure than for typical concrete with a longer post-peak tail, in accordance with observation of the fracture patterns reported earlier. This observation was in line with previous observations regarding the contribution of plastic aggregate to the flflexural strength and potentially to the tensile strength of concrete[14]. The modulus of elasticity E of the artifificial aggregate was calculated according to the pertinent ASTM standard[46]. The value obtained was 20.5 GPa, which is similar to that of normal concrete. However, the concrete with artifificial aggregate experienced more post-peak deformation capacity than the typical concrete with natural aggregate, which means that the pieces of artificial aggregate that cross the failure plane of the concrete can accommodate the displacement better than can natural aggregate, as also observed before .

6. CONCLUSIONS

Five mixes were developed and an optimal mix was chosen based on the mechanical properties and the density, which fulfifilled the requirements of the target specifification (density of 1800 kg/m3 , a 28 days compressive strength of 20-25 MPa, and a 1-day compressive strength of 10 MPa). In this optimal mix, 15% of the natural aggregate was replaced by weight, which equals 37.1% of the volume given the lower density of the manufactured aggregate compared to natural aggregate. The mixes were not recommended for high performance concrete, structural concrete, or for infrastructure projects. A larger concentration of plastic waste in the form of coarse aggregate was used in the current study when compared to past studies that obtained similar mechanical properties. This improvement is due to the innovative method of extruding and pelletizing the plastic waste, as opposed to the methods reported in the literature that entail sorting, cleaning and shredding the plastic waste or to use plastic as a binder with sand to create aggregates. As an example, if mix 5 was used in just 1% of the concrete produced in New Zealand almost 19 million of tons of virgin aggregate would not be mined, and 9 million tons of plastic would be recycled in an average year. Further research on this new aggregate needs to be conducted, especially related to durability. The main conclusions observed from the study are summarised below. While similar observations have been reported in the literature, it is noted that the level of plastic replacement achieved in the current study was signifificantly higher than the typical replacement levels reported in the available literature.

• Inclusion of the manufactured aggregate reduced the density, but jeopardized the workability of the fresh mix. Additives were necessary to obtain a workable mix.
• Inclusion of the manufactured aggregate reduced the compressive strength, but increased ductility and flflexural strength.
• The grading of the artifificial aggregate needs to be improved, which could potentially prevent or reduce the use of air entraining agents, resulting in enhanced mechanical properties

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EFFECT OF ADDING SOLID WASTE SILICA FUME AS A CEMENT PASTE

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ABSTRACT

Due to the large-scale infrastructure construction and environmental protection pressure in China, the demanded cement is in short supply and the price is rising, and the overcapacity of silica fume has caused its price to fall, thus replacing cement paste by silica fume could achieve better economic and environmental benefits. In this study, silica fume (SF) with SiO_2 content of 86.3% and high purity silica fume (HSF) with SiO_2 content of 96% were used to replace cement paste in different proportions. The effects of adding SF or HSF on the workability of fresh con- crete, the mechanical properties and microstructure of hardened concrete were investigated. The microstructures (i.e., porosity, pore size distribution and micromorphological characteristics) were analyzed by using low field nuclear magnetic resonance (LF NMR) and field emission scanning electron microscopy (FE-SEM). The results showed that the slump and air content of the concrete gradually decreased as the amount of SF or HSF increased. When the replacement amount of SF was increased from 0% to 10%, the cubic compressive strength and splitting-tensile strength of concrete were increased by 26.7% and 40.7%, while the cost per cubic meter of concrete was only increased by 1.9%. When the replacement amount of HSF was increased from 0% to 10%, the cubic compressive strength and splitting-tensile strength of concrete were increased by 44.7% and 57.4% respectively, while the cost per cubic meter of concrete was only increased by 5.3%. The total porosity of concrete gradually decreased as the amount of SF or HSF

increased, with the proportion of macropores (>1000 nm) decreasing, and the proportion of

mesopores (100–1000 nm) and capillary pores (0–100 nm) increasing, significantly refining the pore structure and densifying the microstructure of concrete

INTRODUCTION

In 2021, to peak carbon emissions and achieve carbon neutrality is proposed be incorporated into the overall layout of building an ecological civilization in China, and a dual control system of total energy consumption and energy intensity is in place. Increased restrictions on cement production have led to a shortage of supply. The average ex-factory price of P·O42.5 cement in all regions has exceeded RMB 700 per ton, the retail price has reached RMB 800 per ton, and the prices are still

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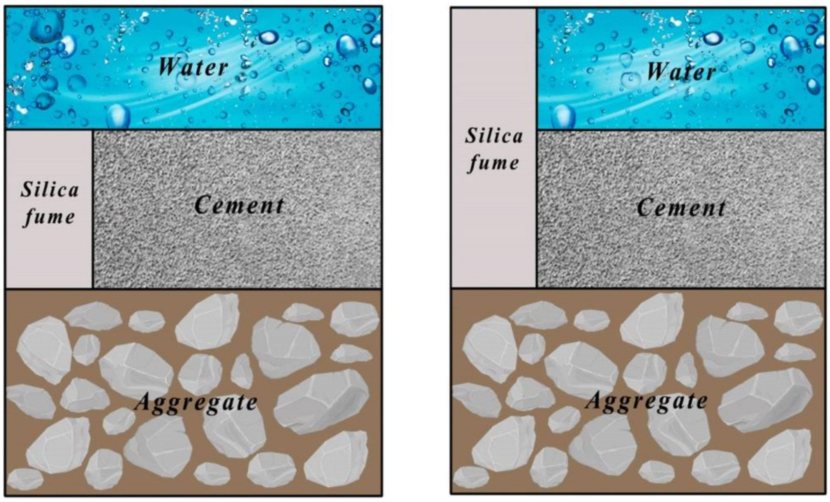
climbing. Meanwhile, the output of



(a) Cement replacement method (b) Paste replacement method

silica fume (SF) has gradually increased as ferrosilicon alloy plants and industrial silicon plants have been equipped with environ- mental protection equipment, but its price has seen a significant drop to RMB 760 per ton due to its low utilisation rate, which is 9.2% below the retail price of cement. High purity silica fume (HSF) has a unit price of RMB 1150 per ton due to the additional process of purification. Further, SF and HSF prices are still falling because of overcapacity.

Silica fume is a gray white dust produced during the smelting of ferrosilicon alloys and industrial silicon. It typically contains 85–95% amorphous SiO_2 [1,2]. The current production of silica fume in China is estimated to be up to 2 million tonnes per year [3]. With China's control of pollution emissions from the metallurgical industry, the resourceful use of recovered SF is of great importance to both environmental protection and economic efficiency. Addtionally, silica fume is an essential component in high-strength con- crete, repaired concrete, dams and other special projects [4–6], because of its high volcanic ash activity, large specific surface area, and small particle fineness [7–9].

In the production of mortar and concrete, solid waste silica fume is often reused as a cement substitute, replacing some of the cementitious materials. This is known as the cement substitution method, as shown in Fig. 1(a). For example, Toutanji et al. [10] investigated the effect of silica fume on the compressive strength of mortars at different water-cement ratios, suggesting that silica fume as a partial replacement for cement enhanced the bond between the cement paste and the aggregate, and increased the compressive strength of the mortar. Hanumesh et al. [11] used silica fume to replace 5%, 10%, 15%, and 20% of cement in the preparation of concrete, and found that the compressive strength of concrete was highest at 10% replacement amount, and it tended to decrease when above 10%. Bhanja et al. [12] studied the effect of silica fume on the splitting-tensile strength of concrete in the range of 0.26–0.42 water-cement ratio by replacing 5%, 10%, 15%, 20%, and 25% of cement with silica fume, and concluded that the optimum splitting-tensile strength was achieved for the 28-day curing concrete at replacement levels in the range of 5–10%, and the increase in splitting-tensile strength was not significant after the replacement of more than

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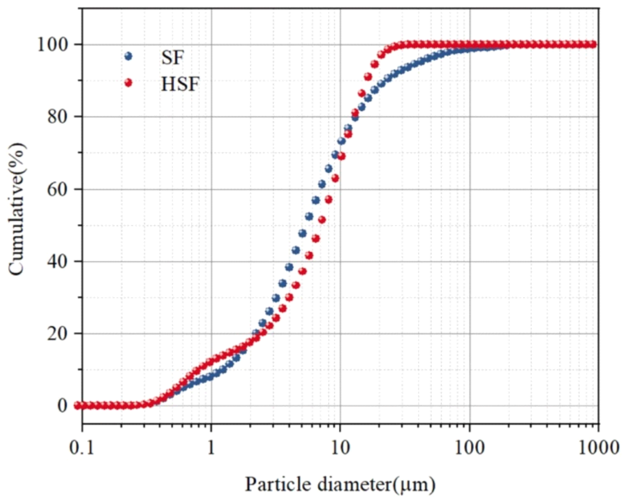
15%. In addition to replacing cement, solid waste silica fume is also used to replace fly ash [13–15]. Memon et al. [13] pointed out that when fly ash was replaced by silica fume, the slump of concrete mixture was decreased, and the compressive strength, tensile strength and flexural strength of hardened concrete were increased significantly. Das et al. [14] found that when the silica fume content was 2%, the geopolymeric concrete had the highest compressive strength and densest microstructure. In the authors' previous work, when 50% of fly ash was replaced by silica fume, the microstructure was densest and the strength was the highest [15].

The cement substitution method and fly ash substitution method usually lead to a reduction in mortar or concrete strength at a high substitution rate. Li et al. [16–18], therefore, proposed a new substitution method where the cement paste was replaced with waste materials (e.g. marble powder, limestone powder) and the water-cement ratio was always kept constant. This is called paste substi- tution method, as shown in Fig. 1(b), which not only contributes to reduce cement content and carbon footprint, but also improves the strength, durability, and dimensional stability of concrete, mitigating the risk of cracking [19–21]. Additionally, silica fume with pozzolanic reactivity does not react chemically in the early stages, so it can inhibits the adiabatic temperature rise and hydration heat of concrete [22–25]. However, different waste materials may have different chemical compositions and physical properties, and thus, the effect of silica fume on the performance of concrete by replacing cement paste with the same quality still needs to be assessed separately.

Boddy et al. [26] pointed out that the performance of concrete mixed with silica fume may be related to the SiO_2 content in silica fume. Previous studies on silica fume concrete mostly used high purity silica fume with SiO_2 content over 90% [27–30]. The Chinese standard GB/T 27690 and the American standard ASTM C1240 both require a minimum SiO_2 content of 85%. Compared to previous



The main chemical components of cement, SF and HSF (%).

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Material	SiO_2	Al_2O_3	CaO	Fe_2O_3	MgO	SO_3
Cement	22.81	5.62	61.43	3.36	1.35	2.17
SF	86.30	–	–	–	–	–
HSF	96	–	–	–	–	–

addition methods of silica fume (as replacement of cement or fly ash), the paste substitution method could effectively improve the mechanical properties of concrete, which provided an new idea for the addition of silica fume. Therefore, two types of silica fume, SF and HSF, with SiO_2 contents of 86.3% and 96% respectively were used as cement paste replacement in this study. Specimens were prepared by using SF and HSF as replacements of 0%, 2.5%, 5%, 7.5%, and 10% of the cement paste respectively.The effect of silica fume with different SiO_2 contents on the workability of fresh concrete, the mechanical properties and pore structures of hardened concrete were compared. The economics of using silica fume as cement paste replacement was also evaluated

• *Materials and experiments*

• *Materials*

Conch brand P·O42.5 ordinary silicate cement produced by Liquan Conch Cement Plant in Xianyang, Shaanxi was used, conforming to Chinese standard GB 175 [31]. The physical and mechanical properties of the cement are listed in Table 1.

The silica fume (SF) was obtained from China West Construction Group Co., Ltd., which was a kind of superfine spherical dust formed when gaseous Si and SiO met O_2 condensation in the air with the discharge of metallurgical flue gas in the process of smelting silicon metal and ferrosilicon alloy. It could be collected by dust removal and recovery devices. The high purity silica fume (HSF) came from Elkem Silicones Group, France, and was obtained by purifying the collected silica fume (SF). Both conforming to Chinese standard GB/T 27690 [32] and American standard ASTM C1240 [33].

The fine aggregate was natural river sand with a fineness modulus of 2.66, which has an apparent density of 2630 kg/m^3 and a bulk density of 1480 kg/m3. The coarse aggregate was limestone gravel with a continuous gradation of 5–20 mm, which has an apparent density of 2835 kg/m3 and a bulk density of 1720 kg/m3.

Table 3

The mix proportions of concrete (kg/m^3).

Code	Water	Cement	SF	HSF	Sand	Coarse aggregate	Superplasticizer
CG-0	115	240	0	0	620	1445	1.20
SF-2.5	112.125	234	8.875	0	620	1445	1.21
SF-5	109.25	228	17.75	0	620	1445	1.23
SF-7.5	106.375	222	26.625	0	620	1445	1.24
SF-10	103.5	216	35.5	0	620	1445	1.26
HSF-2.5	112.125	234	0	8.875	620	1445	1.21

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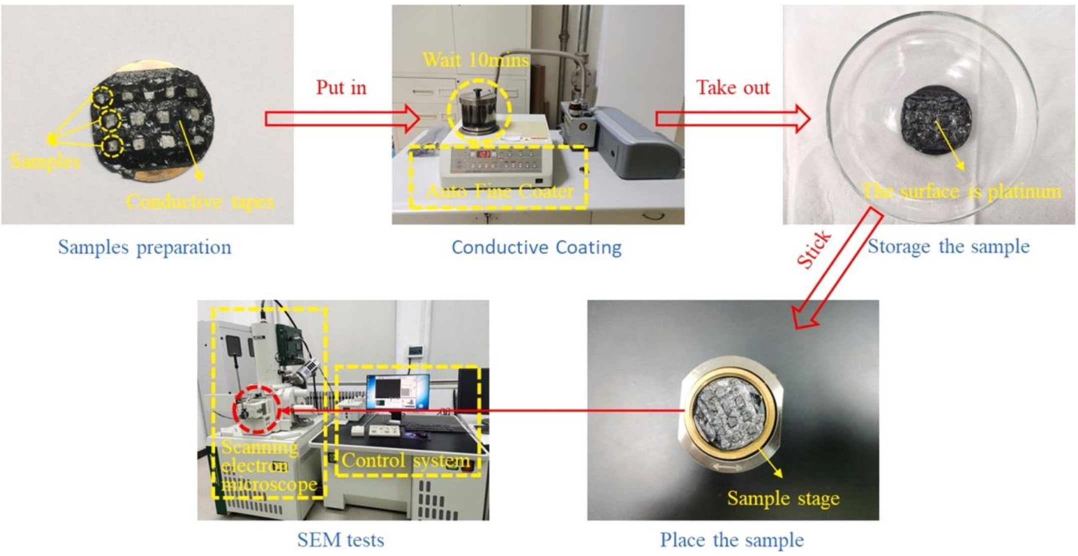
HSF-5	109.25	228	0	17.75	620	1445	1.23
HSF-7.5	106.375	222	0	26.625	620	1445	1.24
HSF-10	103.5	216	0	35.5	620	1445	1.26



Q8086 powder high performance water-reducing agent produced by Shaanxi Qinfen Building Materials Co., Ltd. was used with a water reduction rate of 33%, an air content of 2.0%, and a solid content of 40%, which was dosed at 0.5% of the mass of the cementitious material.

The water used was ordinary tap water from Xi'an.

- *Mix Proportions*

In this test, solid waste silica fume was used to replace the cement paste and the water/cement ratio was always kept constant (W/ C 0.48). Concrete without silica fume was the control group numbered CG-0. It was found during the trial mix that at W/C 0.48 and silica fume content of more than 10%, a very dry concrete mix was produced, and there were a large number of voids on the surface and inside the hardened concrete specimen. Concrete specimens were therefore prepared using two types of silica fume (SF, HSF) as equal mass substitutes for 2.5%, 5%, 7.5%, and 10% of the cement paste, respectively. Each mix group coded using X-Y, where X denoted the type of silica fume and Y denoted the percentage substitution of silica fume. The mix proportions of concrete are shown in Table 3

- *Preparation and testing of the specimens*

Firstly, a twin-shaft concrete mixer was cleaned, and pre-mixed mortar with the same water binder ratio was hung on the inner wall of the mixer and the remainder was poured out. Then the raw materials were weighed according to the ratio, and the coarse aggregate, fine aggregate, cement and silica fume were added to the mixer in turn and mixed for 60 s. Finally, the water mixed with water- reducing agent was poured evenly into the mixer and mixed for 120 s

After unloading, the slump of the fresh concrete was tested and the air content was measured using a direct-reading concrete air content tester, type HC-7 L. The remaining concrete mix was loaded into 100 100 100 mm cubic moulds and

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placed on a vibrating table for vibrating and compacting until the paste continued to appear on the surface. Seven specimens were made for each mix ratio, making a total of 63, which were demoulded after 24 h and cured naturally.

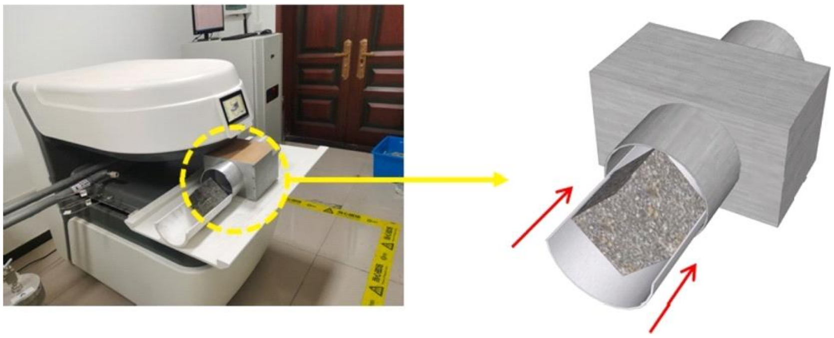
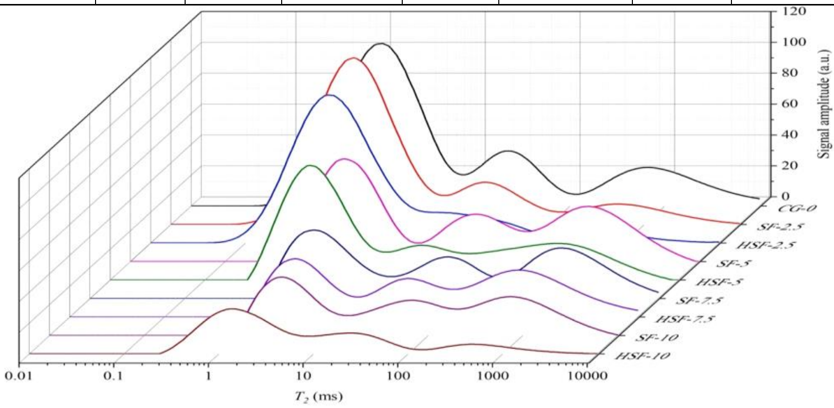


Table 4

Workability of fresh concrete.

Code	CG-0	SF-	SF-5	SF-7.5	SF-10	HSF-2.5	HSF-	HSF-7.5	HSF-
Slump	137	129	110	105	100	130	115	110	91
Air	5.1	5	4.9	4.5	4.4	4.8	4.6	4.1	3.8



Code	Porosity (%)	Pore size distribution		
		0–100 nm	100–1000 nm	> 1000
CG-0	1.8832	52.56%	10.31%	37.13%
SF-	1.6694	50.48%	12.43%	37.09%
SF-5	1.5402	47.04%	17.83%	35.13%
SF-	1.3238	44.36%	22.76%	32.88%
SF-	1.1041	42.29%	27.45%	30.26%
HSF-	1.4907	47.40%	16.54%	36.06%
HSF-	1.4711	45.59%	20.67%	33.74%
HSF-	1.2130	42.40%	26.97%	30.63%
HSF-	0.8043	40.62%	32.73%	26.65%

According to Chinese standard GB/T 50081 [34], the cubic compressive strength

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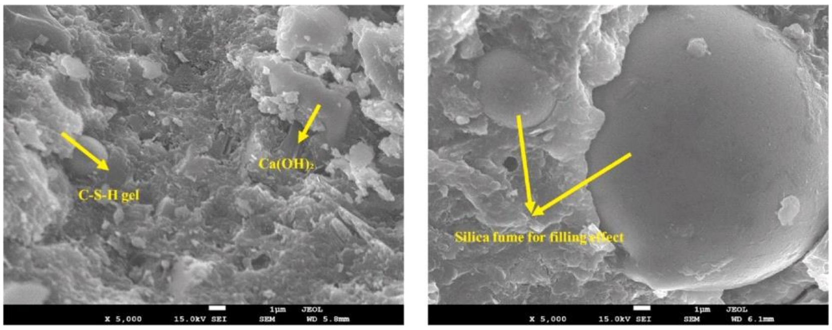
and splitting-tensile strength of the 28-day concrete for each mix ratio (3 specimens for compressive strength and 3 specimens for splitting-tensile strength) were tested using an MTS 2000 kN universal testing machine. During the cubic compressive strength test, the load was applied at a rate of 0.5 MPa/s until the specimen was damaged. During the splitting-tensile strength test, the load was applied at a rate of 0.05 MPa/s until the specimen was destroyed.

The central part of the crushed specimen with the stones removed was placed in a sample bag. The sample was pasted with conductive tapes, treated with platinum spray on its surface using a JFC-1600 automatic fine coating machine (Nippon Electron Co., Ltd.), and evacuated using a JSM-7610 F FE-SEM (Nippon Electron Co., Ltd.). The surface micromorphology of the sample at an age of 28 d was observed to obtain FE-SEM images.The process is shown in Fig. 3.

The remaining one specimen of each mix group was pressurised with a vacuum pressure saturation device (ZYB-II) for 24 h to allow the water to be fully pressed into the pores. Then CPMG pulse sequence data was collected using a LF NMR microstructure analysis and imaging system (MacroMR12–150 H-I) manufactured by Suzhou Niumag Corporation (as shown in Fig. 4) to generate T_2 spectra and to obtain the porosity and pore size distribution of concrete for each mix ratio. The instrument was set to a constant magnetic field of Porosity and pore size distribution



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0.3 T, an operating frequency of 13.025 MHz, and a magnet temperature of 32 ± 0.05 °C.

- ***Results and discussion***

- *Workability of fresh concrete*

The slump value and air content of fresh concrete with the addition of two types of silica fume (SF and HSF) at different replacement amounts are listed in Table 4. Compared to the concrete without silica fume, the slump of concrete mix decreased as the

amount of silica fume increased. This was due to the fact that silica fume replaced cement paste rather than cement, and as the amount of silica fume increased, the powder content increased and the water content decreased, thus significantly reducing the workability of the concrete mix. Additionally, silica

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fume, as an ultra-fine material with a large specific surface area, are able to bind free water in concrete. Therefore, the concrete mix containing a high percentage of silica fume were more viscous [35–37]. However, the loss of slump could be made up by adding high performance water reducing agents. As the amount of silica fume increased, the air content of the concrete mix gradually decreased. This was due to the fact that silica fume particles, which are finer than the cement particles, filled the gaps between cement particles, resulting in a relatively dense microstructure and a relatively small air content. The same conclusion was reached by G. Appa Rao in his study on the properties of cement pastes and mortars doped with silica fume [38].

- *Effect of adding silica fume as a cement paste replacement on the porosity and pore size distribution of concrete*

The T_2 spectrum of the 28-day curing samples with different silica fume amounts are shown in Fig. 5. Its relaxation time represents the pore size and the signal represents the pore ratio. There were three relaxation peaks in the T_2 spectrum, the first of which had the largest peak area. The total peak area of the control group (CG-0) was 5586.60; at 2.5%, 5%, 7.5% and 10% SF substitution, the total peak areas were 4979.47, 3977.04, 3198.11, and 2564.95, respectively; at 2.5%, 5%, 7.5%, and 10% HSF substitution, the total peak areas were 4351.98, 3824.20, 2896.00, and 1529.84, respectively. With the increase of silica fume amount, the total peak area decreased and the pore size distribution curve tended to flatten out because of the secondary hydration of silica fume.(Table 5).

As shown in Fig. 5, the total porosity of concrete gradually decreased as the amount of silica fume increased. Compared to the control group (CG-0), at 2.5%, 5%, 7.5% and 10% SF substitution, the reductions in total porosity were 11.4%, 18.2%, 29.7% and 41.4%, respectively; at 2.5%, 5%, 7.5% and 10% HSF substitution, the reductions were 20.8%, 21.9%, 35.6% and 57.3%, respectively. Thus replacing the cement paste with a moderate amount of silica fume (no more than 10%) helped to reduce the porosity of concrete. At the early stage of hydration reaction, due to the pozzolanic reactivity of silica fume, there is no chemically reaction of silica fume. But the average particle size of silica fume was smaller than that of cement, therefore, the porosity was reduced by the filling effect

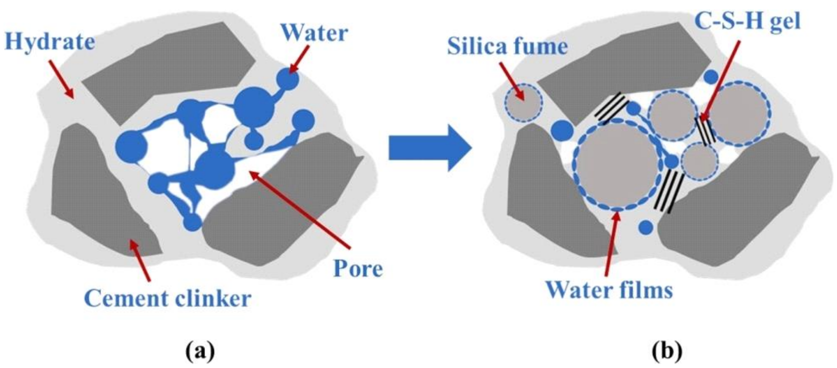

Fig. 7. Schematic diagram of cement paste microstructure:

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(a) without silica fume, (b) with silica fume.

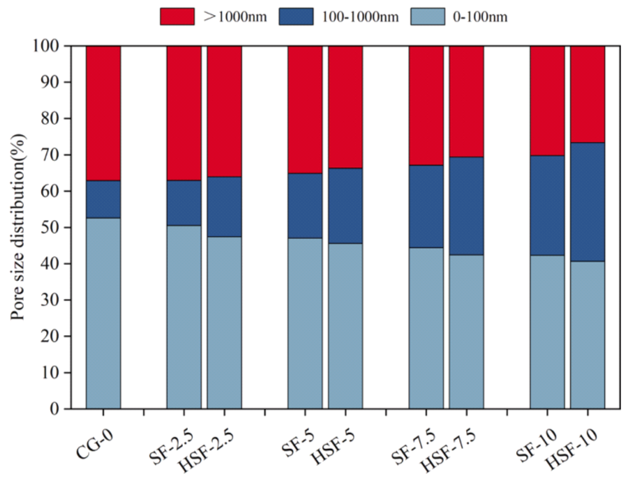

Fig. 8. Pore size distribution of concrete samples with different silica fume replacement amounts.

silica fume in cement matrix [39]. At the later stage of hydration reaction, silica fume reacted with the $Ca(OH)_2$ which was produced by the hydration of the cement to form additional C-S-H gels. These gels filled the pores in the concrete which induced the concrete interior more denser (as shown in Fig. 6). Another possible reason was that this substitution method reduced the water content and increased the powder content, leading to a relatively low water-to-powder ratio. At the same time, due to the large specific surface area of silica fume, the water or paste film encasing the powder particles became more thinner [40]. Therefore, it was easier for the pores to be filled by gel products produced by the hydration reaction of the cement and the pozzolanic effect of silica fume (as shown in Fig. 7). The porosity of concrete with HSF as a cement paste replacement was lower than that with SF for the same amount of replacement.

A possible reason was that, the bulk average particle sizes of SF and HSF were measured to be 12.35 µm and 8.87 µm, respectively, so HSF with a smaller average particle size filled smaller pores in concrete and reduced the total porosity. The other possible reason was that the content of SiO_2 in HSF was higher than that in SF, so more C-S-H gels may be generated after the secondary hydration reaction, thus reducing the porosity even more.

Pore size distributions of the 28-day curing concrete samples with different silica fume amounts are shown in Fig. 8. The ratio of each class of pore size within concrete obtained by LF NMR testing was continuous and spanned several orders of magnitude. Different scholars have proposed their own classification of the range of pores [41,42,44]. In this study, the classification of macroporous (>1000 nm), mesopores (100–1000 nm), and capillary pores (0–100 nm) was adopted by combining the existing views. Compared to the control group (CG-0), the concrete with silica fume had a more significant effect on the refinement of the pore structure. As the amount of silica fume increased, the proportion of macroporous and capillary pores gradually decreased and the

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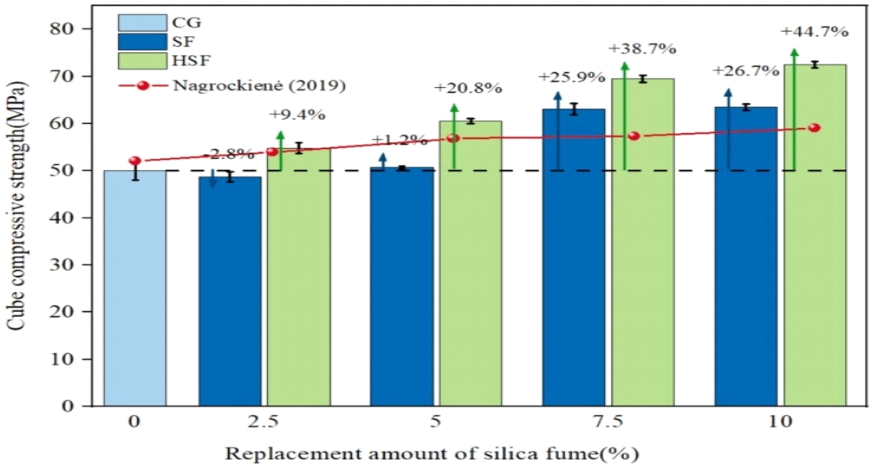
proportion of mesopores increased. The reason was that the SiO_2 in silica fume reacted with $Ca(OH)_2$, a hydration product of cement clinker, to produce C-S-H gels filling part of the pores, while the average particle size of silica fume was approximately one order of magnitude smaller than that of cement particles, replacing cement paste with silica fume effectively filled the internal micron-sized macroporous
(>1000 nm) of the hardened cement paste, resulting in a reduced proportion of macroporous [45]. Additionally, as the silica fume
content increased, the total internal porosity of concrete decreased and the overall percentage of mesopores and capillary pores (0–1000 nm) gradually increased, thus refining the pore structure in concrete. Similar conclusions were obtained by Lei Wang et al.



- *Effect of adding silica fume as a cement paste replacement on the cubic compressive strength and splitting-tensile strength of concrete*

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Compressive strength of the 28-day curing concrete mixed with two types of silica fume in different amounts is shown in Fig. 9. Compared to the control group (CG-0), the increase in compressive strength of the samples was 2.8%, 1.2%, 25.9% and 26.7% at 2.5%, 5%, 7.5% and 10% SF substitution, respectively; 9.4%, 20.8%, 38.7% and 44.7% at 2.5%, 5%, 7.5% and 10% HSF substitution, respectively. It can be seen that the cubic compressive strength of concrete at 28 days of age increased with the amount of silica fume. This was because: (1) Silica fume with small particle size filled the pores in cement-based materials, which reduced the porosity and densified the microstructure. [49]. (2) The content of the active ingredient SiO_2 in silica fume was much higher than that in cement. As the amount of silica fume increased, more C-S-H gels were produced because of the pozzolanic effect produced by silica fume, thus increasing the strength of concrete [50–52]. (3) The replacement of cement paste with silica fume increased the

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powder content and reduced the water content, thus reducing the concrete bleeding and increasing the bond strength at the cement paste-aggregate interface [53,54].

Compared with the control group CG-0, the compressive strength decreased by 3.8% when SF replacement was 2.5%. When the replacement amount was 5%, the compressive strength increase was not obvious. Imam et al. [55] suggested that the best replacement amount of silica fume should be in the range of 8–12%, if it was lower than 8%, the compressive strength would not be significantly improved. This replacement method reduced the total amount of cement, which reduced the effect of the first hydration reaction, resulting in a slight loss of strength. SF only participated in the secondary hydration reaction, when SF replacement was less than 5%,

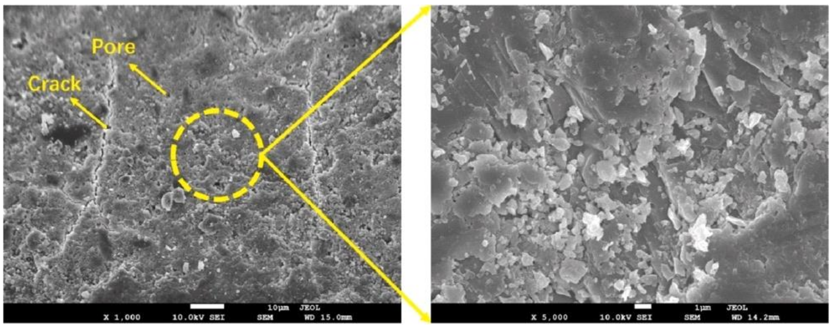

Fig. 11. The 28th day microstructure of concrete numbered CG-0.

the small amount of C-S-H gels generated failed to make up for the strength loss in the first hydration reaction. Roy et al. [56] made the same conclusion by studying the effect of partial replacement of cement by silica fume on hardened concrete.

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A similar study was done by Nagrockiene˙ et al. [57], who used silica fume with a SiO_2 content of 93.35% to replace 2.5%, 5%, 7.5%, and 10% of cement at W/C 0.47, and the increase in compressive strength of the 28-day curing concrete was 3.5%, 9.1%, 10.1%, and 13.4%, respectively, compared to silica fume at 0%. As shown in the red dotted line graph in Fig. 9, the cubic compressive strength increased with increasing silica fume amount, which was generally consistent with the pattern obtained in this test.

Splitting-tensile strength of the 28-day curing concrete mixed with two types of silica fume in different amounts is shown in Fig. 10. Compared to the control group (CG-0), the increase in the strength was 7.8%, 18.9%, 34.4% and 40.7% at 2.5%, 5%, 7.5% and 10% SF substitution, respectively; 14.8%, 23.3%, 42.6% and 57.4% at 2.5%, 5%, 7.5% and 10% HSF substitution, respectively. The effect of silica fume on splitting-tensile strength followed a similar trend to that on cubic compressive strength, both increasing with the amount of silica fume, and the increase in the former was greater than that in the latter. In general, the water-cement ratio is the main factor determining the mechanical properties of concrete. The lower the water-cement ratio, the higher the splitting-tensile strength [58,59]. In this test, however, the replacement of the cement paste with silica fume significantly increased the splitting-tensile strength, despite the water-cement ratio remaining the same. One possible reason was that the addition of silica fume increased the cubic compressive strength, leading to a corresponding increase in the splitting-tensile strength. Another possible reason was that the hardening degree of the cement paste was reduced by the increase in silica fume, making it weaker in tension and less hard than the aggregate particles [53].

For the same amount of silica fume, the cubic compressive strength and splitting-tensile strength of concrete with HSF were greater than those with SF. A possible reason was that the SiO_2 content in HSF was as high as 96% compared to 86.3% in SF. The higher the SiO_2 content in silica fume, the greater the activity in alkaline environments and the more effective the modification of the mechanical properties of concrete. A large amount of SiO_2 rapidly reacted with $Ca(OH)_2$ in a secondary hydration reaction to produce more C-S-H gels, which filled the pores in concrete and better improved the cubic compressive strength and splitting-tensile strength of concrete [60].

- *The relationship between mechanical properties and microstructure of concrete*

The microstructure image of the control group (CG-0) obtained by FE-SEM on the 28th day of curing was shown in Fig. 11. When the figure was magnified 1000 times, many pores and cracks were observed. When magnified 5000 times, it can be observed that there were some relatively large crystals inside the sample and the microstructure was quite loose. The compressive strength and splitting- tensile strength of the control group were also the lowest.

Microstructures of the 28-day curing concrete mixed with two types of silica fume in different amounts obtained by FE-SEM are shown in Fig. 12. According to the figure, at 2.5% and 5% silica fume substitution, the concrete surface was covered with irregularly structured C-S-H gels, but cracks and pores were still present inside the concrete; at 7.5% and 10% silica fume substitution, the internal cracks disappeared and the C-S-H gels further densified the microstructure. Compared to the control group (CG-0), more silica fume actively reacted with $Ca(OH)_2$ in a secondary hydration reaction to form C-S-H gels, and much less large crystals were formed within the hardened concrete, resulting in a more dense microstructure of concrete. Additionally, the rapid consumption of $Ca(OH)_2$, which was harmful to concrete [61], contributed to a high growth in the cubic compressive strength and splitting-tensile strength of concrete. A regression analysis of the correlation between cubic compressive strength and porosity is shown in Fig. 13, where the R values for the two types of silica fume are 0.884 and 0.942, respectively. A regression analysis of the correlation between splitting-tensile strength and porosity is shown in Fig. 14, where the R values for the two types pf silica fume are 0.986 and 0.980, respectively. Both the cubic compressive strength and splitting-tensile strength showed a good linear relationship with porosity, and both were inversely pro- portional to it. This was consistent with the results of other studies [62,63]. In fact, it is generally accepted that the

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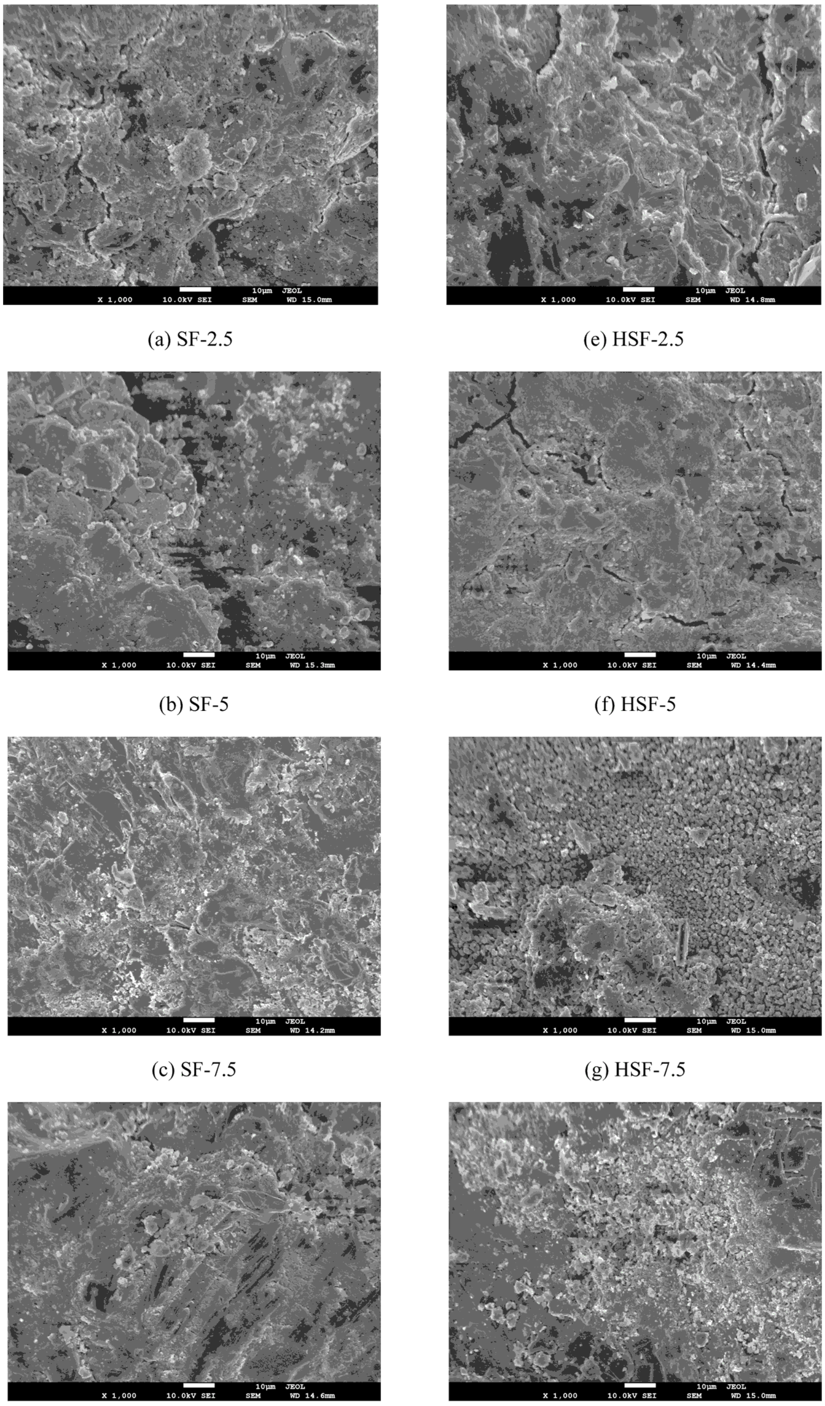
mechanical properties of concrete depend on the pore structure, and that the volume fraction of macropores has a greater influence on the me- chanical properties of the cementitious material than the volume fraction of mesopores and micropores [64]. As the amount of silica fume increased, the proportion of macropores decreased and the overall proportion of mesopores and capillary pores increased, thus



(a) SF-2.5 (e) HSF-2.5

(b) SF-5 (f) HSF-5

(c) SF-7.5 (g) HSF-7.5

(d) SF-10 (h) HSF-10

Fig. 12. The 28th day microstructure of concrete with different silica fume replacement amounts.

ISBN: 978 – 81 – 959860 – 0 – 2

refining the pore structure and reducing the average pore size and porosity. Consequently, the compressive strength and splitting-tensile strength of concrete with silica fume as a cement paste replacement were higher than those of the control group (CG-0)
at all replacement volumes for the same water to ash ratio (W/C=0.48).

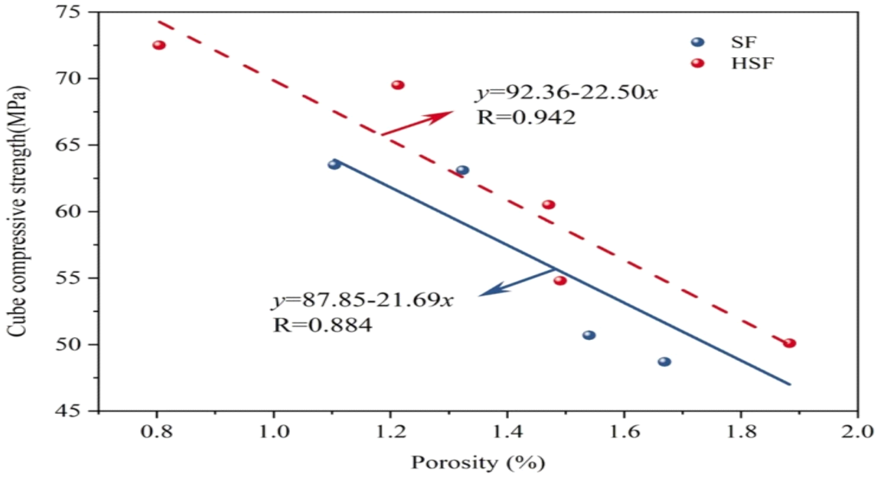


Fig. 13. Fitting of porosity and cubic compressive strength.

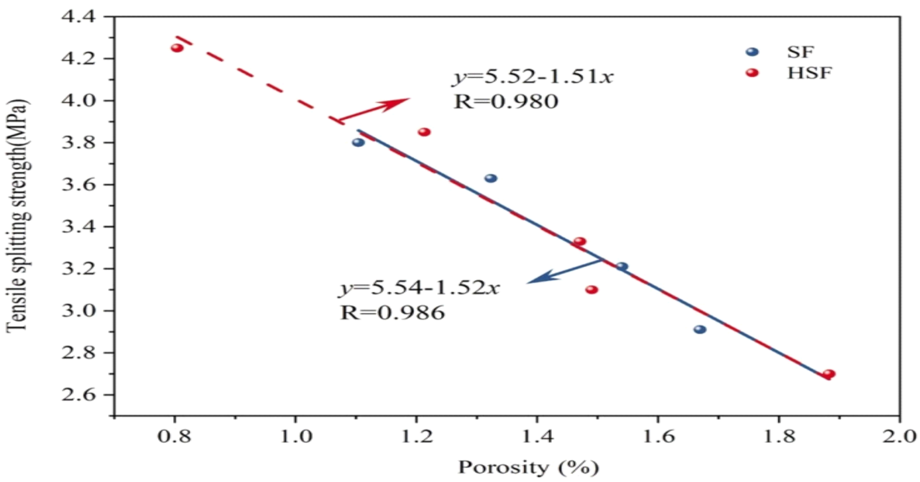


Fig. 14. Fitting of porosity and splitting-tensile strength.

Table 6 Material cost of 1 cubic meter concrete(Yuan/m^3).

Group	Water	Cement	SF	HSF	Sand	Coarse aggregate	Superplasticizer	Total
CG-0	/	192	0	0	68.2	151.7	3	414.9
SF-2.5	/	187.2	6.7	0	68.2	151.7	3	416.8
SF-5	/	182.4	13.5	0	68.2	151.7	3.1	418.9
SF-7.5	/	177.6	20.2	0	68.2	151.7	3.1	420.8
SF-10	/	172.8	27	0	68.2	151.7	3.2	422.9
HSF-2.5	/	187.2	0	10.2	68.2	151.7	3	420.3
HSF-5	/	182.4	0	20.4	68.2	151.7	3.1	425.8
HSF-7.5	/	177.6	0	30.6	68.2	151.7	3.1	431.2
HSF-10	/	172.8	0	40.8	68.2	151.7	3.2	436.7

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- *A discussion on ecological and economic benefits*

In this study, by replacing 0–10% of the cement paste with industrial solid waste silica fume, it was found that 2.9–11.5 kg of cement per cubic metre of concrete could be saved. The reduction of cement content significantly reduced the carbon footprint, so as to improve the environmental sustainability. Additionally, there were considerable economic benefits. The material cost per cubic metre of concrete for each ratio group is listed in Table 6. Compared to the control group (CG-0), the compressive strength of concrete

increased by 26.7% and 44.7% when SF and HSF replaced 10% of the cement paste, respectively, while the cost per cubic metre of concrete increased by only 1.9% and 5.3%.

When the replacement rate was 7.5% and 10%, the cubic compressive strength of both SF-added and HSF-added concrete was higher than 60 MPa. With the same strength level, the material cost per cubic metre of concrete in this study was lower than the that of C60 concrete (RMB 464/m^3) provided by China West Construction Group Co., Ltd.

- ***Conclusions***

In this study, modified concrete capable of reducing the carbon footprint was prepared by replacing 0%, 2.5%, 5%, 7.5%, and 10% cement paste with two types of solid waste silica fume, and the workability, cubic compressive strength and splitting-tensile strength of the 28-day curing concrete were measured. The effects of replacing cement paste with solid waste silica fume on the mechanical properties and microstructure of concrete were investigated by measuring the porosity and pore size distribution of concrete using LF NMR and observing the surface micromorphology of concrete at 28 days of age using FE-SEM. The main conclusions are as follows:

- As the replacements of cement paste by SF and HSF were increasing, the slump and air content of fresh concrete were both monotonically decreasing. When the replacement amount of SF and HSF were increased from 0% to 10%, the slump of concrete mixture was decreased by 27.0% and 33.6% respectively, and the air content was decreased by 13.7% and 25.5% respectively.
- The addition of silica fume as a cement paste replacement can significantly improve the mechanical properties of concrete. When SF substitution amount was increased from 0% to 10%, the cubic compressive strength and splitting-tensile strength were increased by 26.7% and 40.7% respectively. When the replacement amount of HSF was increased from 0% to 10%, the cubic compressive strength and splitting-tensile strength were increased by 44.7% and 57.4% respectively.
- As the replacement amounts of SF and HSF were increased from 0% to 10%, the total porosity of concrete was decreased by 41.4% and 57.3%, respectively. At the same time, the proportion of macropores (>1000 nm)

ISBN: 978 – 81 – 959860 – 0 – 2

was gradually decreasing while the total proportion of mesopores (100–1000 nm) and capillary pores (0–100 nm) was gradually increasing. In addition, the cubic compressive strength and splitting-tensile strength were negatively correlated with the total porosity.

- When the replacement amounts of SF and HSF were increased from 0% to 10%, the mechanical properties of concrete were significantly improved, but the cost per cubic meter of concrete was increased by only 1.9% and 5.3%, respectively. Addi- tionally, for the same compressive strength class, the cost per cubic metre of concrete in this study was lower than that without using silica fume. Using SF and HSF as the replacement of cement paste can reduce the dosage of cement while provide better mechanical properties and economic efficiency.

Declaration of Competing Inter

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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PARTIAL REPLACEMENT ON THE PROPERTIES OF FRESH

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AND HARDENED CONCRETE USING BIO- MEDICAL WASTE IN CONCRETE BY PARTIAL REPLACEMENT OF FINE AGGREGATE

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ABSTRACT

In building, cement is a binder—a substance that binds together various materials by setting, hardening, and sticking to them. In most cases, sand and gravel are combined with cement rather than being utilised on their own. To make mortar for masonry, cement is combined with fine aggregates; to make concrete, cement is combined with sand and gravel aggregates. Concrete is a composite material made of fine and coarse aggregate that is joined by a flowable cement that eventually becomes hard. India is the second-largest cement producer in the world, producing approximately 425 million tonnes of cement annually, or 6.9% of global cement output. Biomedical waste, generated from medical sources and activities is a cause of concern for environmentalist. These wastes are generated in the process of diagnosis treatment and similar activities pertaining to human and animals. Also in the production or testing of biological instruments/components. Biological waste is broadly classified as biological and non- biological wastes that may or may not be infectious.

I.INTRODUCTION

Approximately 72% of the 4,05,702 kg of biomedical waste that is produced daily in India, according to the ministry of environment and forest, is disposed of. However, more than 28% of it is neglected biomedical waste. Incineration in facilities designed expressly for biomedical waste is the most popular method of biomedical waste disposal. Biomedical waste is burned to produce ash, which is then dumped in landfills. However, these wastes can be used successfully in the manufacturing of concrete, which will reduce the need for land for the disposal of biomedical waste ash on the one hand and contribute to environmental protection by lowering cement production and consumption on the other.

Biomedical waste's toxicity and potential risks typically depend on where it came from. Heavy hazardous metals in it are extremely detrimental to human health. 140 incinerators and 170 common biomedical waste treatment facilities are already available across the nation. Concrete can employ biomedical waste in place of cement, weight for weight. Ash from medical waste can be added to cement matrices and used as building material. Additionally, it can be used to stabilise asphalt and concrete pavements.

II. MATERIALS IN CONCRETE

An experimental programme was used in the current investigation to examine the suitability of using biomedical waste ash as a partial replacement for cement in concrete and the impact of this replacement on the workability of concrete in general and compressive strength in particular.

A. CEMENT (Portland cement 53 grade)

Portland Pozzolanacement (fly ash based) of a single lot was used in the investigation. According to IS 1489(part I):1991 specification, cement is utilised.

Fig.1 Cement

A binder, or substance used in construction to bind materials together, is somewhat like cement. It sets, hardens, and clings to other materials. Most often used in conjunction with sand and gravel (aggregate), cement is used to hold materials together. To make mortar for masonry, cement is combined with fine aggregate; to make concrete, cement is combined with sand and gravel aggregates.It dries and combines with carbon dioxide in the air to set non-hydraulic cement; it does not set in moist conditions or under water. After setting, it is resistant to chemical attack.The dry ingredients and water in hydraulic cements, such as Portland cement, react chemically to set and become adhesive. Mineral hydrates, which are formed as a result of the chemical reaction and are not particularly water soluble, are quite durable in water and resistant to chemical attack. This permits setting in damp conditions or underwater and additionally shields the chemically toughened substance. Ancient Romans discovered a chemical procedure for making hydraulic cement that used lime (calcium oxide) and volcanic ash (pozzolana).

B. FINE AGGREGATES (Natural Sand)

The natural river sand utilised as the fine aggregate in this experiment confirms to IS gradation zone I after passing entirely through a sieve with a 4.75 mm aperture size:383-Specified in 1970. The majority of the particles in fine aggregates pass through a 9.5mm screen and are typically made of natural sand or broken stone. The majority of the particles in fine aggregates typically pass through a 3/8-inch filter and are often made of natural sand or crushed stone.

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Natural sand that has been cleaned and sieved to remove particles greater than 5 mm is what is referred to as fine aggregate. The IS 383:1970 code should be consulted to comprehend the fine aggregate specification.

Fig.2 Fine aggregates

C. COARSE AGGREGATE

Particles larger than 4.75 mm in diameter, but typically between 9.5 mm and 37.5 mm, are referred to as coarse aggregates. They may come from first-, second-, or third-hand sources. There are numerous applications for coarse aggregates in the construction sector. They serve as a base layer or drainage layer beneath pavements and in materials like asphalt and concrete for structural purposes. The numerous varieties of coarse aggregates are examined in this lesson. Since coarse aggregate is extracted from rock quarries or dredged from riverbeds, its size, shape, hardness, texture, and a wide range of other characteristics can vary significantly depending on the area where it is mined. Even materials from the same quarry or pit and stone type can differ significantly. In general, coarse aggregate can be categorised as either angular (like crushed stone) or smooth or rounded (like river gravel). Since precise identification is impossible due to this variability, test methods are available to characterise the most important characteristics. The behaviour of coarse aggregates is

Fig.3 Coarse aggregates

III. WATER

The primary component of Earth's streams, lakes, and seas as well as the fluids of the majority of living things is water, a transparent and essentially colourless molecule.Many fresh and hardened concrete properties, such as workability, compressive strengths, permeability and water tightness, durability and weathering, drying shrinkage, and other factors, are influenced by the amount of water in the

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concrete possibility of cracking. For both constructability and service life, it is crucial to limit and regulate the water content of concrete.For the preparation, mixing, and curing of cement composites, portable water is used. Water has a pH of 6.5, and all other components are in accordance with Indian Standards.

IV.BIOMEDICAL WASTE ASH

Ash from biomedical waste was obtained from Maridi Eco Industry Private Limited in Bangalore and used throughout the experiment.Primary ash and secondary ash are the two types of waste ash that are collected.

Fig. 4 Bio medical waste ash

The water cement ratio was taken as 0.5 which should be the maximum for M20 grade under mild exposure condition.

Sl.no.	DESIGN STIPULATIONS	QUANTITY
1.	Characteristic compressive strengthrequired in field at 28days	20 N/mm^2
2.	Maximum size of aggregate	20mm
3.	Degree of quality control	Good
4.	Type of exposure	Severe (for plain concrete)

V. TEST DATA FOR MATERIAL

Sl.no.	TEST DATA FOR MATERIAL	QUALITY
1.	Cement used	OPC 53grade
2.	Specific gravityofcement	2.875
3.	Specific gravity of fine aggregate	2.82
4.	Specific gravity Of coarseaggregate	2.78
5.	Water absorption of coarse aggregate	1.35%

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V. TEST RESULTS ANDDISCUSSIONSWORKABILITY OF CONCRETE

Workability is often referred to as the ease with which a concrete can be transported, placed and consolidated without excessive bleeding or segregation.

Workability of concrete

Sl.no		**Slump in mm**
1	Conventional	55
2	5% Bio medical waste ash	30
3	10% Bio medical waste ash	40
4	15% Bio medical waste ash	52

Workability of concrete increases with the increase in replacement of cement by biomedical waste ash and reaches a value which is almost equal to the conventional concrete.

A. DENSITY OF CONCRETE

A typical cubic metre of concrete weighs 2400 kg. The quantity and density of the aggregates, the amount of entrained air (and entrapped air), the amount of water and cement content, and the unit weight of concrete (density) all affect the density.

Density of concrete for compressive strength

Mix Type	**Density in kg/m^3**		
	7 days	**14 days**	**28 days**
Conventional	2425.67	2479.99	2452.34
5% Bio medical waste ash	2415.8	2455.3	2370.37
10% Bio medical waste ash	2398.02	2374.32	2390.12
15% Bio medical waste ash	2407.9	2427.65	2413.83

COMPRESSIVE STRENGTH, N/mm^2						
Type of moulds	7 days strength(N/mm^2)		14 days strength(N/mm^2)		28 days strength(N/mm^2)	
Conventional	25.38	25.03	27.84	28.14	35.64	33.33
	24.8		28.4		32.44	
	24.94		27.96		31.91	
5% Bio medical waste ash	16.35	18.72	21.55	20.67	36.22	34.82
	18.04		18		32.48	
	21.78		20		35.77	
10% Bio medical waste ash	15.87	20.32	21.55	22.25	31.2	28.55
	24.08		20.04		22.44	
	21.02		20.44		32	
15% Bio medical waste ash	15.64	16.91	21.64	19.85	17.86	20.07
	18.22		22		20.08	
	16.88		23.11		22.26	

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Density of concrete for split tensile strength

Mix Type	Density in kg/m³		
	7 days	14 days	28 days
Conventional	2307.1	2293.9	2408.9
			8
5% Bio medical waste ash	2356.15	2333.5 1	2371.2 5
10% Bio medical waste ash	2310.88	2339.1 8	2297.6 7
15% Bio medical waste ash	2327.85	2305.2 2	2312.7 7

The density of biomedical waste ash concrete is almost equal to that of conventional concrete which is 2400kg/m^3.

B. COMPRESSIVE STRENGTH

The most frequent test performed on hardened cement composites is the compression test, in part because it is simple to execute and in part because the majority of the desirable qualitative characteristics of concrete are directly tied to its compressive strength. On cylindrical or cubical specimens, the compressive test is run. The cube specimen measures 100 mm in all directions. Using the formula f = P/AN/mm2, the compressive strength of concrete on a standard 100 mm cube is determined.

where,f = compressive strength of cement composite in N/mm^2

p = ultimate load resisted by cement composites in Newton's

A = Cross sectional area of cube specimen in mm^2 Table Readings of Compressive strength

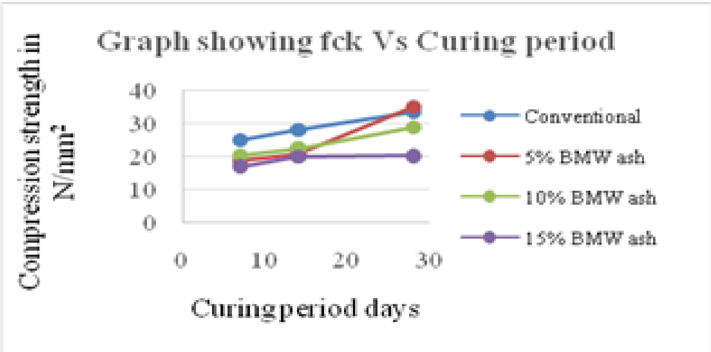

Fig.5 Plot of compressive strength v/s curing period

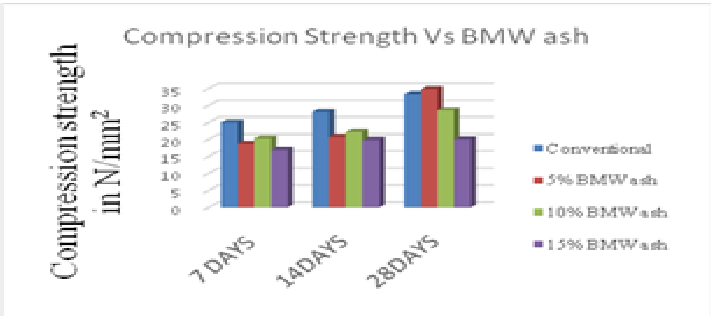

Fig.6 Plot of compressive strength v/s BMW ash

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The compressive strength of concrete decreased with addition of BMW ash when compared to conventional concrete. Compressive strength of the BMW ash for 5% and 10% replacement has shown a good results while 15% replacement strength reduced when compared to 5% and 10% strength. This effect is may be due to reduction in density of the BMW ash concrete.

C. SPLIT TENSILE STRENGTH

A cylindrical specimen is tested by positioning it horizontally between the loading surfaces of the compression test machine until the specimen fails along its vertical diameter. The cylindrical specimen is used for the split tensile test. The specimen is 150 mm in length and 100 mm in diameter. A concrete's split tensile strength can be calculated using the formula Ft = 2 P/d LN/mm2.

Where,P = failure load of specimen in Newton's

d = diameter of specimen in mm

L = length of the specimen in

Readings of split tensile strength

SPLIT TENSILE STRENGTH, N/mm^2						
Type of moulds	7 days strength(N/mm2)		14 days strength(N/mm2)		28 days strength(N/mm2)	
Conventional	2.35	2.31	2.66	2.68	3.37	3.39
	2.27		2.70		3.41	
5% Bio medical waste ash	1.78	2.28	2.7	2.71	2.6	2.42
	2.78		2.73		2.25	
10% Bio medical waste ash	2.64	2.33	3.09	2.72	2.19	2.66
	2.02		2.36		3.13	
15% Bio medical waste ash	2.12	2.16	1.41	1.44	1.88	1.89
	2.20		1.47		1.90	

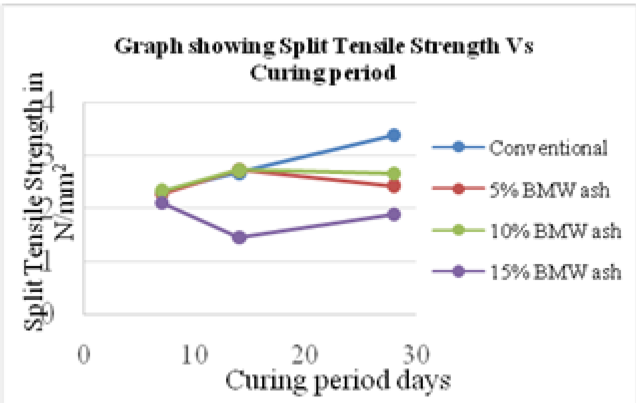

Fig.7 Plot of Split tensile strength v/s curing period

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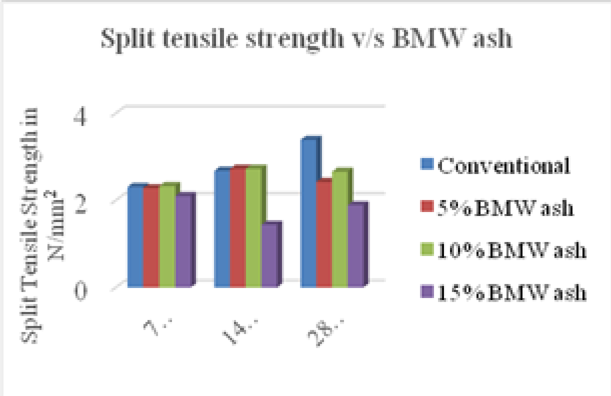

Fig 8 Plot of Split tensile strength v/s BMW ash

The BMW ash concrete's Split Tensile strength has been obtained at a level that is nearly equal to that of regular concrete.Excellent results were obtained for the split tensile strength of the BMW ash for 5% and 10% replacement, although 15% replacement strength was lower than 5% and 10% strength.

VIII. CONCLUSIONS

- It is observed that density of concrete decreased marginally with the increase in the replacement level of BMW.Biomedical waste ash can effectively be used in concrete making upto 10% replacement.
- Workability of concrete made using biomedical waste ash is lower than that of conventional concreteThe compressive strength of concrete decreased with addition of BMW ash when compared to conventionalconcrete.
- Compressive strength of the BMW ash for 5% and 10% replacement has shown a good results while 15% replacement strength reduced when compared to 5% and 10% strength.
- The Split Tensile strength of the BMW ash concrete has been reached almost the same strength of conventional concrete.Split Tensile strength of the BMW ash for 5% and 10% replacement has shown a excellent results while 15% replacement strength reduced when compared to 5% and 10% strength.
- After comparing all the experimental test results, 10% replacement level is taken as the optimizedpercentage.

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FLEXURAL MECHANISM AND DESIGN METHOD OF NOVEL PRECAST CONCRETE SLABS WITH CROSSED BENT-UP REBAR

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ABSTRACT

Precast concrete slabs are one of the most widely used types of structural member in building industrialization. In this paper, a novel precast concrete slab with crossed bent-up rebar was proposed, where the rebar of precast concrete units was bent-up and embedded crossways in cast-in-place concrete toppings, forming a novel joint configuration of precast concrete slabs. The effects of two bent-up angles of the rebar in the precast concrete units, different thicknesses of the cast-in-place concrete toppings, and different reinforcement ratios on the failure modes of novel precast concrete slabs were studied using flexural loading tests with eight specimens. The failure modes of the specimens changed from the joint failure to the failure of the termination section of lap-splice rebar (TSLSR), when the horizontal angle of the bent-up rebar changed from 90 to 60°. Bent-up ends with an angle of 60° prevented the joint failure of the novel precast concrete slabs, and strengthened the flexural performance of the joint. The horizontal component force of the bent-up ends markedly strengthened the flexural capacity of the joint, and the vertical component force of the bent-up ends made the precast concrete units connect tightly with the cast-in-place concrete toppings, enhancing the anchorage effectiveness of the lap-splice rebar. There were two primary failure modes of the specimens: joint cracking caused by the yield of the lap-splice rebar in the joint, and plastic cracking failure of the section beyond the TSLSR. Finally, the design equations of the flexural capacity of the joint and the anchorage length of the bent-up ends were established, and the design process of the novel precast concrete slabs was given.

INTRODUCTION

Precast concrete structures exhibit many advantages , such as higher construction efficiency, shorter construction period, and excellent product quality, compared with cast-in-place concrete structures. The precast concrete slab is one of the most widely used structural members in precast concrete structures. A precast concrete slab consists of precast concrete units and a cast-in-place concrete topping, where the former is typically used as permanent formwork for the latter. A precast concrete slab is formed after the concrete of a cast-in-place concrete topping has hardened. Precast concrete slabs have broad application prospects in precast concrete structures.

The configuration of precast concrete units is a crucial characteristic of precast concrete slabs. Shear tests have shown that cast-in-place concrete toppings could

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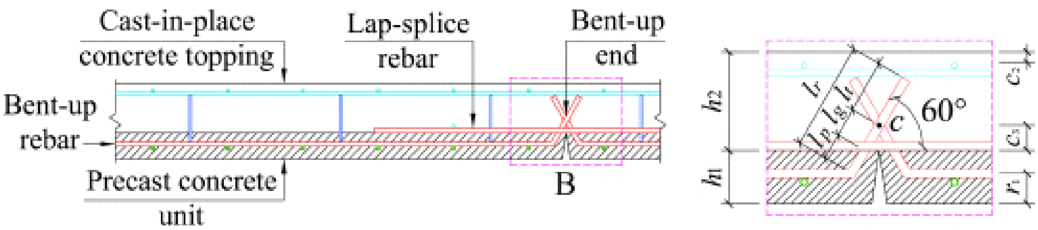
markedly strengthen the shear capacity of precast concrete hollow core slabs when the interfacial bond strength between precast concrete hollow core units and the cast-in-place concrete toppings was sufficiently large. Flexural tests have shown that cast-in-place concrete toppings enhanced the flexural capacity of precast concrete hollow core slabs and shown that the self-weight of ferrocement-AAC precast concrete slabs could be markedly reduced with the same flexural capacity when autoclaved aerated concrete blocks were filled into the precast concrete slabs [14]. Experimental and theoretical research of precast concrete slabs with precast ribbed units has been carried out. Then, a design method of one-way precast concrete slabs with precast ribbed units was established based on quasi-static experimental research, and a simplified elastic design method of two-way precast concrete slabs with precast ribbed units was derived according to theoretical research. Precast concrete slabs with lattice girder trusses were studied based on quasi-static tests and theoretical analyses, prompting their corresponding design method.

Precast concrete units with narrower widths were designed to facilitate their transportation and installation. As shown in Fig. 1, two precast concrete units with lattice girder trusses were used as the permanent formwork of a cast-in-place concrete topping, and lap-splice rebar were mounted at the joint of the precast concrete slab.

Precast prestressed concrete slabs [17,27,28] were studied based on quasi-static tests and theoretical analyses. This paper proposed a novel precast prestressed concrete slab with crossed bent-up rebar, as shown in Fig. 3. Rebar was placed in three layers in precast concrete units, and these rebars were prestressed steel wire, bent-up rebar, and wavelike shear rebar from the bottom to top, as shown in Fig.1(a). A rough surface was designed at the top surface of the precast concrete units. The ends of the bent-up rebar were bent up, creating "bent-up ends". Two precast concrete units were connected, and the bent-up ends were embedded crossways in the cast-in-place concrete topping, as shown in Fig.1 (b).



(a) (b) B

To study the flexural performance of novel precast concrete slabs with crossed bent-up rebar, two precast concrete units with a width of 1 m were connected in the direction of the prestressed steel wire as permanent formwork of the cast-in-place concrete topping (Fig. 3(b)). Lap-splice rebar was placed on the top surface of precast concrete units in the joint, and transverse rebar were mounted vertically above the lap-splice rebar. Rebar meshes were located on the top of the precast concrete units, and concrete was poured into the precast concrete units to form the novel precast concrete slab with crossed bent-up rebar. The effects of the bent-up angles of the bent-up rebar, the thicknesses of the cast-in-place concrete toppings, and the reinforcement ratio on the mechanical performances of the specimens were analyzed using flexural loading tests [29]. Then, the failure modes of the specimens and the force transfer mechanism in the joint were investigated, and the design method for the joint section of the novel precast concrete slab was described in detail.

The novel precast concrete slab with crossed bent-up rebar exhibits the following advantages.

(1) There was no need to set formworks or post-cast concrete strips between two the precast concrete units, improving the construction efficiency of novel precast concrete slabs;
(2) The novel precast concrete slab only added one manufacturing step - manufacturing the bent-up ends of the bent-up rebar - compared with the popular precast concrete slabs. The bent-up ends were embedded crossways in the cast-in-place concrete topping, making force transmission continuous between the bent-up rebar in the joint.

To study the flexural performance of novel precast concrete slabs with crossed bent-up rebar, two precast concrete units with a width of 1 m were connected in the direction of the prestressed steel wire as permanent formwork of the cast-in-place concrete topping (Fig. 1(b)). Lap-splice rebar was placed on the top surface of precast concrete units in the joint, and transverse rebar were mounted vertically above the lap-splice rebar. Rebar meshes were located on the top of the precast concrete units, and concrete was poured into the precast concrete units to form the novel precast concrete slab with crossed bent-up rebar. The effects of the bent-up angles of the bent-up rebar, the thicknesses of the cast-in-place concrete toppings, and the reinforcement ratio on the mechanical performances of the specimens were analyzed using flexural loading tests [29]. Then, the failure modes of the specimens and the force transfer mechanism in the joint were investigated, and the design method for the joint section of the novel precast concrete slab was described in detail.

PROCEDURE

Test specimens

Two identical precast concrete units were connected by joints, and the concretes of cast-in-place concrete toppings were poured to form a novel precast concrete slab with crossed bent-up rebar. Below Fig shows the design dimensions of the precast concrete units, and their length, width, and thickness were 2400 mm, 1000 mm, and 70 mm, respectively. Three layers of rebar were mounted in precast concrete units, and these rebars were prestressed steel wire with a diameter of 9 mm, bent-up rebar…

Load-deflection curves

The load-deflection curves of the specimens. The x-axis represents the deflection, v, of the specimens, which is the average deflection of the specimens measured by the LVDTs in the midspan section. The y-axis indicates the load, F, borne by specimens, which was measured by the load cells. Two characteristic points of the load-deflection curves, the cracking load, Fc, and yield load, Fy, were identified. The yield load, Fy, was the external load borne by specimens when the strain…

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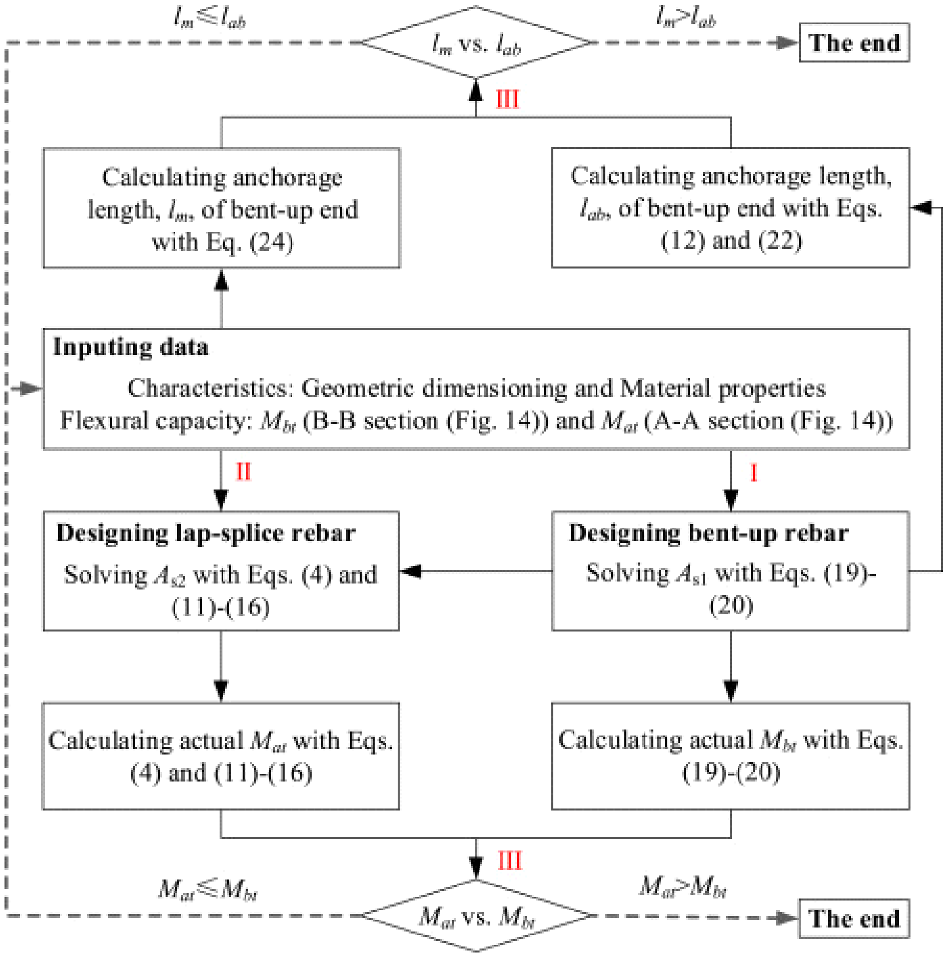

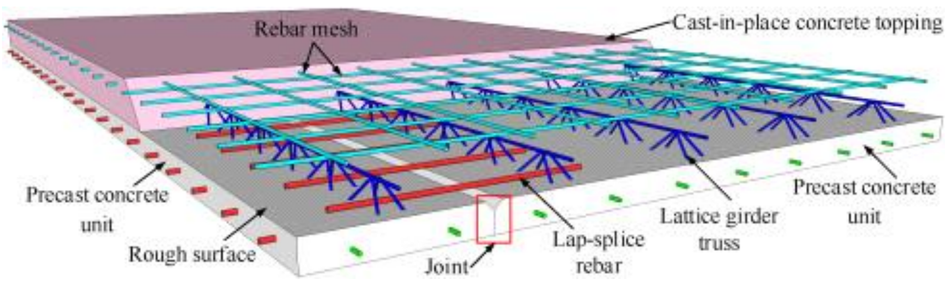

Strain of bent-up ends in joints

The mechanical model of the joint of specimens. As shown in Fig. (a), the tension zone of the joint of the specimen included lap-splice rebar and bent-up ends (R1 and R2). Two precast concrete units in the joint were discontinuous, and the thickness, h_1, of the precast concrete units was ignored in the mechanical analysis of the joint. As shown in Fig. 13(b), a mechanical model of the joint with a micro segment length, $d\,x$, of cast-in-place concrete topping was established to…

Yield sequence of rebar

From the failure modes described in Section 3.2, the weak section of the specimens was either the joint or the section beyond the TSLSR. The distance between the strain gauges, RS, of the bent-up rebar and the joint was 600 mm (Fig. 7), and the distance between the TSLSR (Figure and joint was 510 mm. Eqs. (4), (11), (11), (12), (13), (14), (15), (16) were used to calculate the flexural capacity of the joint of the

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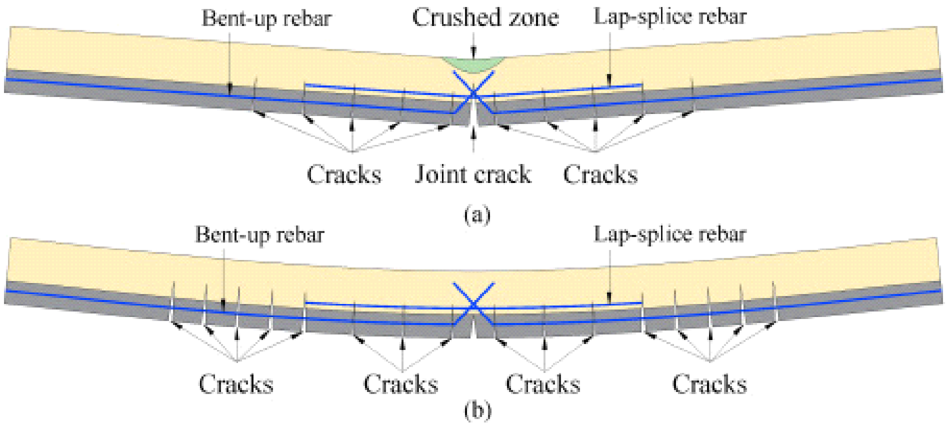
specimens. According to the balance condition of internal force, the….



Design process of novel precast concrete slabs

Yield sequence of rebar

From the failure modes described in Section 3.2, the weak section of the specimens was either the joint or the section beyond the TSLSR. The distance between the strain gauges, RS, of the bent-up rebar and the joint was 600 mm (Fig. 3), and the distance between the TSLSR (Fig. 2(a)) and joint was 510 mm. Eqs. (4), (11), (11), (12), (13), (14), (15), (16) were used to calculate the flexural capacity of the joint of the specimens. According to the balance condition of internal force, the

Design process of novel precast concrete slabs

According to the analysis of the failure mode of the test specimens, the design goal of the novel precast concrete slabs is to avoid the failure of the joint section before the failure of the TSLSR. This study realizes this design goal from two aspects: 1) making the flexural capacity of the joint section greater than that of the flexural capacity of the TSLSR for the novel precast concrete slabs; and 2) making the anchorage length of the ben t-up ends meet the design requirements. Fig. 18 shows…

Conclusions

In this paper, the mechanical performances of specimens with two bent-up angles of rebar in precast concrete units, different thicknesses of cast-in-place concrete toppings, and different reinforcement ratios were studied using flexural loading tests with eight specimens. Also, the flexural mechanism and failure modes of the specimens were analyzed. The primary conclusions of this study are the failure modes of the specimens changed from the joint failure to TSLSR failure.

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Acid Treatment Technique for Determining the Mortar Content of Recycled Concrete Aggregates

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ABSTRACT

The performance of concrete manufactured with recycled concrete aggregates (RCA) compared to concrete made with natural aggregates (NA) has reportedly been reduced as a result of the presence of old cementitious mortar in RCA. This discrepancy in performance has been linked to the amount of mortar utilised to cast the initial parent concrete in the RCA as opposed to the NA. As a result, figuring out the mortar content could be a useful way to gauge how well RCA is made overall. Additionally, when developing concrete mixes cast using RCA, it is crucial to consider the amount of mortar present in RCA as part of the overall amount of mortar present, as indicated in the literature. However, there is currently no simple, accepted way for calculating the precise cementitious mortar composition of RCA. To ascertain the mortar content of RCA, an acid treatment testing method is suggested in this study. The procedure, which takes around 24 hours to complete, is capable of removing the majority, if not all, of the cementitious mortar. Investigators looked into how mortar content affected RCA's 24-hour water absorption, bulk density, and Los Angeles abrasion resistance. Investigations were also conducted on how the original parent concrete's strength affected the relationships between mortar content and RCA characteristics. The study was confined to only granitic coarse aggregates.

KEYWORDS: mortar content, acid treatment, recycling, concrete, aggregate

1. INTRODUCTION

The production of coarse recycled concrete aggregates (RCA), which may readily meet the requirements for use in structural concrete, has been made possible by recent improvements in the yield and efficiency of recycling techniques combined with steps to ensure the proper sourcing of raw materials from concrete debris [1-3]. As a result, coarse RCA has gained wider acceptance as a substitute for natural aggregates (NA). The literature that is now accessible, however, demonstrates that differences in the parent concrete's properties and the method of crushing can lead to significant variations in RCA's properties [4,5]. Therefore, having access to standard tests is crucial for the on-site quality control of RCA.

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After being crushed and sieved into various single-sized fractions, the coarse RCA particles (>4 mm) may include one or more natural coarse aggregate particles completely or partially encircled by a layer of mortar and/or cement paste. Alternately, the RCA might resemble a lump of mortar with various pro-portions of smaller-sized NA implanted in it. The quantities of both forms of RCA in batches of RCA vary typically [3]. Coarse RCA is less dense, absorbs more water, and loses more abrasion than NA [2,6,7].The degree to which RCA's attributes diverge from those of NA depends on

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National University of Singapore, 2Dept. of Civil and Environmental Engineering, #07-03, BLK E1A, 1 Engineering Dr. 2, Singapore 117576.several aspects of the recycling process, including the original concrete's characteristics and the crushing technique. According to past research' findings, mortar content appears to be the primary variable proportionally determining the fundamental characteristics of coarse RCA [8,9].

According to reports, RCA contains between 20% and 70% (by mass) of old mortar and/or cement paste [8]. Although previous studies have primarily referred to the mortar portion of RCA as "attached or adhering mortar," the term "attached mortar" tends to imply a thin layer of surface materials attached to the single sized particles only and does not account for the presence of lumps of aggregate-sized particles consisting primarily of mortar. The term "mortar content" by mass or by volume, which encompasses all the major categories of aggregate-sized particles in a specific RCA sample, may therefore be more applicable.According to De Juan et al. [8], there is a nearly linear relationship between the mortar content (by mass) and the fundamental characteristics of RCA, such as water absorption, density, and abrasion resistance. Other researches [10,11] have also reported on such proportional connections. Therefore, at concrete recycling and ready-mix concrete plants, an accurate, quick, and simple method to assess the mortar content of RCA is required, provided that appropriate quality control criteria are available. The latter is particularly significant because it has been recommended earlier that mix proportioning procedures should take into account the amount of mortar present in RCA when estimating the volume of new mortar required in order to produce recycled concrete that is more durable [12,13].The majority of the mortar content measuring methods now in use are either unreliable or unsuitable for long-term on-site measurements [3,8]. At this momentThrough the complete removal of mortar from RCA in just 24 hours, an acid treatment technique is suggested for evaluating the mortar content of the sample. The findings of a thorough experimental programme aimed at examining the connections between mortar content, determined using the novel technique, and RCA parameters such as 24-hour water absorption, bulk density, and Los Angeles abrasion resistance are also reported. The

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goal is to develop a trustworthy set of quality control standards based on accurate mortar content measurement. Only the RCA of granitic coarse particles were included in the study.

1.1 PreviouslyProposedMortarContentMeasurementTechniques:

The previously suggested methods for measuring mortar content mostly include removing mortar through mechanical, chemical, or thermal processing, or by combining one or more of these methods, and then calculating the weight or volume loss. The mortar content is then expressed as the difference between the weight (or volume) of the removed part and the original RCA prior to treatment. Conventional heat treatment [14], immersion in weak acids [15], mechanical rubbing [14,16], microwave-assisted treatment [3], and various combinations of these approaches [3,14] are some of the techniques used. These approaches are not appropriate for frequent on-site use, particularly the routine measurement of mortar content, due to a number of significant limitations, including the inability to entirely remove all mortar, lengthy testing times, the need for cumbersome equipment, and expensive prices [3,8]. Concrete recycling and ready-mix operations might not always have the expensive and large equipment necessary for the traditional thermal treatment, mechanical rubbing treatment, and microwave-assisted treatment. Additionally, when using mechanical processing methods like rubbing, a sizeable portion of the embedded NA of RCA may be reduced to powder and combined with the separated mortar, inflating the amount of mortar present. Additionally, according to the findings of other studies, none of the aforementioned approaches can entirely remove the mortar that is present in RCA and that extra manual or mechanical brushing is necessary to properly separate the mortar from the individual aggregate particles [3, 8]. According to Akbarnezhad et al. [3], applying traditional heating, mechanical rubbing, acid treatment, and microwave-assisted treatment methods under the initial [14–16] suggested circumstances only caused the removal of 10%, 20%, 40%, and 50% of the total mortar, respectively. For the total elimination of mortar, a modified acid treatment method was also put forth [3]. Abbas et al. [17] described a dual treatment strategy to remove the mortar from RCA using mechanical stresses developed by freezing and thawing the RCA and chemical degradation caused by exposing the RCA to sodium sulphate solution. Although the approaches put forth by Akbarnezhad et al. [3] and Abbas et al. [17] appeared to offer a trustworthy assessment of the RCA mortar content, they take 5 and 7 days, respectively, to complete and may not be appropriate for routine on-site testing. evaluation of RCA in typical ready-mixed and recycling concrete facilities.
As an alternative, it has been suggested to estimate the mortar content of RCA by using an image processing technique that determines the relative area of the old mortar in a new concrete cast with RCA and coloured cement [18]. Such image processing techniques, however, take a long time to complete since they need to cast fresh concrete, cut sample specimens, and use cameras and image processing software.

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1.2RemovalofCementitiousMortarfromRecycledConcreteAggregatesUsingAcidTreatment

The objective of the current study was to alter the previously suggested acid treatment technique in order to produce an easy-to-use testing procedure for the assessment of the mortar content of RCA. The acid treatment method was chosen for further research because it is simple to use, does not depend on the operator, and does not need expensive or specialised equipment.

Because cement is alkaline, cementitious materials corrode rapidly and can be removed using powerful acids [19]. Depending on the type of acid used, different processes have reportedly been implicated in the corrosion of cement paste by acids [19]. When sulfuric acid is employed, for example, corrosion is mostly brought on by the dissolving of calcium hydroxides and the expansion and subsequent cracking brought on by the creation of gypsum and ettringite [19,20].Numerous studies [20,21] have been conducted to determine the mechanism and rate of acidic corrosion of concrete and cement paste specimens. The acid corrosion of RCA (tiny particles of crushed concrete), however, has received far fewer reports [3,15]. Comparing RCA particles to the majority of the concrete/cement paste specimens examined in the literature, they have a substantially greater "exposed surface to volume" ratio.As a result, significantly higher acidic corrosion rates for RCAs than those for concrete/cement paste may be anticipated. Permeability is primarily responsible for regulating the rate of acidic corrosion of cementitious materials [20,21].

Tam et al. [15] first suggested using acid treatment to remove mortar from RCA as a way to improve RCA quality rather than to ascertain the mortar content. This procedure involves soaking RCAs in 0.1 molar acidic solution for 24 hours, followed by washing to remove any remaining acid and prevent corrosion.According to Tam et al. [15], the sulfuric (H2SO4) and hydro-chloric (HCl) acids produced the highest mortar removal rates among the various acids tested (HCl, H2SO4, and H3PO4), which decreased the water absorption of RCA by 7.27% to 12.17%. However, the data seem to indicate that only a little amount of mortar may be removed using the suggested acid treatment procedure when such reductions are compared to the actual differences between the water absorptions of RCA and NA (which are often in the order of at least a few times). Akbarnezhad and others.later demonstrated that sulfuric acid could be used to completely remove asphalt using acid treatment at concentrations significantly higher (>2 molar) and for longer soaking times (>5 days) than those suggested by Tam et al.(0.1 molar acid soaking for 24 hours). The latter, however, has the disadvantage of a lengthy testing period. Concrete recycling and ready-mixed concrete factories require a quick, simple, and accurate way of detecting the mortar composition of RCA.

The goal of the current investigation was to shorten the time spent evaluating the acid treatment approach. Due of the fact that practically all of the coarse concrete aggregates used in Sin- gapore are granite, acid corrosion is thought to be a particularly suitable

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approach for removing mortar from RCA. Granite has been utilised in numerous applications where corrosion resistance is necessary because of its great chemical resistance. For instance, skid tops and tank liners (bottoms, walls, and covers) in continuous acid pickling lines used for the descaling of steel have frequently been made of granite [22].For removing mortar when the NA used in RCA are primarily made of granite, HCl and H2SO4 are the best options. This is mostly due to the component minerals of granite being insoluble in these acids compared to other strong acids [22,23]. Due to the fact that hydrofluoric acid is the only acid in which quartz, feldspar, and mica, the main components of the majority of industrial granites, are readily soluble, it may be thought of as the worst option for RCA acid treatment [22,23]. Sulfuric acid was used as the cor- rosive agent in the current study.

1.3 Relationship between Recycled ConcreteAggregatePropertiesandMortarContent

In general, RCA are less dense than NA. Depending on the size of the aggregates, the bulk densities of RCA under saturated-surface-dry (SSD) and oven-dry (OD) conditions have been reported to vary from 2310 to 2620 kg/m3 and 2290 to 2490 kg/m3, respectively [6,24,25]. When the same crushing machinery and the same number of crushing stages were utilised, Hansen et al. [24] demonstrated that the density of RCA increased with size. They said that the fundamental reason for this is that under these circumstances, smaller RCA particles typically contain more mortar.
Similar to this, there have been numerous publications on the water absorption of RCA and how it varies with particle size and density. The results that have been reported are extremely dispersed and range from 1% to 12% [8,25-28]. Testing on RCA samples from four separate recycling facilities revealed an almost inversely linear relationship between the RCA's density and water absorption, according to Ruhl [28]. De Juan et al. also supported this connection between density and water absorption.It has been suggested that variations in the mortar content, which vary with the size of RCA, can be blamed for the fluctuation in water absorption and density with particle size [29].
Previous studies have also looked into the toughness (abrasion and impact resistance) of RCA. Because crushing strength, abrasion resistance, and elastic modulus of aggregates are all interrelated properties, toughness is a crucial indicator of aggregate quality [1]. According to Tabsh et al. [1], the RCA they tested exhibited Los Angeles abrasion losses that were generally larger (>30%) than NA. The hardness of all the RCA samples examined, according to the scientists, was within the acceptable range of 50% for structural applications.The presence of mortar has also been linked to the decreased toughness of RCA.RCA characteristics (water absorption, density, and abrasion resistance) and mortar content have been correlated in a manner similar to prior studies [3,18].
However, there was significant variation in the mortar content values reported for RCAs made using somewhat comparable recycling techniques [8]. The characteristics of NA and the mortar percentage of the parent concretes used to create the RCA under study may differ in this way. Additionally, the interpretation of the test results reported

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in published studies may have been impacted by the variations in the reliability of the various mortar content measurement techniques employed.The more accurate mortar content measurement method, which is described in the section "Tests to Deter- mine Mortar Content of Recycled Concrete Aggregates," was used in this study to investigate the connections between mortar content and the tested RCA's tested properties. Additionally, the impact of the parent concrete's strength variation on such relationships was looked into.

2. MATERIALS &EXPERIMENTALPROGRAM

Grade 30 and Grade 60 laboratory cast concrete specimens—hereinafter referred to as RCA/C30 and RCA/C60, respectively—were crushed in two separate batches to create RCAs. The lowest and highest grades of concrete utilised in the majority of Singapore's concrete structures are Grade 30 and Grade 60, respectively. To look into any variations between RCA created in a lab and RCA produced commercially, a second batch of RCA made by one of Singapore's largest concrete recycling plants was used (hence referred to as RCA/P). Unknown were the mechanical characteristics and age of the concrete utilised to create the RCA/P samples. In this investigation, only RCA samples between 8 and 12 mm in size were employed. Table 1 lists the mix proportions of parent concretes utilised to create the laboratory-crushed RCA. The cement used was ASTM type I ordinary Portland cement with a Blaine fineness of 347 m2/kg and a specific gravity of 3150 kg/m3. The virgin coarse (mostly granite) and fine (natural sand) aggregates had bulk densities of 2590 kg/m3 and 2540 kg/m3, respectively, in OD circumstances. Additionally, the 24-hour water absorption capacities of virgin coarse and fine aggregates were roughly 0.6% and 0.5%, respectively.

Additionally, a number of mortar and pure cement paste specimens with mix proportions similar to those of the corresponding parent concretes used to create RCA in the lab (Table 1) were cast in order to determine the bulk density of the mortar and pure cement paste portions of RCA for verification purposes (explained in the section "Relationships between Mortar Content and Recycled Concrete Aggregate Properties"). The density of OD in After 40 days, mortar and cement paste samples were measured experimentally and found to have average densities of 2100 and 1800 kg/m3 for C30 mixes and 2180 and 1910 kg/m3 for C60 mixes, respectively.

CONCRETE GRADE

TABLE1—*Mix proportions and compressive strength of the parent concretes used to produce RCA.*

	C30	**C60**
w/c	0.69	0.45
Cementcontent,kg/m^3	282	375
Water, kg/m^3	195	167
Fineaggregate,kg/m^3	804	736
Coarseaggregate,kg/m^3	1072	1072
Superplasticizer,l/m^3	0	2
Averagecompressivestrength,MPa	27	63

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TESTSTODETERMINEMORTARCONTENTOFRECYCLEDCONCRETE AGGREGATES

The effectiveness of several testing processes was examined in order to optimise the acid treatment process with the goal of removing all mortar in just 24 hours. The four different testing methods taken into account in the current investigation are summarised in Table 2. distinct sulfuric acid concentrations of 1 to 6 molar and two distinct volumetric ratios (Vacid/VRCA 2.5 and 5) between the acidic solution and RCA were studied. All of the trials utilized a 24 h soaking period. RCA samples were oven dried before and after acid treatment in order to provide a more accurate assessment of the mortar content.The first testing method (reference method) involved soaking the samples in diluted sulfuric acid solutions in a covered plastic container for 24 hours, as suggested earlier by Tam et al. [15] and Akbarnezhad et al. [3]. The second methodology was comparable to the reference method, with the exception that samples were washed over a 4 mm sieve to remove the corroded mortar from the RCA after 8 hours of soaking. The RCA were then immersed for the remaining 16 hours in a fresh sulfuric acid solution with a concentration comparable to the first acidic solution.The third and fourth methods were comparable to the first and second approaches, with the exception that a rotary agitation apparatus was employed to repeatedly rotate the samples end-over-end at a speed of 10 6 1 rpm.

After 24 hours, the RCA samples from each method were rinsed on a 4 mm screen to get rid of the mortar and acid. The amount that was still in the sieve was dried in the oven and weighed. The ratio of the removed mortar was used to determine the weight loss of the RCA sample as a percentage (compared to the initial weight of the RCA sample). If the presence of mortar in RCA could still be seen after a visual assessment, samples were then put through one more round of the same testing. Otherwise, if visual inspection revealed no or very little mortar,To confirm that all mortar had been removed completely, the 24-hour water absorption of the RCA sample was measured in accordance with ASTM C127 [30] and compared with that of the original NA used in the parent content (0.64%). The removal of mortar (Fig. 1) was completely removed from RCA samples when the water absorption of RCA after acid treatment was greater than that of NA.The mortar content was then determined as a percentage of the overall weight reduction of RCA samples following the complete removal of mortar (in relation to the samples' initial weight). Fig. 1 summarises the overall experimental process.

Additionally, three 1 kg batches of natural granite aggregates were immersed in sulfuric acid solutions at the maximum concentrations (6 molar) for 24 hours to study the resistance of NA to sulfuric acid corrosion. The weight loss was then determined after the samples were rinsed on a 4 mm filter.

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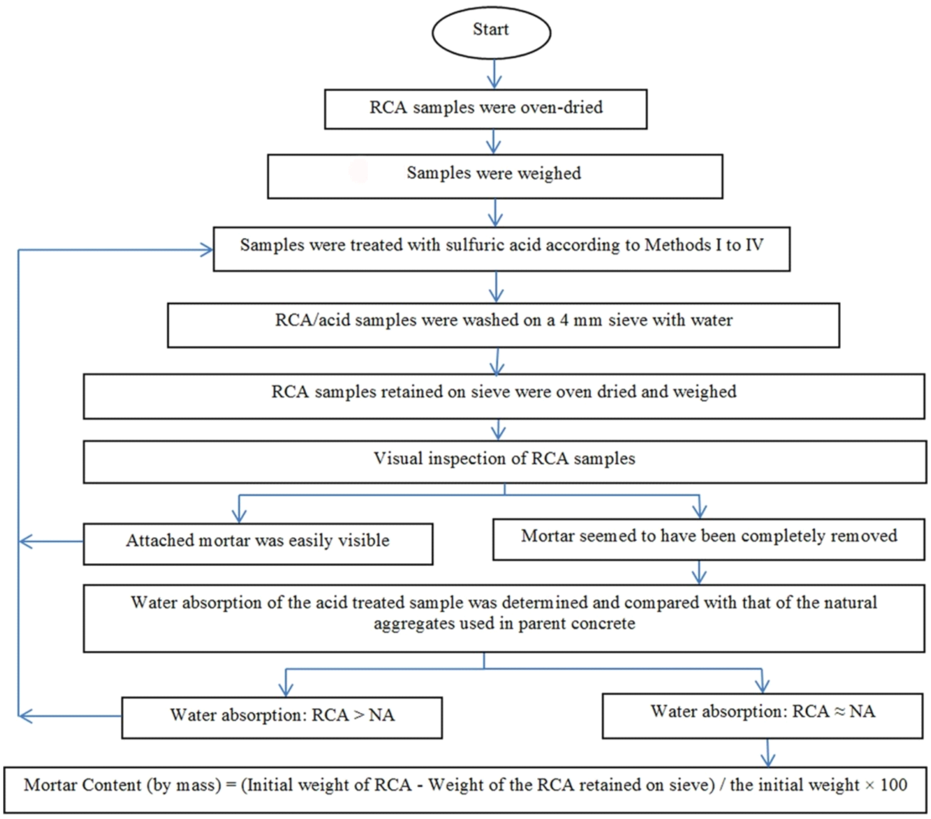
PRODUCTIONOFRECYCLEDCONCRETEAGGREGATESAMPLESWITHVARIOUSMORTARCONTENTSANDMEASUREMENTOFPROPERTIES

More than 100 RCA samples with various mortar contents were examined for 24-hour water absorption, bulk density (OD), and Los Angeles abrasion loss in order to examine the relationship between mortar content and RCA attributes. About 30 to 35 batches of each RCA type (RCA/C30, RCA/C60, and RCA/P) were immersed in sulfuric acid solutions with various concentrations for various soaking times in order to generate RCA with various mortar proportions.Each RCA batch had some of its mortar removed as a result of soaking in sulfuric acid, creating RCA batches with various amounts of mortar. According to ASTM C127 [30], the bulk density (OD) and water absorption of each RCA batch were determined. According to procedure IV from the section "Tests to Determine Mortar Content of Recycled Concrete," at least three 500 g samples from each batch of RCA were used to calculate the average mortar content.

TABLE2—*The four different acid treatment testing procedures considered.*

ActionTaken	I	II	III	IV
Soaking in sulfuric acid solution (for a total duration of 24h)	3	3	3	3
Continuous rotary agitation of RCA/acid container			3	3
Washing away the corroded mortar after 8h		3		3
Replacement of the acidic solution with a fresh acidic solution (after8h)		3		3
Washing and cleaning of RCA samples on 4mm sieve after 24h	3	3	3	3



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aggregates. In the Los Angeles abrasion test in accordance with ASTM C131 [31], a 5 kilogramme sample from 33 chosen RCA batches (11 samples of RCA/C30, 11 samples of RCA/C60, and 11 samples of RCA/P) was utilised.

3. RESULTS AND DISCUSSION

Precision of Mortar Content Measurement Tests

The findings of the numerous tests discussed in the section "Tests to Determine Mortar Content of Recycled Concrete Aggregates" are summarised in Tables 3 and 4. As can be shown, an increase in the acid concentration and/or the volumetric ratio between the acid and RCA appears to boost the removal effectiveness by increasing the presence of the H ions needed for corrosion.Additionally, it was shown that comparing the rates of mortar removal using methods III and IV to those obtained using methods I and II, respectively, showed that rotating the RCA/acid container could significantly increase the rate of mortar removal by increasing the accessibility of acid to uncorroded mortar and exposing fresh surfaces for corrosion to occur at by washing away the previously corroded mortar and aluminosilicate gel material from the RCA surface.

Figure 2 compares the typical soaking time needed to remove mortar completely using various methods at varying acid concentrations and the Vacid/VRCA ratios taken into account. As can be observed, the results indicate that technique IV, when used at a minimum acid concentration of 3 (molar) and a Vacid/VRCA ratio of 5, can completely remove mortar from RCA in only 24 hours.

Table 3- efficiency of acid treatment methods I and II at different acid concentrations in the removal of mortar from RCA

Acid ($[H^+]$) Concentration, mol/l	Mortar Removed/Total Mortar, % by mass[a]				Minimum Number of Repetitions Required in Order to Achieve Complete Removal of Mortar[b]			
	Method I		Method II		Method I		Method II	
	V_{acid}/V_{RCA}[c]		V_{acid}/V_{RCA}		V_{acid}/V_{RCA}		V_{acid}/V_{RCA}	
	2.5	5	2.5	5	2.5	5	2.5	5
1	12 ± 4	22 ± 6	27 ± 5	45 ± 8	14 ± 4	8 ± 3	11 ± 3	7 ± 2
2	23 ± 9	54 ± 8	33 ± 4	79 ± 6	10 ± 1	5 ± 1	7 ± 2	6 ± 1
3	35 ± 8	73 ± 4	57 ± 7	88 ± 2	12 ± 4	5 ± 1	8 ± 1	3 ± 1
4	43 ± 8	68 ± 2	59 ± 5	85 ± 8	11 ± 2	4 ± 1	7 ± 3	4 ± 1
5	51 ± 4	70 ± 7	55 ± 4	91 ± 4	7 ± 5	4 ± 1	6 ± 1	4 ± 2
6	48 ± 5	75 ± 7	50 ± 8	88 ± 3	7 ± 3	4 ± 1	7 ± 2	3 ± 1

[a]Mean values (for at least three samples) and deviations have been rounded to the nearest integer.
[b]The additional soaking duration (days) required in order to achieve the complete removal of mortar.
[c]Ratio between the volume of acidic solution and that of the RCA.

Table 4- Efficiency of acidtreatment methodsIII and IV at different acid concentrations in the removal of mortar from RCA

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Acid ($[H^+]$) Concentration, mol/l	Mortar Removed/Total Mortar, % by mass				Minimum Number of Repetitions Required in Order to Achieve Complete Removal of Mortar			
	Method III		Method IV		Method III		Method IV	
	V_{acid}/V_{RCA}		V_{acid}/V_{RCA}		V_{acid}/V_{RCA}		V_{acid}/V_{RCA}	
	2.5	5	2.5	5	2.5	5	2.5	5
1	23 ± 8	79 ± 6	37 ± 4	86 ± 7	5 ± 1	1	4 ± 2	1
2	35 ± 5	86 ± 5	44 ± 5	94 ± 4	3 ± 1	1	2 ± 1	1
3	47 ± 10	85 ± 8	42 ± 7	~100	3 ± 1	1	2 ± 1	0
4	44 ± 7	91 ± 4	67 ± 7	~100	3 ± 1	1	2 ± 1	0
5	56 ± 3	82 ± 6	77 ± 9	~100	3 ± 1	1	2 ± 1	0
6	55 ± 5	89 ± 3	70 ± 3	~100	3 ± 1	1	2 ± 1	0

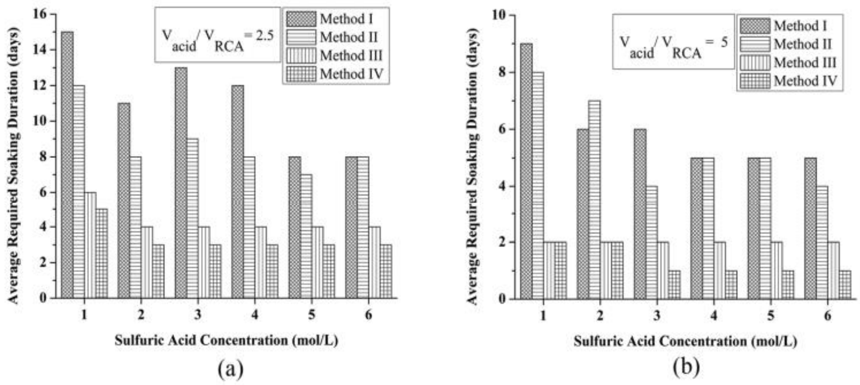

FIG. 2—*Averagesoakingdurationrequiredin orderto achievecompleteremovalof mortarfromRCAusingvariousacid treatmenttechniques atvarious sulfuricacidconcentrations andV_{acid}/V_{RCA}ratiosof(a) 2.5 and(b) 5.*

Relationships Between Mortar Content and Recycled Concrete Aggregate Properties:

The following lists the outcomes of tests for bulk density, 24-hour water absorption, and Los Angeles abrasion resistance for RCA samples made using various mortar contents and according to the procedure described in the section "Production of Recycled Concrete Aggregate Samples with Variable Mortar Contents and Measurement of Properties."

Bulk Density and Water Absorption—Figs. 4 and 5 demonstrate, respectively, the relationship between the mortar content and bulk density (OD) of RCA for RCA/C30 and RCA/C60 samples. Additionally, the results of all bulk density measurements (combined results for RCA/C30, RCA/C60, and RCA/P samples) are compared in Fig. 6 to show the effects of variation in the parent concrete strength on the overall relationship between mortar content and bulk density. As shown in Figs. 4 and 5, the

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bulk density appeared to decrease practically linearly as the mortar content of RCA increased for both the RCA/C30.

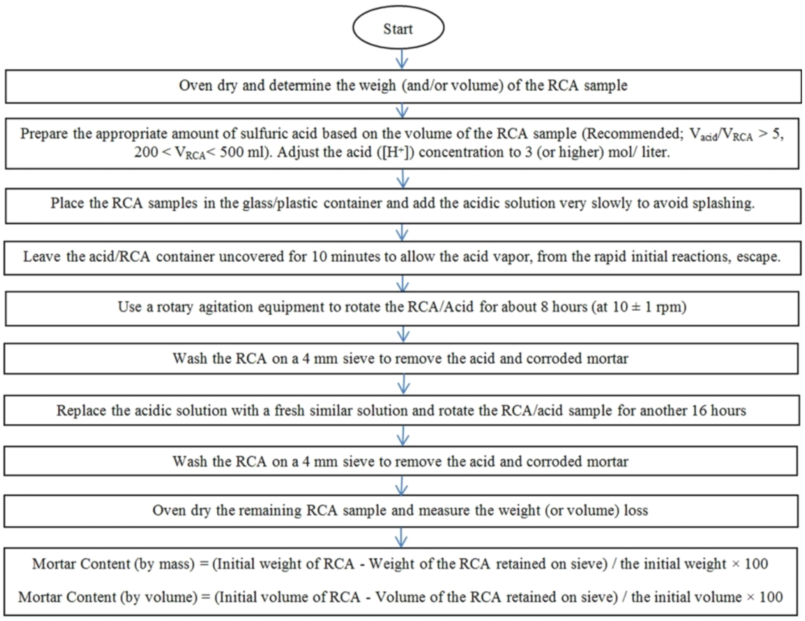

FIG.3—

TheproposedtestmethodfordeterminingthemortarcontentofRCA.

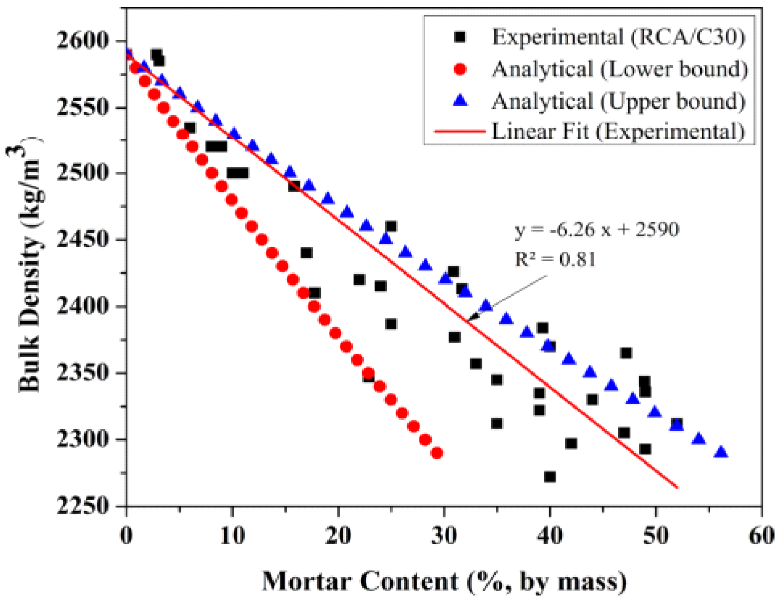

FIG. 4—*Comparison of analytical estimations and experimental measure-mentsofmortarcontentfortheRCAobtainedfromGrade30concrete.*

Additionally, Fig. 7 displays the connections between the mortar content and the water absorption of RCA for the RCA/C30, RCA/C60, and RCA/P samples. As

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anticipated, an increase in mortar content led to an almost linear rise in the water absorption of RCA because mortar is more porous than NA.

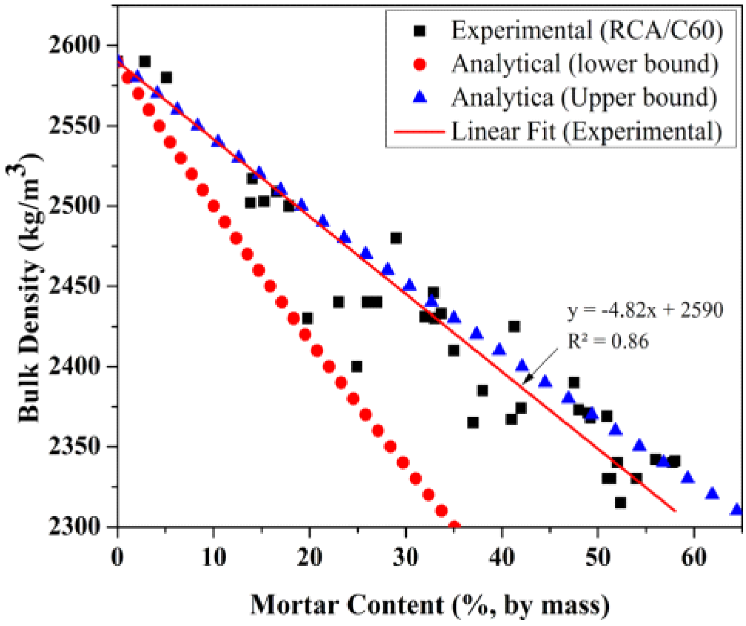

FIG. 5—*Comparison of analytical estimations and experimental measure-mentsofmortarcontentfortheRCAobtainedfromGrade60concrete.*

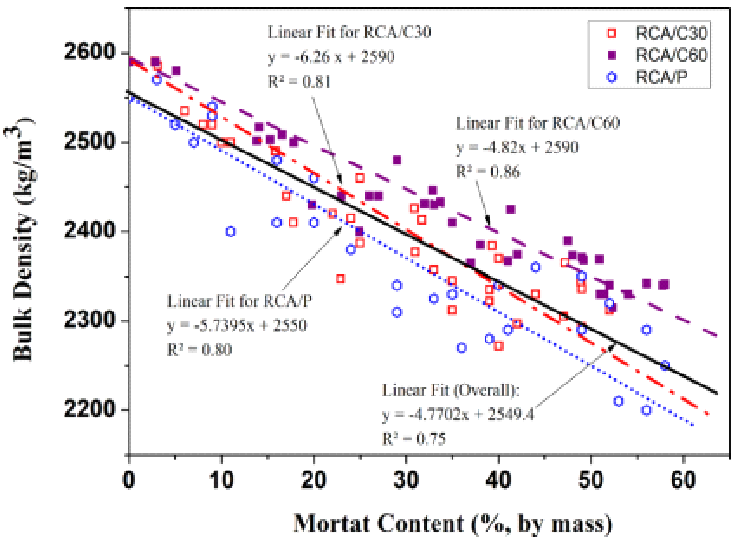

FIG.6—*RelationshipbetweenthemortarcontentandbulkdensityofRCA.*

The linear fit and the coefficient of determination (R2) for each linear regression were calculated in order to assess the predictability of RCA water absorption and density using the mortar content. These results are displayed in Figs. 4–7. As can be shown in Figs. 4–7, all three varieties of RCA had strong correlations between their bulk densities and water absorption and their mortar contents. In comparison to

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RCA/30 and RCA/60 samples, the RCA/P samples demonstrated a substantially reduced proportionality between the mortar content and their properties.

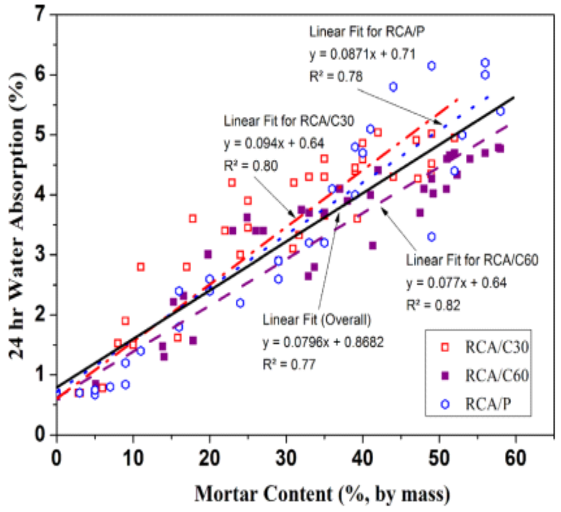

FIG. 7—*Relationship between the mortar content and 24-hour water absorp-tionof RCA.*

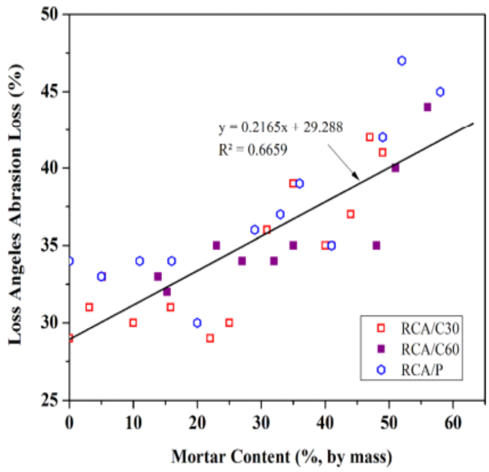

FIG. 8—Relationship between the mortar content and Los Angeles abrasionlossofRCA.

Fig. 8. As can be seen, there was a direct correlation between the Los Angeles abrasion loss and the RCA's mortar composition. This is due to mortar's typically lesser abrasion resistance compared to NA. The ability of aggregates to resist being worn down or broken off by impact, friction, and rubbing while being loaded as well as during handling, stacking, and mixing, is known as their abrasion resistance [19]. As a result, the mortar content's appropriateness as a gauge of RCA quality is supported by the linear relationship between the mortar content and abrasion loss.

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CONCLUSIONS:

For the purpose of determining the mortar content of coarse granitic RCA, a new testing method was put forward. Experimental and analytical proof of the proposed technique's dependability was provided. The variation of RCA characteristics with mortar content was examined using the proposed measurement approach. The findings demonstrate fairly linear connections between the bulk density, Los Angeles abrasion loss, and 24-hour water absorption of RCA and its metal concentration. The findings also demonstrate that change in mortar strength did not appear to have a significant impact on the association between mortar content and RCA qualities when a same type of NA was utilised. Determining the mortar composition may therefore be regarded as a valid test for assessing the overall quality of RCA and, consequently, the effectiveness of the recycling procedure utilised for RCAs produced from concretes with roughly identical coarse NA (type and quality). When proportioning concrete mixes cast with RCA, the measured mortar content of the RCA may also be used to estimate how much new mortar is needed.

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USE OF MARBLE AND GRANITE DUST WASTE AS PARTIAL REPLACEMENT OF FINE AGGREGATES IN CONCRETE

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ABSTRACT

The rapid depletion of the accessible natural resources was caused by the expansion of infrastructure development. Contrarily, the manufacture of marble and granite has resulted in an enormous amount of by-products in the form of fine particles, which has led to widespread environmental degradation. Due to the disposal of this million tonnes of fine particles, this has raised significant concerns in the environmental as well as the building industries. The goal of this project is to conduct an experimental investigation into whether marble and granite dust by-products can partially replace fine particles in concrete.

In this work, cement is partially replaced with slag (GGBS) by a ratio of 40% and a mixture of marble and granite dust in a ratio of 0.5:0.5 is used as a for substituting sand in various percentages (10%,20%,30%,40%,50%) by weight. At curing ages of 7 and 28 days, the effects of sand replacement on the strength behaviour of concrete were examined, and the results were contrasted with those obtained from using regular concrete blocks. In comparison to controlled concrete, a 20% replacement of fine particles with a marble and granite dust mixture increased compressive strength by 23.34% and 14.4% at 7 and 28 days of curing.

Keywords: Marble dust, Granite dust, Partial replacement, Compressive strength**.**

1.INTRODUCTION:

India is home to a variety of rocks and minerals, the most of which are from the state of Rajasthan. Granite, marble, limestone, sandstone, quartzite, slate, etc. are all abundantly found there. Tones of solid waste are produced worldwide, with the stone industry accounting for a sizable portion. Due to its non biodegradable nature, this trash can seriously harm the environment if improperly managed or the rate at which it is produced is not carefully observed. If adequate measures aren't implemented to decrease its production, these wastes could pose a serious hazard to the ecology. In addition to lowering the amount of trash produced, steps must be done to efficiently reduce or recycle these wastes. Therefore, handling these wastes has become increasingly important over the past few years. Recycling trash helps protect natural resources, cut down on energy use, and lessens emissions produced during the production of finished goods. lowered the greenhouse gas emissions responsible for

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the global warming. The cutting and polishing of stones generates a lot of trash, which is then disposed of in landfills that take up a lot of arable land. In turn, landfills effectively emit the dangerous gases that cause climate change.
The mining of marble has expanded dramatically in recent years. When limestone is subjected to the pressure and heat of metamorphism, marble is created. Mostly, it is a metamorphic rock. Calcite is the primary component of marble, which also typically contains mica, quartz, pyrite, and other minerals. Every year, India produces over one lakh cubic metres of granite fine. Granite is a light-colored igneous rock that is primarily made up of quartz and feldspar and was created when magma crystallized. Over 20% of the world's total granite resource is obtained as red, pink, grey, or white granite from dark mineral grains. The goal of the current study is to replace some of the natural sand while preserving it, using cement and GGBS as a cementations material and a combination of marble and granite dust as a partial replacement for natural sand. This activity is viewed as creating a long-term replacement for natural sand.

2.MATERIALSUSEDANDTHEIR PROPERTIES

2.1Cement:

Concrete uses cement as a binder. Throughout the project, Ordinary Portland Cement (OPC) of grade 53 conforming to IS 12269-1987 [7] was used. The cement was determined to have a specific gravity of 3.14.

Ground Granulated Blast Furnace Slag(GGBS)”

OPC was partially replaced with Ground Granulated Blast Furnace Slag (GGBS) Slag conforming to IS 16714 -2018 [8] from JSW Cement Limited. Utilising GGBS as a cement substitute lowers CO2 emissions while also preserving limestone resources. It was determined to have a specific gravity of 2.9, DLBD of 1050 kg/m3, and fineness of 386 m2/kg.

2.2 Super plasticizer:

Superplasticizers make highly workable concrete and reduce water content, boosting concrete strength. In this experiment, SC Maximoplast PC 300 according to IS 9103-1999 [9] was utilised.

2.3 Fine Aggregates:

Sand that is either manufactured or naturally occurring, or a combination of both, that is made up of sterile, long-lasting, spherical or cubical-shaped particles is referred to as fine aggregate. Dust, dirt, sludge, and other polluting elements should not be present in

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the fine aggregate. Fine aggregates range in size from 0.075 to 0.425 mm. In this experiment, M-sand that complied with IS 383-2016 [10] was utilised; it had a specific gravity of 2.75, a moisture content of 4.17%, and a water absorption rate of 4.5%.

2.3 Coarse Aggregates:

Coarse aggregates range in size from 20 to 4.75mm. They enhance the bonding properties and quality of the concrete, increasing its flexural strength. They assist in minimising shrinking. Coarse aggregates with a specific gravity of 2.85, a moisture content of 1.01%, and a water absorption value of 0.8% that conform to IS 383-2016 [10].

2.4 Marble dust:

Specificgravityofmarbledustwas2.33.Marbledustwhichwasusedaspartialreplacementofsandin concrete, was obtained from a quarry in Rajasthan.

Properties	Test results
Specific gravity	2.33
Colour	White
Form	Powder
Odour	Odourless
Fineness Modulus	2.03

Table1. Physical properties of marble dust.

2.5 Granite Dust:

The granite dust had a specific gravity of 2.23. Granite dust, which largely replaced sand, was also supplied from a Rajasthani quarry.

Properties	Test results
Specific gravity	2.23
Colour	Grey
Form	Powder
Odour	Odourless
Fineness Modulus	3.7

Table2.Physical properties of granite dust**.**

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3.TESTING OF MATERIALS

3.1 Specific gravity test:

Table 3 contains the results of a specific gravity test performed in accordance with IS:2386 (Part III)-1963 [11] on fine aggregates, coarse aggregates, marble dust, and granite dust.

Materials	Specific gravity
Fine aggregate	2.75
Coarse aggregate	2.85
Marble dust	2.33
Granite dust	2.23
50% Marble dust+ 50% Granite dust	2.27

Table3. Specific Gravity Test Results.

3.2 Sieve Analysis:

Fine aggregates, marble dust, and granite dust were all subjected to sieve examination both individually and when mixed in a proportion of 50% each. The tests were performed in accordance with IS:383-2016 [10], and table 4 lists the results obtained. The particle size distribution of marble dust, granite dust, and a combination of the two is shown in Figure 1.

Description	Fineness Modulus	Zone
Fine aggregate	2.87	II
Marble dust	2.03	IV
Granite dust	3.7	I
50% Marble dust+ 50% Granite dust	2.82	III

Table4. Sieve Analysis Test Results.

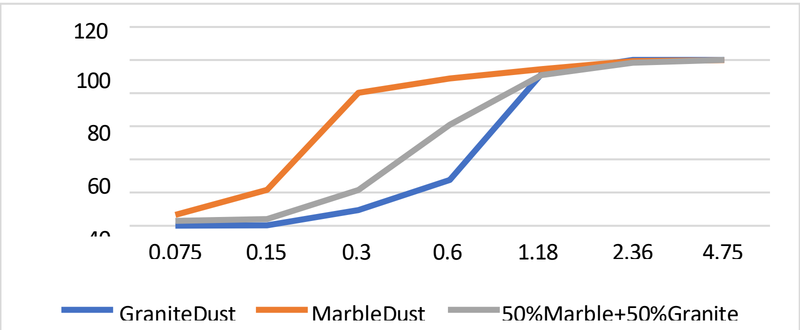

Figure1. Particle size distribution.

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3.3Dry Loose Bulk Density: According to IS 2386 (Part III)-1963 [11], a dry loose bulk density test was performed on fine aggregates, marble dust, and granite dust. The findings are shown in table 5.

Table 5. Dry Loose Bulk Density (DLBD) of Samples.

Material	DLBD
Marble dust	1.41 kg/L
Granite dust	1.45 kg/L
50% Marble dust+ 50% Granite dust	1.43 kg/L

Moisture Content : According to IS:2720 (Part II)-1973 [12], a moisture content test was conducted on fine aggregates, coarse aggregates, marble dust, and granite dust. The findings are shown in table 6.

Table 6. Moisture Content of Samples.

Material	Value (%)
Fine aggregate	4.17
Coarse aggregate	1.01
Marble dust	0.28
Granite dust	1.52
50% Marble dust+ 50% Granite dust	0.88

4.MIX PROPORTION:

The M25 grade concrete was created in accordance with IS:10262-2019 [13] and IS:456-2000 [14], and table 7 lists the weights of the ingredients used. A total of 36 150x150x150mm cubes were cast, and after 7 and 28 days, they underwent compressive strength tests. A mixture of 50% marble trash + 50% granite waste belonging to zone III classification was employed in these trials because marble belongs to zone IV classification and granite dust belongs to zone I classification and are not suitable to be used for construction activities.

Table 7. Mix proportion.

Sr. No.	Description	Mass (kg/m³)					
	Trials	Trial 1	Trial 2	Trial 3	Trial 4	Trail 5	Trial 6
	% Replacement	0%	10%	20%	30%	40%	50%
1	Cement	204	204	204	204	204	204
2	GGBS	136	136	136	136	136	136
3	Fine Aggregate	748.52	673.668	598.816	523.96	449.112	374.26
	Marble Powder	0	35.67	71.34	107.02	142.69	178.36
	Granite Powder	0	35.67	71.34	107.02	142.69	178.36
4	Coarse Aggregate	1257.52	1257.52	1257.52	1257.52	1257.52	1257.52
	10mm	498.04	498.04	498.04	498.04	498.04	498.04
	20mm	759.48	759.48	759.48	759.48	759.48	759.48
5	Water	162.96	165.23	169.99	173.48	177.66	180.5
6	Water-Cement Ratio	0.47	0.47	0.47	0.47	0.47	0.47
7	Superplasticizer	1.02	1.02	1.02	1.02	1.02	1.02

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Figure 2. Filling of concrete moulds.

Figure 3. Curing of concrete blocks.

Figure 4. Compression testing machine.

5.RESULTS AND DISCUSSIONS

Test on Fresh Concrete:

According to IS 456-2000, the slump cone test was used to gauge the fresh concrete's workability [14]. It was discovered that genuine slump was present in every case of replacement. Table 8 presents the findings.

Table 8. Slump Test Values.

% Replacement	W/C Ratio	Slump Values
0%	0.47	117
10%	0.47	114
20%	0.47	111
30%	0.47	109
40%	0.47	107
50%	0.47	104

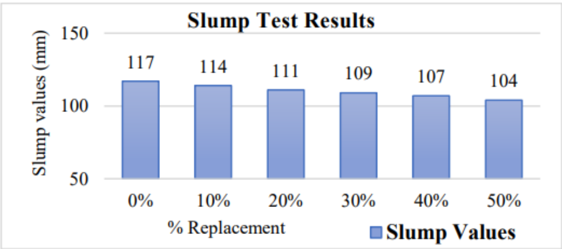

Figure 5. Slump test results.

Test on Hardened Concrete:

According to IS:516-1959 [15], compression strength tests on hardened cubes were performed at 7 and 28 days. The results are shown in table 9. The compressive strength at 7 days and 28 days is shown in Figures 6 and 7.

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Table 9. Compressive Strength Test Results.

Sr. No.	% Replacement	7 days strength N/mm²	28 days strength N/mm²
1	0%	26.22	37.06
2	10%	31.63	40.98
3	20%	32.34	42.41
4	30%	30.02	39.25
5	40%	28.36	37.63
6	50%	24.05	35.60

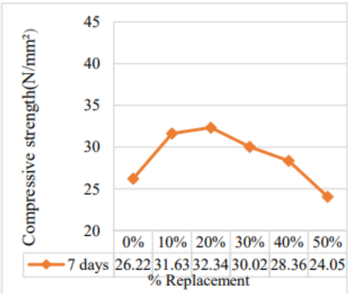

Figure 6. Compressive strength at 7days.

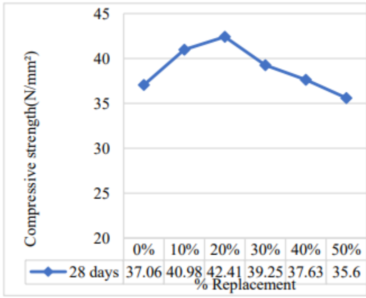

Figure 7. Compressive strength at 28 days.

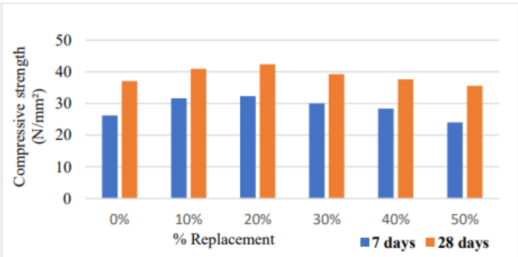

Figure 8. Compressive strength comparison.

The compressive strength of various concrete mixtures at 7 and 28 days is shown in Figure 8. According to the findings, all of the mixes that included granite and marble dust had compressive strengths that were closer to those of the control mix. According to the findings, the highest compressive strength is achieved when 20% of fine aggregates are replaced with a mixture of marble and granite dust waste. At 7 days, the compressive strength at 20% replacement was 32.34 N/mm2, whereas at 28 days, it was 42.41 N/mm2. At 7 days and 28 days, respectively, the strength increased by 23.34% and 14.43% in comparison to the control mix results.

Young’s Modulus or Modulus of Elasticity of Concrete :

Concrete's Young's modulus, Ec, which can be computed using equation (1), is referred to as the material's measure of stiffness.

$$E_c=5000\sqrt{f_{ck}} \qquad (1)$$

Young’smodulusfordifferentmixesisgivenintable10.

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Table 10. Young's modulus.

Mix	Young's Modulus (MPa)
Control Mix	30.44
10% replacement	32.00
20% replacement	32.56
30% replacement	31.32
40% replacement	30.67
50% replacement	29.83

High performance concrete has a stiffer structure because its elastic modulus is higher than that of conventional strength concrete. At 20% and 50% replacement of fine aggregates with a mixture of marble and granite dust, respectively, the highest and lowest elastic modulus are obtained. Even though IS:456-2000 [14] recommends equation (1) for conventional concrete, there may not be many differences between it and Young's Modulus of concrete with marble and granite waste, which can be calculated from plot of stress-strain curve for the aforementioned mixes.

6.COST ANALYSIS

Marble dust and granite dust have been separately tried as partial replacement of sand in mortar and concrete. In the present study, use of various combinations of marble dust and granite dust mixed together in various proportions for better performance of concrete and also to reduce the cost of concrete, was taken up. Normally, marble and granite dust is obtained from quarries and also from the sellers of these tiles. Since it is waste product, it is available almost free of cost. Sand used in concrete or mortar is either natural sand or manufactured sand whose cost varies from place to place.

Table 11 lists the material costs based on local market prices that were used in the current investigation. Although marble and granite dust are currently freely available, only a small amount is envisioned to account for transportation costs. Table 12 displays the % savings in material costs overall and in the cost of sand alone. As can be shown, using artificial sand in place of natural sand to the amount of 20–40% can reduce costs by roughly 20–40% without compromising the strength of the resulting concrete. In light of the prohibition or restriction on the extraction of natural sand from rivers, which causes environmental issues, this savings is rather significant.

Table 11. Material cost assumed in the present study.

Material	Cement +Slag	Coarse aggregates	Fine aggregates (Sand)	Marble dust	Granite dust	Water	Admixture
Cost per kg in Rupees	7	1.6	1.5	0.02	0.02	0.025	150

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Table 12. Saving in material cost.

Percentage replacement of sand (%)	7-Days Strength (N/mm^2)	28 - Days strength (N/mm^2)	Cost per cu.m. of concrete (Rs.)	Percentage saving in sand (%)	Percentage saving in overall material cost (%)
0	26.22	37.06	5671.89	0	0
10	31.63	40.98	5561.09	9.87	1.95
20	32.34	42.41	5450.36	19.75	3.91
30	30.02	39.25	5339.59	29.62	5.86
40	28.36	37.63	5228.74	39.49	7.81
50	24.05	35.6	5118	49.36	9.77

7. CONCLUSIONS

The slump test indicates a low workability mix as compared to conventional concrete by showing a decreasing trend with an increase in the percentage replacement of fine particles with a mixture of marble and granite dust. This may be explained by the fact that finer dust particles require more cement and water for hydration since they have a bigger surface area than natural or synthetic sand. At 20% replacement of aggregates with a mixture of marble and granite dust, which is higher than conventional concrete by 23.34% and 14.43%, respectively, the maximum compressive strength of concrete is obtained at both 7 and 28 days.Compressive strength increased up to a replacement of 20%, after which it started to decline and eventually fell below that of conventional concrete at a replacement of 50%. At 20% and 50% replacement of fine aggregates with a mixture of marble and granite dust, respectively, the highest and lowest elastic modulus are obtained. The replacement of 20–40% of the sand results in savings of 20–40% when the cost of sand is taken into account. The savings in material costs range from 4 to 8%.To identify its usefulness in routine RCC works, more research on these materials can be done by examining the strength behaviour (split tensile and flexural strength) and durability features (carbonation tests, fire test, etc.).

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SOIL EROSION CONTROL IN SLOPES BY USING COCONUT FIBER MATS AND WOOD WOOL MATS

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ABSTRACT

Soil erosion is a common challenge faced by geotechnical engineers, occurrings naturally in the environment due to wind, water, and gravity. The loss of soil from the land surface can be detrimental to both terrestrial and aquatic environments by depleting nutrients, increasing runoff and affecting aquatic life. Plenty of methods that can be used to control soil erosion. One of the common ways is using erosion control mat such as geotextile, turf reinforcement mats and fibromat biodegradable. The problems with the current mat are the manufacturer is focusing on the duration of the mat to decompose without considering the effectiveness to help vegetation grow. Through this research, the biodegradable erosion control mat was fabricated by using coconut coir as the main material (known as a coir mats) to promote the growth of vegetation roots, thereby reducing soil erosion. The research aim is to investigate the effectiveness of coir mats by monitoring vegetation roots growth whilst soil strength was evaluated by determining its shear strength, both with coir mat and without coir mat via Direct Shear Test. From visual observation, the results showed that the vegetation roots best developed in the soil covered with coir mat, where the fibrous of roots with coir mat is significantly uplifting compared to without coir mat. Besides that, the cohesion of soil for both with and without coir mat is 0 kN/m2 and it validated that the soils have the same water content during the test. However, the friction angle of the soil with coir mat is lower than without coir mat. This due to the smaller coir mat opening size, thereby affect the penetration and development of the vegetation

Keywords: ASTM D625, BS1377, coir mat, vegetation root, shear strength, slope vegetation, soil erosion

1. INTRODUCTION

Almost all development in hilly areas consists of cutting and filling. Hence, it is easily exposed to erosion and needs an urge to cover. Erosion mitigating measures shall be installed or constructed before commencement of site clearing and earthworks. This includes planning for ‘work in stages’ and also plans for diverting as much as possible surface runoff from the work areas. It should lead to trouble free slope. This involves all cut and exposed areas to be protected during and after construction against water and all fill areas to be well packed and similarly protected [1]. Construction of slopes therefore plays a very large role in behaviours of slope during the service. Bad slopes construction will require a lot of maintenance since they are very easily affected by the action of water leading to endless problems from erosions, settlements, seepages and slips to landslides [2]. Many methods have been introduced to control soil erosion. One of the common method is using erosion control mat such as geotextile, turf reinforcement mats etc. Erosion control mat should be established on patchy and barren slope faces or terraces to reduce erosion [3]. Such mats act as miniature dams and prevent the seeds or seedlings which used to be washed away by rain and wind and facilitating the growth [4]. Recently, erosion control mats by biodegradable materials have gained popularity to protect disturbed slope and channel areas from wind and water erosion [5]. The biodegradable mat materials are natural or by-product materials such as straw, wood excelsior and agricultural fibres mats. Erosion control mats can be effective in minimizing the erosive effect of rainfall when used to cover bare or newly planted soil. Besides to control soil erosion, they also effectively to protect new vegetation and reduces the potential for introducing sediment into storm water run-off. Iannotti [3] stated that the vegetation can stabilize soil and prevent erosion on steep slopes by binding loose soil with roots and slowing the passage of water down the slope. Replanting disturbed locations after construction with a combination of trees, shrubs and ground/soil cover is key. Pueraria Phaseoloides is one of the tropical forage with deep-rooted characteristics that are potential for soil erosion control. This species native to China and South East Asia and well adapted to numerous soils types and no significant pest and diseases was reported by Tian et al. [6]. Pueraria Phaseoloides becomes one of the cover crops chosen for soil erosion control since 1920s [7]. This species able to increase soil permeability and have been proved with research done by Pardomuantambunan et al. [8]. Vegetation roots can increase soil physical properties and strengthening soil infiltration. The roots system is able to reduce surface runoff in which it is important to minimize erosion [6]. Seedling growth of tropical kudzu is only moderately vigorous during the first 3-4 months [8]. Seedling vigour is superior to other cover crops such as Centro (Centrosema Pubescens Benth.) and Calopo (Calopogonium Mucunoides Desv.) [8]. Once established, it is very vigorous and quickly smothers weeds. In Malaysia, it reaches 60-70% cover after about 4 months and 90-100% after 8 months. It can form a tangled mat of vegetation 60-75 cm deep [8]. The maximum slope to be considered for vegetative stabilization is 1.5 horizontal to 1.0 vertical (1.5H: 1.0V). There are many good vegetation in the form of grasses, vines, shrubs a minor tree that can be used for slope stabilization projects. Vegetation selection is dependent upon the goals of erosion control program and site conditions. Typically, effective programs incorporate structural diversity in vegetation selections (trees/shrubs with ground covers) and use a mix of species [3]. Planting practically depends greatly on the character of the slope and particularly on the slope angle. A slope of 1.5H:1.0V (33 degrees) should be considered the dividing line between a manageable slope and a slope steep enough that vegetation would be difficult or impossible to establish without employing other reinforcement [3]. Furthermore, in an observation-based study by SBMS Group Malaysia, the steeper the slopes, the higher the shear stress and velocity.

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This study is focusing on the performance of coir mat in helping the growth of vegetation roots in order to reduce the erosion of soil and to identify shear strength parameter of soil with and without coir mat. The problem occurred with soil erosion is not only happened off-site but also on-site. The loss of soil from the land surface can be detrimental to both terrestrial and aquatic environments by depleting nutrients, increasing runoff and affecting aquatic life [9]. With one aim, to minimize the effects of water erosion on slopes, the material used in this research is coconut coir. This material degrades slowly, allowing vegetation that will be vegetation in the area to grow and take over the job of protecting the soil from erosion when the mats have finally degraded completely [4, 10]. In planting, coconut coir is used as a soil amendment [3]. It improves the air porosity of soils, even when wet, and aids in moisture retention. Coir absorbs 30 percent more water and much easier to re-wet, when dry. It helps loosen the texture of clay soil and improve drainage. It also allows the sandy soil to hold onto water longer [4]

2. MATERIALS AND METHODS

Two main materials were used in this research are coconut coir and Pueraria Phaseoloides seeds. The coconut coir was collected from T&H Coconut Fibre Sdn Bhd, Batu Pahat, Johor. While seeds of Pueraria Phaseoloides was collected from Ladang Tabung Haji Bukit Lawiang, Kluang, Johor. In this research, coconut coir was used for to produce coir mat as an alternative for helping Pueraria Phaseoloides roots to grow on the soil, thus protect the soil against erosion. The success of the coir mats in – promoting the vegetation's roots growth was analysed by visual monitoring. However, the soil strength with and without coir mats has been examined through a Direct Shear Test.

3.1 Fabrication of Coir Mat – ASTM D6525

The coir mats are fabricated in 297 mm length, and 210 mm width with thickness 6 mm as per refer to ASTM D6525 – Standard Test Method for Measuring Nominal Thickness of Rolled Erosion Control Products [11]. The coir mats were mainly produced at Composite Technology Workshop, UTHM Pagoh, Johor. 80 g of coconut coir was placed in a steel mould and then inserted it between two hot press plates. The coconut coir is compressed using Hydraulic Moulding Press Machine at a temperature of 160°C temperature with 30 kN pressure for 15 minutes.

2.2 Sample Preparation

The loam soils are placed into containers which have the same size as the coir mat. Firstly, put soil half of the container. The soil used was collected from Tan Ah Hwang Nursery, Muar, Johor. Next, loosen the top of the soil and make sure that the top of the soil is free from disturbance. 0.5 g of seeds was planted at 4 points inside the loam soil in every container. All seeds must be soaked for 6 hours in warm water to fasten the germination. The coir mats were then installed on the top of soil surface. However, the coir mat needs to be immersed in the distilled water for 15 minutes before used. After all the above procedures is done, spread 7 g of Egyptian Rock Phosphate (ERP) fertiliser on top of the soil and water it. This fertiliser was collected from SRAT Sdn Bhd, Simpang Renggam, Johor.

2.3 Testing

2.3.1 Visual Inspection Test

The visual inspection test was carried out to investigate the effectiveness of coir mat for growth of vegetation roots in order to reduce the soil from erosion. There are 8 samples were tested, where 4 samples were covered with coir mat on top of the loam soil whilst the other 4 samples were coverless. The progress of the vegetation roots was monitor by measuring the growth of vegetation in terms of length and fibrous every 7 days for a month. 2.3.2 Direct Shear Test – BS1377 Part 7 Direct Shear Test was conducted at Geotechnical Engineering Technology Laboratory, UTHM Pagoh, Johor. The aim of this test is to determine the shear strength parameters (include cohesion and friction angle) of soil with and without coir mat. This test was conducted followed by BS1377 Part 7 – ShearStrength Test (Total Stress) [12].

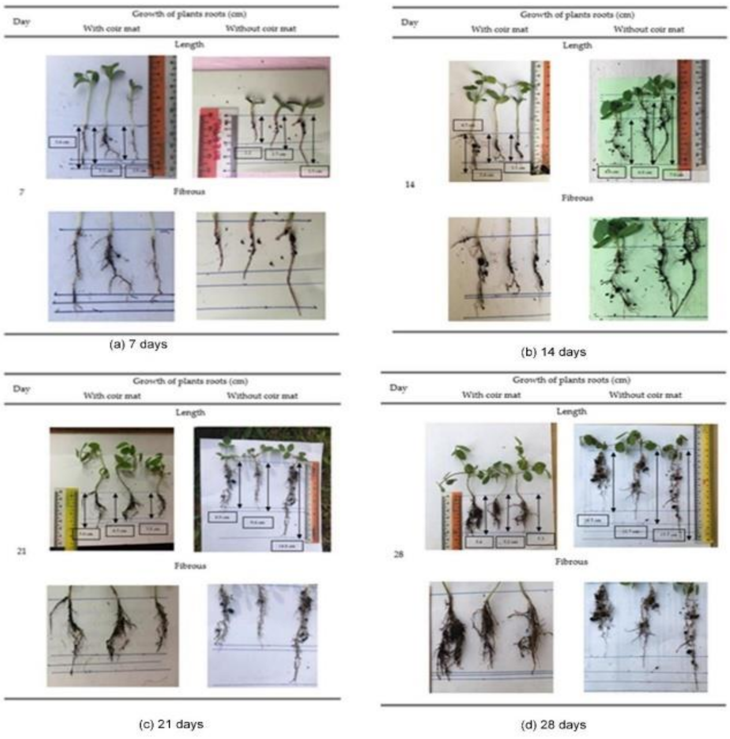

Figure 1 comparison growth of pueraria phaseoloides roots with and without coir mat

The tests were performed on test samples of 60 mm square and 26 mm thickness. It is placed in a square box which is split into upper and lower halves. The constant horizontal shear force is applied to the upper half of the shear box with a shear rate of 0.5 mm/min. Three identical soil samples were tested under different normal load namely 1.0 kg, 2.0 kg and 3.0 kg for both soil conditions, which are with and without coir mat, respectively.

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3. RESULTS AND DISCUSSION

3.1 Vegetation Development

The visual observation of the development of Pueraria Phaseoloides roots with and without coir mat at different days (7, 14, 21 and 28 days) are shown in Figure 1. Based on its fibrous, roots were best developed in the soil covered with coir mat. It can be seen since days 7 where the fibrous of the roots with coir mat is uplifting compared to without coir mat. Even though roots without coir mat is longer than with coir mat, but the fibrous of the roots is influencing its hold towards soil. Therefore, coir mat does not significant in increasing length of roots but it does significant in increasing the fibrous of roots. Fageria and Moreira [13] stated that the stronger the roots hold soil, the lesser the potential of soil to erode as roots bind soil particles at the ground surface reducing their susceptibility to erosion which is beneficial to slope stability

Table 1: Comparison growth of roots length with and without coir mat

Visual Inspection Test		
Durations	**With Coir Mat (cm)**	**Without Coir Mat (cm)**
7 days	3.3	2.8
14 days	3.7	6.2
21 days	4.4	11.1
28 days	5.4	12.9

Based on Table 1, only days 7 shows the average length of roots with coir mat longer than without coir mat. Differ for the following days, where length of roots with coir mat is shorter than without coir mat. Dasaka and Sumesh [14] claimed that the increasing nutrient supplies in the soil may also decrease root length but increase root weight in a quadratic fashion. Roots with adequate nutrient supplies may also have more root hairs than nutrient-deficient roots [14]. Thus, coir mat can help in increasing nutrients supplies in the soil along with helping vegetation get established to reduce soil erosion.

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3.2 Shear Strength Characteristics

Figure 2 indicates the shear strength parameters are envelopes through the relationship of shear stress versus normal stress based on the peak shear strength obtained from Direct Shear Test.

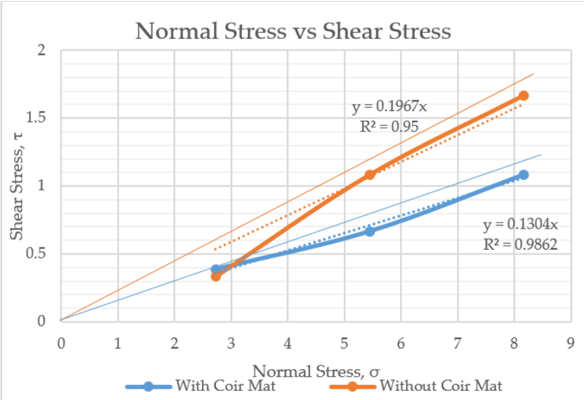

Figure 2 Mohr – Coulomb criterion of failure

Table : showed the summary of the shearing resistance (cohesion and friction angle) of the soils, with and without coir mat. The cohesion of soil for both with and without coir mat is 0 kN/m^2 and it validated that the soils have the same water content during the test. Moreover, it was shown that the loam soil is non-cohesive soil as it does not have cohesive forces. Thus, the particles have internal friction and their shear strength depends upon the angle of internal friction between particles. The results showed that the soil with coir mat had a lower friction angle than without coir mat. This may be attributed to the limited opening sizes of coir mat in forms of apertures such that vegetable roots are not able to penetrate. Thus vegetable growth does not progress generously. Nonetheless, Sidhar and Prathapkumar [15], Sidhar and Prathapkumar [16] and Rahman, Musa & Jeni [17] reported that the reinforcement of coir mat on soil can help in strengthening shear of soil.

Table 2 Comparison growth of roots length with and without coir ma

	With Coir Mat	**Without Coir Mat**
Cohesion, c kN/m^2	0	0
Friction Angle, Φ	7.4°	11.1°

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4. CONCLUSION

The paper presents is to investigate the effect of coir mat on vegetation root growth and soil strength. The visual observation revealed that the roots were better developed in the soil covered with coir mat. However, no significant effect has been seen on the shearing resistance of soil with and without coir mat. Through the observation, it can be

inferred that the opening size is one of the significant parameters that should be considered in the fabrication of the coir mat, where the large opening size helps the vegetation to penetrate and grow rapidly as reported by Paz et al. [18]. The following suggestions have been drawn for further research.

a. Pueraria Phaseoloides seeds can be planted directly on the ground or even on the slope without using container so that it is more similar to an actual situation when applied on site.

b. Coir mat can be designed with different opening size such as 10 mm, 20 mm and 30 mm.

c. Prepare soil sample at different water contents.

d. Conduct the Tensile Strength Test to identify the strength of coir mat and roots.

e. Safe precautions should be practised before conducting Direct Shear Test to prevent soil from disturbed.

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EXPERIMENTAL INVESTIGATION OF CONCRETE PARTIAL REPLACEMENT OF CEMENT BY LIME POWDER IN CONCRETE

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ABSTRACT

An experimental inquiry is carried out to explore the behaviour of concrete by substituting locally available red soil for the fine aggregate. It entails a series of tests to see how the quality of concrete improves when red soil is put to it. To achieve good concrete strength, sand was partially replaced with red soil according to the particular mix proportion. Previous scientific research have found that increasing the amount of red soil reduces the strength of concrete and causes it to absorb more water. As a result, in our project, lime powder is also mixed into the concrete to prevent water absorption and porosity. In this project, the strength of M20 concrete is recommended, and the amount of red soil is to be put in the following percentages: 15%, 30%, and 45%. To differentiate the strength and imperviousness of red soil mixed concrete and plain concrete, mechanical parameters such as compressive strength, split tensile strength, and flexural strength tests were performed. The tests are performed on the seventh, fourteenth, and twenty-eighth days after cure.

Key words **:** lime powder , porosity , water absorption

1. INTRODUCTION

There is a scarcity of sand nowadays, and it has become quite difficult to obtain sand in an economical manner. Overcoming this issue is critical for researching alternate materials. Some alternate material must be discovered in order to meet the fine aggregates requirement. As a result, it is envisaged in this project to conduct an experimental activity by preparing concrete blocks with a partial substitution of fine aggregate by available natural red soil. Sand is a fundamental component of mortar and concrete preparation and plays a critical role in mix formulation. Due to the extensive usage of concrete and mortar, natural sand is generally consumed at significant rates. Because of this, developing nations have a very high demand for natural sand to keep up with the expansion of their infrastructure.So, for these projects, we used red soil. All types of areas have red soil availability, and it has unlimited resources everywhere that can be used to mix red soil into concrete to build structures. Weathering of igneous and metamorphic rocks results in the formation of red soil. Due to its size and the presence of iron in it, it turns red when mixed with concrete and becomes extremely impervious.

2. MATERIALS

2. 1 Cement:

In these concrete, regular Portland cement grade 43 was used.

2.2 Fine aggregate:

Locally available nature river sand to be used.

2.3 Coarse aggregate

A well graded nature aggregate to be used in the concrete.

2.4 Lime powder

A fine lime powder is to used in concrete even it will give good result .Thus, Hydraulic lime is best one suitable for concrete

Objectives:

• To make red soil-mixed concrete more durable than conventional concrete.
• To decrease the amount of fine aggregate used in concrete;
• To decrease the porosity and water absorption of concrete made with red soil;
• To produce high strength using more efficient methods

3. PROPERTIES OF MATERIALS

3.1 Cement:

The cement serves as a binding substance. It meets IS456-2000-53 grade requirements. The process entails grinding the raw materials, mixing them thoroughly in a specific ratio based on their purity and composition, and then burning them in a kiln at a temperature of between 1300 and 1500 degrees Celsius, at which point the material Cinters and partially fuses to form modular chapped clinker. In order to create Portland cement, the clinker is cooled and ground to a fine powder with the addition of 2 to 3% gypsum. Because it is used to bind sand and aggregate and because it resists atmospheric action, cement is the most significant ingredient of all the materials that affect how concrete behaves.

Coarse Aggregate, Fine aggregates are materials with a size less than 4.75 mm. Fine aggregate is often made of natural sand. As fine aggregates in this experimental work, crushed sand with a fineness modulus of 3.2 that complies with IS - 383 - 1970 grading Zone III was employed to replace the river sand.

3.2 *Fine Aggregate*

3.2.1 *Specific gravity*

This test is done by le Pycnometer apparatus. And the value of specific gravity of cement is 3.14.

3.2.2 Void Ratio & Porosity

The void is also done in pycnometer that value is .And use the relation to determine the porosity value as 0.409 & 29.02%

3.2.3 Sieve Analysis

The sieve analysis is used determine the fineness modulus and zone grading of aggregate as 3.11 and zone III respectively.

3.3 *Coarse Aggregate*

3.3.1 Specific Gravity

This test is done by le Pycnometer apparatus. And the value of specific gravity of cement is 3.54.

3.3.2 Sieve Analysis

The fineness modulus and zone grading of the aggregate are determined using the sieve analysis and are 2.69 and zone III, respectively.

3.4 *Test for Water Absorption*

In essence, the aggregate does not absorb any more water. It merely takes in a little fraction of 0.96%.

3.4.1 Effect Test

To ascertain the impact strength, the test can be carried out in a toughness testing equipment. This amount is 16.30%.

3.4.2 Form Test

The flakiness and elongation tests are two examples of the form tests. The aggregate's shape, thickness, and length are primarily determined by this.

4. Cement

4.1 Specific Gravity

This test is done by le chartelier's apparatus. And the value of specific gravity of cement is 3.14.

4.1.2 Fineness Test

The fineness value of the cement is 3.63% from 1 kg of thecement sample.

4.1.3 Initial & Final Setting Time

The initial and final setting time of the cent is done in vicat apparatus.The determined value of initial and final setting time of cement is 30min & 600min respectively.

4.1.4 Mix Design

The process of choosing appropriate concrete ingredients and figuring out their relative proportions with the goal of creating concrete with a specific maximum strength and durability as affordably as possible is known as mix design.

5. Mixing of concrete

Concrete manufacturing must be done with extreme precision at every stage to produce concrete of the highest quality. The final concrete will be of poor concrete if thorough attention is not taken and proper regulations are not followed. Therefore, in order to produce concrete of high quality, we must be aware of the good guidelines that should be followed at each stage of the manufacturing process.
1. Batching 2. Mixing 3. Placing 4. Compacting 5. Curing

5.1 Batching

The proper way to measure the materials is via batching. Always use a weigh batching method when pouring crucial concrete. Utilizing a weight system for batching promotes accuracy, adaptability, and simplicity. There are various weigh batchers available, including the Depending on the job, a certain type may be employed. When weigh batching is used, water must be precisely measured using measuring jars.

5.2 Mixing

When mixing concrete on a small scale, hand mixing is used. An impervious brick or concrete floor big enough to hold one bag of cement should be used for hand mixing. Alternately layer the measured amount of coarse aggregate and fine aggregate. Pour the cement on top of it, then mix the dry ingredients together using a shovel, rotating the mixture repeatedly to achieve colour homogeneity. This consistent mixture is dispersed with a thickness of roughly 20 cm. This process is carried out until a good uniform, homogenous concrete is produced. It is of utmost importance to ensure that the water is merely sprinkled, not poured. Even a small amount of water makes a difference at that point. The red dirt is then added to the concrete at various concrete percentages, and half as much lime powder is also put to the concrete**.**

5.3 Placing

The concrete must be placed in a systematic manner in order to get the best results; it is not enough for the concrete mix to be properly formulated, batch-mixed, or poured. the safety measures and techniques to use when pouring concrete into moulds.

5.4 Compaction

For modest concrete projects, hand compaction of the concrete is used. This technique is occasionally utilised in situations involving a significant amount of reinforcement that cannot ordinarily be compacted mechanically. Rodding, ramming, or tamping are the methods used for hand compaction. Concrete is kept at a high level of consistency when hand compaction is used. Tamping is one of the often used techniques for compacting road pavements, floor slabs, and roofs when the thickness of the concrete is relatively thin and the surface needs to be finished flat and level.

5.5 Curing

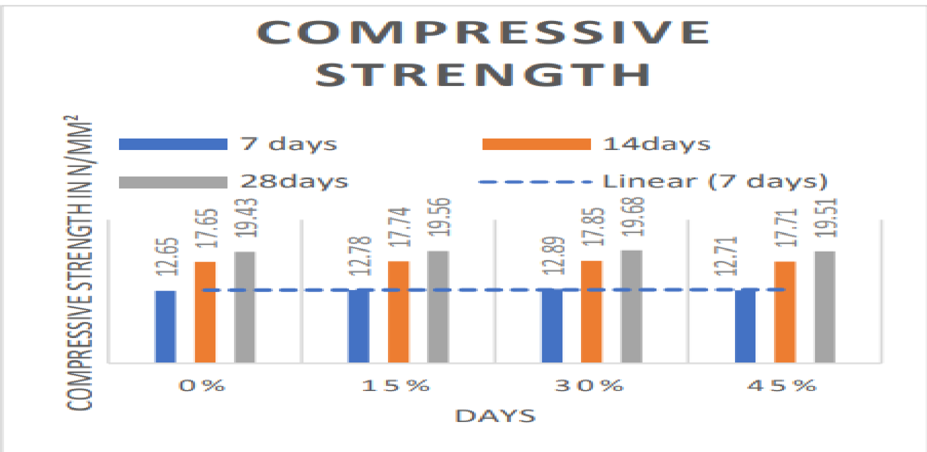
When cement particles hydrate, concrete gains strength. Cement hydration is a lengthy process rather than an instantaneous one. Keeping the concrete moist and warm enough to allow the cement to continue to hydrate is another way to explain curing. More specifically, it is the process of preserving an acceptable moisture content and a comfortable temperature in concrete for the first few hours after placement, allowing the cement to continue to hydrate until the desired properties are sufficiently developed to meet the needs of service. For 7, 14, and 28 days, the cast cubes and cylinders are submerged in water tanks.

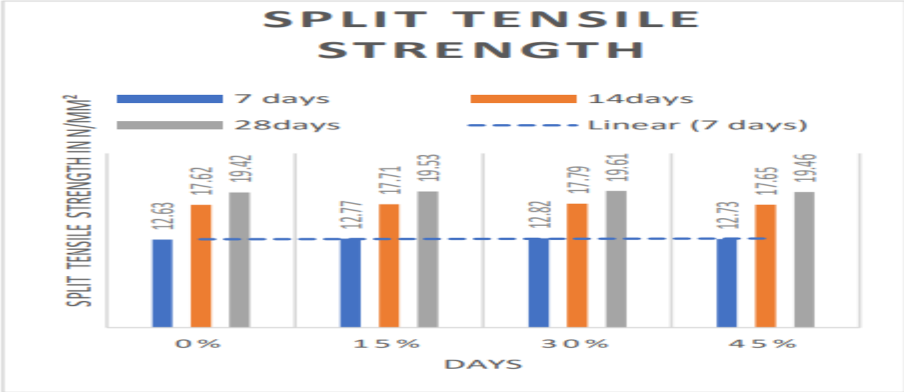
6. TESTING OF A SAMPLE

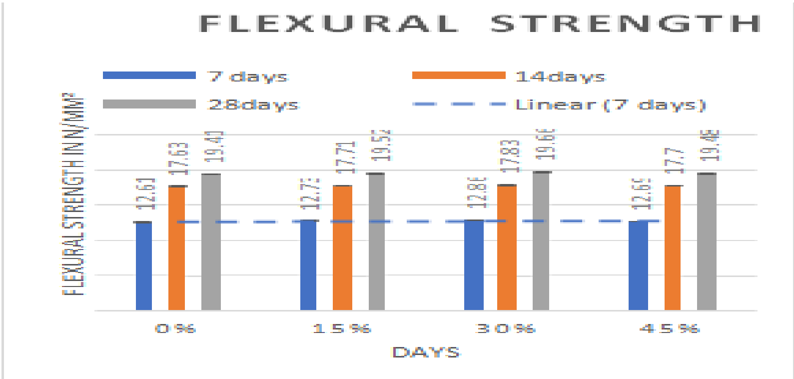
The cylinders were tested for split tensile strength similarly to compression testing machine, but the position of the cylinder in horizontal position to capture an accurate result, and flexural test was conducted in the compression testing machine for the cubes. Flexural testing apparatus then recorded the outcome with the corresponding cure ages of 7, 14, and 28 days.

Below are the test results for concrete samples: Compressive strength, split tensile strength, and flexural strength were all higher for 15% red soil than for plain concrete on all days.

When compared to a specimen of plain concrete, the compressive strength and split tensile strength for 30% red soil increased in 7 days and 14 and 28 days, respectively. Both the compressive strength and split tensile strength for 45% red soil were lower than for plain concrete on all days. The compressive, split tensile strength, and flexural strength of red soil-replaced concrete specimens rose from those of plain concrete specimens with 0% red soil while loading for both 15% and 30% of the sand replacement. Overall, red soil replacement of 45% was found to improve compressive strength, split tensile strength, and flexural strength the most. Red soil demonstrated nearly identical compressive and split tensile strength in 28 days of curing, but both strength decreased in 7 days of curing because concrete absorbed more water with the addition of soil.







The test findings showed that the strength and imperviousness of red soil-mixed concrete are comparable to those of plain concrete. In terms of compressive strength for 28 days, red soil mixed concrete has higher values (22.3N/mm2) than plain concrete (19.6N/mm2). Additionally, experimental evidence suggests that adding lime powder to red soil improves the concrete's strength. When compared to conventional concrete, the red soil mixed concrete is stronger in terms of compressive strength, split tensile strength, and flexural test.

7. CONCLUSION

The test findings showed that the strength and imperviousness of red soil-mixed concrete are comparable to those of plain concrete. In terms of compressive strength for 28 days, red soil mixed concrete has higher values (22.3N/mm2) than plain concrete (19.6N/mm2). Additionally, experimental evidence suggests that adding lime powder to red soil improves the concrete's strength. When compared to conventional concrete, the red soil mixed concrete is stronger in terms of compressive strength, split tensile strength, and flexural test.

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DESIGN OF ANDROID APPLICATION FOR CURING AND IRRIGATION

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ABSTRACT

In the present world due to the rising of the construction field at a rapid rate the demand for manpower and resources has increased over a period of time. By taking this in mind the project topic which was selected to work was regarding Curing and Irrigation. In this particular project themajor concentration will be given to understand the behavior of the concrete and the soil for different water supplies from least to the excess. Based on the observations made on this behavior suitably a device will be developed and will be connected to an application so as to have an automation i.e. in order to perform scientific curing and scientific irrigation.

INTRODUCTION

In the construction industry, there is a rapid growth due to the urbanization. So, there will be a maximum demand for manpower and resources. Due to the limitations of manpower and resources, their minimum wages are also increasing day by day.

In the past few years, the SoR (Schedule of rates) of the different states in India has also changed the rate for the labour into hourly basics instead of daily wages. If the work is extended for at leastone hour, there will be a huge increase in the construction cost.

The resources used for the construction (cement, aggregates, and water) is also increasing due tourbanization and usage of the materials. When coming to the structural issues the strength of the concrete or cement will attain very high when it is cured at a perfect time along with good water properties (free from salts etc).

So, it is evident to get good strength, the freshly poured concrete should get enough content ofwater. If we increase the timings of the labour it will also increase the cost of the project.

To overcome this problem, we can use the technology and make a sensor-based curing systemwhich will automatically supply the water when the water is below the required content. We can even build an android application so that we can monitor it from anywhere.

Objectives:

- Minimize the consumption of the water used for the curing purpose.
- Save the power which will be exhausted for the curing purpose.
- Reduce the manpower involved in the curing of the concrete structure.
- Introduction of IT to the field of civil engineering to allow the future research and development inthis field.
- Provide an ease and comfortable method for the curing purpose to the owner or the contractoror the engineer.

METHODOLOGY

In this project for curing and irrigation we did different experiments in order to determine the efficient method of curing and minimum amount of water required for crop. So for curing us casted2 mould and fixed 3 temperature sensors to know the heat of hydration and one sensor to know the surface temperature.
For irrigation we irrigated one land and took the readings before and after the irrigation then after24hrs after that readings are taken at temporary and permanent wilting point. At the end we decided the minimum water content needed for the crop.
Based on these value we prepared one device that will be monitored and controlled by the android device.

PROJECT DESCRIPTION

In this project, the Arduino UNO microcontroller board is used. A water content sensor is connected to the board. This board will regulate the water flow, based on the water content.

The problem which is being faced during concrete curing is that the water is spent in excess. No calculated amount of water is being provided which ultimately results in wastage of water, which is a very serious issue and needs to be addressed at the earliest. There is also associated manpower requirement, which if not monitored properly will end up with financial and structural damages for the owner.
On the other hand, in order to promote agriculture, the Government has been providing free/subsidized power for irrigation pump sets. As a result, farmers irrigated their land day and night at places where there is enough water availability without even bothering the actual water requirements of the crop they grow, which resulted in the wastage of scarce natural resource inwater as well as energy.
The temperature of the concrete is monitored by using a temperature sensor (LM 35) and a moisture sensor (HL- 05) for soil moisture content. When the values shoot up the predefined threshold values, the microcontroller (Arduino UNO) will trigger the respective motors for pumping the water and will operate for predetermined periods. The notifications regarding operations of the motor and various parameters will be updated in the owner's mobile phone and also has the liberty of manually operating the motor using the android application.

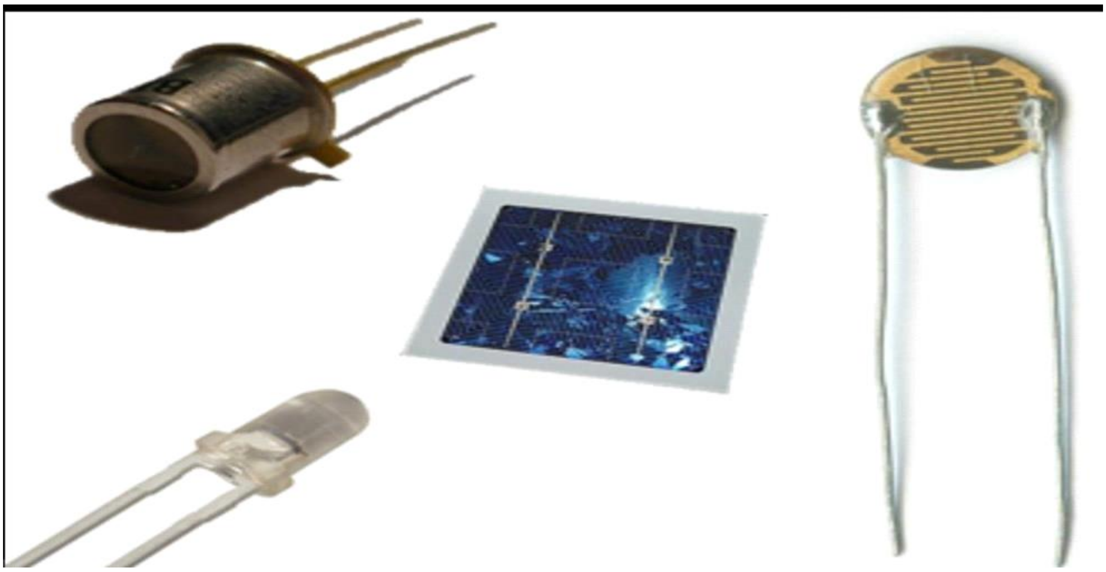
The work conducted is a pioneering step towards introducing automation in the field of civil engineering and agriculture. This is an entirely different concept which is attempted by using the very basic technology and demonstrates its intended efficiency. The equipment is cost effective and helps in efficient use of man power and energy.

The device also helps in better management of time and water which is a major advantage. Mostimportantly it gave ease and comfort to the user as the user needn't go to the site for performingthe curing and irrigation operation.

REQUIREMENTS

Water content measuring sensor Wi-Fi module for sending and receiving the data. Android studio for making an android applications.

One way relay for turning on the water source.



PROJECT IMPLEMENTATION

1.Setup the water content measuring sensor in the respective place.

2.Connect the Arduino to the sensor.

3.Setup the limit for the water sensor using the Arduino

.4.Connect the relay to Arduino.

• Connect the wi-fi module to the Arduino so that the Arduino can be controlled using an androidapplication.

• Now you can regulate the water flow based on sensor data and also, we can supply water whenever needed remotely using an android application.

The new device uses a sensor to monitor the temperature of the concrete and another one to track the moisture of the soil. When the sensors observe .When the sensors observe a predefined threshold value, they trigger a microcontroller to switch on motors to pump water for a predetermined time.

Notifications regarding the operation of the motor and various parameters will be updated on the mobile phone of the owner, who has the liberty of manually operating the motor using an android application. The students claim that their device is a pioneering step towards introducing automation in agriculture using very basic technology. The equipment is cost effective and helps in efficient use of manpower, energy, and water.

Most importantly, it provides provides ease of operation to the user who need not go to the site for performing curing and irrigation. How come if it is possible to monitor the progress of concrete curing as well as save water used in irrigation? Well, a team of second year civil engineering have developed a distinctive device with which they are able to monitor concrete curing and irrigation operations in a smart way.

The problem which is being faced during concrete curing is that the water is spent in excess. No calculated amount of water is being provided which ultimately results in wastage of water, which isa very serious issue and needs to be addressed at the earliest.

There is also associated manpower requirement, which if not monitored properly will end up with financial and structural damages for the owner. On the other hand, in order to promote agriculture, the Government has been providing free/subsidized power for irrigation pump sets.

As a result, farmers irrigated their land day and night at places where there is enough water availability without even bothering the actual water requirements of the crop they grow, whichresulted in the wastage of scarce natural resource in water as well as energy

6. Advantages

- Less use of workers
- Can regulate the water supply remotely
- Minimization of water consumption
- Used for irrigation purpose
- Save some money in less using of workers

CONCLUSION

- By comparing the above outputs it is clear that the temperature of surface of the concrete will bereduced after curing in each method is almost same.
- So the sprinkling method can be taken as most efficient one because the water consumption inthis process is very less comparatively.
- As we know that too much is too bad, the water which is the easily available water Content for theplant is 450. So maintain that level in the root zone of the plant.

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MECHANICAL PROPERTIES OF NANO-CEMENT MORTAR: COMPRESSION AND TENSION

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ABSTRACT

The present research examines the compressive and tension strength of nano cement mortar by using micro cement, micro sand, nano silica and nano clay in developing a nano-cement mortar which can lead to improvements in concrete construction. The results have shown an increase in both the compressive and tensile strength of mortar at early stages of hardening. For testing purpose, 50 mm cubes and 250x50x10 mm prisms were cast and tested for determining the compressive and tensile strength of nano-cement mortar. The parameters that were taken consideration during the investigation were micro sand, micro cement, nano silica, developed nano clay and naphthalene sulphonate as super- plasticizers. It has been concluded that the measured results demonstrate significant increase in the tensile strength of the developed mortar. Accordingly, an empirical equation is formulated for the tensile strength prediction.

Keywords– compressive; tensile; nano-cement; nao-silic

1. INTRODUCTION

Nanomaterial can enhance and improve the properties of the construction materials like concrete [1]. Besides, Nano materials play a big role in the minimizing the environmental impact, improving safety and decreasing costs associated with civil infrastructure [2]. Nano silica, carbon nano tubes and nano alumina have been extensively used over the last decade due to their exceptional contribution in enhancing the materials properties. However, nano materials are gaining widespread attention to be used in construction sector so as to exhibit enhanced performance of materials in terms of smart functions and sustainable features. The literature showed that the use of nanomaterial in cementitious system is mainly due to the fact that concrete remains the most complex material and its hydration mechanism is still not completely understood [3]. It is well known that concrete is the core of the construction industry.

It is estimated that around three billion tons of cement, the binder in concrete, were produced worldwide in 2010. In general, it is a fact that cement industries is an energy intensive process and represents 7% of worldwide energy consumption and 4% of worldwide industrial CO_2 emissions [4]. Therefore, nano materials can improve the structural efficiency, durability and strength of cementitious materials and can thereby assist in improving the quality and durability of structures. The use of nanoscale industrial waste-based cement replacements can reduce carbon dioxide emissions associated with concrete production [5]. The addition of some metal oxide nanoparticles to concretes can both reduce the permeability of concrete to ions and increase the strength of concrete, thereby improving durability. The addition of TiO_2 nanoparticles [6], Al_2O_3 nanoparticles [6], ZrO_2 nanoparticles [8], Fe_2O_3 nanoparticles [9], SiO_2 nanoparticles [10] and metal oxide containing nano clays [11] have all been shown to improve concrete and/or cement mortar properties. Properties of the cement-based composites made from the CNTs/CNFs- grown cement/mineral admixture were presented. Experimentally, Li et al, [12] studied the mechanical properties of nano-Fe_2O_3 and nano-SiO_2 cement mortars. The 56-day pore structures of the cement mortars produced by the addition of silica fume and nano-SiO_2 (NS), nano-Al_2O_3 (NA) and nano-Fe_2O_3 (NF) powders. Basically, singular, binary or ternary combinations at different proportions of the binder content were investigated through MIP and BETanalysiss[13]

Metal oxide nanoparticle addition accelerates reactions during initial hydration thus strengthening cement composites. The metal oxide nanoparticles react with CaOH increasing the amount of calcium silicate hydrate (C-S-H) produced, leading to a more compact microstructure. By this means not only decreasing permeability but also improving mechanical properties [14] such as compressive strength, flexural strength and abrasion resistance [15]. The flexural strength of a very thin ferrocement element, by using NSCSC mortar as a replacement to the normal cement mortar, usually used in ferrocement elements was examined. The measured results showed an increase the flexural strength of a very thin ferrocement using NSCSC mortar [16].

Zhang and Li [17] found that the addition of 1% by weight of binder of 15 nm diameter TiO_2 to concrete refined the pore structure and increased the resistance to chloride penetration by 31%. Shekari and Razzaghi [18] found that the addition of 1.5% (by weight of cement-based material) of 10– 25 nm ZrO_2, TiO2, Al_2O_3 or Fe_3O_4 increased the compressive strength and reduced chloride penetration of the concrete by 20–80% respectively. Through-depth cracks, of course, severely compromise improvements in impermeability.

Oscar et al. [19] studied the effect of the reagglomeration

process of Multi-Walled Carbon Nanotubes (MWCNT) dispersions on the activity of silica nanoparticles at early ages when they are combined in cement matrixes.

MWCNT/water/superplasticizer dispersions were produced via sonication and combined with nano silica particles in the mixing water of the cement samples. The methods and theories of in situ growth of CNTs/CNFs on cement/mineral admixture, including chemical vapour deposition method and microwave irradiating conductive polymers method, were summarized [20]. The addition of SiO_2 nanoparticles is widely reported to be effective for strengthening concrete; both normally vibrated concrete and self-compacting concrete [21].

Al-Rifaie et al. [22] examined the compressive and flexural strength of nano cement mortar by using micro cement, micro sand, nano silica and nano clay in developing a nano cement mortar which can lead to improvements in ferrocement construction. In addition, the influence of heating on compressive strength of cement mortar, whereas ferrocement eco-housing system was able to produce very energy efficient dwellings [23]. Nazari and Riahi [24] reported that the compressive, split tensile and flexural strength of the 4 wt.% SiO_2 nanoparticle concrete is, 1.7, 2.2 and 1.6 respectively times greater than that of the equivalent SiO_2 nanoparticle free concrete after 28 days of curing. Generally, cement-based materials containing SiO_2 nanoparticles are stronger than those containing SiO_2 fume [25]. This is attributed to the accelerated cement hydration, increased pozzolanic activity, reduced pore size and improved interfacial bonding between

the hardened cement paste and aggregate that is associated with the decreased average particle size of the SiO_2 [26]. The effect of elevated temperatures on chemical composition, microstructure and mechanical properties of high strength mortars with nano alumina was investigated [27].
Effect of nano clay particles on mechanical, thermal and physical behaviours of waste-glass cement mortars was investigated [28]. The compressive strengths and the microstructure photographs of cement mortars containing nanosilica with various sizes compared with cement mortar with silica fume was investigated by Sattawat et al. [29]. Finite element method was used to investigate the impact of inclusion in hypothetical nano composite [30], cracked nano composite [31], debonding between the nanofibe and the matrix[32], pre-crack existence in nanocomposite [33] as well as studying the impact of the mismatch properties [34]. Moreover, FEA has been used to investigate the effect of the nanoinclusion [35], interfacial debonding defects [36], interfacial defects [37] and fractured particulate composion on the characteristics and failure of the nano composite.

The authors present a research work to examine the mechanical properties of nano particles in developing a nano cement mortar which can lead to improvements in the performance of ferrocement to be the replacement to the materials needed, for example, strengthening or rehabilitation of pipe lines for pressurized pipes rather than using polymeric composite materials, construct poles for lighting and wind turbine, manufacturing under water turbine blades and even impellers, and bullet proof protective panels or even anti explosion sheets used in trucks [39-41]. Cubes and prisms were cast and tested for determining the compressive and tensile strengths. The parameters considered during the investigation were micro sand, micro cement, nano silica, naphthalene sulphonate, nano clay and the chemical compositions of micro cement. Besides, the nano silica, the develop nano clay and the general specifications of naphthalene sulphonate are carried out. In the present work, compressive and tensile strength of the developed nano cement mortar will be investigated.

2. MATERIALS PROPERTIES

Cement: Micro Portland cement sulphate resistance, conforming ASTM C150 type II, particle size (45- 0.7)µm, thechemical and physical compositions are given in Tables (I andII).

Table I. Chemical Composition Of Cement Considered In The Present Investigation

	Standard	Used cement
Silicon dioxide(SiO_2),min %	-	-
Aluminum oxide(Al_2O_3),max%	-	-
Ferric oxide(Fe_2O_3),max%		-
Magnesium	6.0	-
C3A ,max. %	8	2.0
Sulfur trioxide (SO3), max, %	3.5	0.95
Loss on ignition , max%	4	0.92
Insoluberesidue ,max%	0.75	0.71
Tricalcium silicate(C2S),min%	-	-
Dicalcium silicate(C2S),min%	-	-
Tricalcium	-	-
Tetracalcium alumino ferrite	-	-

Table II. Physical Composition Of Cement Considered In The Present Investigation.

Item	*Standard*	*Used cement*
Air content of mortar ,		
Max.	12.0	-
Min.	-	-
Fineness, specific surface .m2 /Kg(alternative methods):		
Turbidimetertest ,min	160	
Air permeability test,	280	298
Autoclave expansion ,	0.8	
Strength, not less than the values shown for the ages Indicated as Follows		
Compression strength ,Mpa		
3 day	15.0	19
Time of setting (alternative methods)		
Vicat test		
Time of setting . min, not less than	45	53
Time of setting .min, not more than	375	488

Sand: Micro sand (finer than 75 µm) , conforming ASTMC33.

Silica: Nano silica (500-40)µm, the chemical composition given in Table III

Table III. Chemical Composition of Nano Silica

Chemical composition	Contents %
Silicon dioxide, SiO_2	94.3
Aluminum oxide, Al_2O_3	0.06
Ferric oxide, Fe_2O_3	0.46
Calcium oxide, CaO	0.51
Titania	2.31
Loss on Ignition	2.25

Clay: Developed nano clay (200-3)µm.

Table IV gives the chemical composition obtained by burning the clay

Table Iv. Chemical Composition Of The Develop Nano Clay

Chemical composition	*Contents %*
Silicon dioxide, SiO_2	49.87
Aluminum oxide, $Al2O_3$	32.11
Ferric oxide, Fe_2O_3	8.78
Calcium oxide, CaO	0.34
Titania	1.45
MgO	0.28
K_2O	0.81
Na_2O	0.77
Loss on Ignition	0.66

Naphthalene sulphonate used as super-plasticizers, high range (i.e., 88%) water reducing according to ASTM C494. Table V gives the general specifications of this material:

Table V. Specifications Of Naphthalene Sulphonate

color	*Brown*
density	1.12-1.14 kg/liter
Chloride content % (EN480-10)	Less than 0.1
Alkaline content % (EN480-12)	Less than 10

3. TESTING PROCEDURES

The mortar matrices considered during the present investigation may be summarized in the following groups:

- (A): Sand/ cement ratio 1/ 1, 1.5/1, 2/ 1, 2.5/1, 3/1 with w: c ratio = 0.4.
- Group (B): Sand/ cement ratio 1/ 1, 1.5/1, 2/ 1, 2.5/1, 3/1, each with 10% of nano silica, and 1.4% naphthalene sulphonate, w: c ratio = 0.34.

Group (C): Sand/ cement ratio 1/ 1, 1.5/1, 2/ 1, 2.5/1, 3/1, each with , 18% nano clay, and 1.4% naphthalene sulphonate, w: c ratio = 0.34.

- Group (D): Sand/ cement ratio 1/ 1, 1.5/1, 2/ 1, 2.5/1, 3/1, each with , 18%

nano clay, 10% nano silica and 1.4% naphthalene sulphonate, w: c ratio = 0.34.

1. Compressive strength at age of 28 curing days were carried out: Sixty 50mm mortar cube specimens with the above mortar groups (A, B, C, D) were performed after 28 curing days on 250 kN machine according to ASTM-C 109/C 109M– 99.
2. Tensile strength at 28 curing days were carried out: Sixty 50mm cube specimens with mortar group (D) were performed after 28 curing days.

4.RESULTS AND DISCUSSION

Table VI gives the outcomes of compression and tension tests after 28 curing days. A graphical representation of the results are shown in Figs. 1 and 2. It may be noted that each of the above compressive strength and tension strength values is theaverageofsixcubes

Table VI. The Measured Compressive, And Tensile Strength Of The Developed Nano Cement Mortar At Age Of 28 Curing Days

	Sand: cement	*Compressive*	*Tensile Strength,*	
A	1	25.33	3.24	7.82
	1.5	36.66	8.22	4.46
	2	34.76	6.55	5.31
	2.5	30.43	5.3	5.74
	3	27.54	4.21	6.54
B	1	50.65	8.98	5.64
	1.5	62.54	12.43	5.03
	2	59.76	11.99	4.98
	2.5	56.87	10.65	5.34
	3	52.87	9.07	5.83
C	1	60.87	13.98	4.35
	1.5	73.99	15.34	4.82
	2	70.43	14.99	4.70
	2.5	69.66	14.32	4.86
	3	65.99	13.65	4.83
D	1	76.43	16.65	4.59
	1.5	85.32	18.45	4.62
	2	82.87	17.34	4.78
	2.5	80.43	17.55	4.58
	3	77.70	16.97	4.58

The investigation of Al Rifaie et al. [21] was concluded that the developed nano cement mortar of group (D) can achieve more than 15% of its final compressive strength in one day and more than 60% in fourteen days (normally the final strength of concrete can be achieved in 120 days). The behaviour at early ages gains importance in precast structures as the case with most of ferrocement structures when submitted to early stresses due to transportation and erection operations. It was seen that the developed nano mortar of group (D) can achieve more than 40% of compressive strength in one day in comparison with compressive strength of group (A) with 28 curing days and the compressive strength in 7 days is greater than the compressive mortar group (D) beyond age 120 curing days do not change, and this means that the dehydration is completed. In addition, a formula for estimating the cube compressive strength, in terms of days, was proposed as follows:

According to ASTM: C 109 [41], tests were carried out to measure the compressive and tensile strength of ordinary sand: cement mortar 3:1 with water: cement ratio of 0.4 and the size of sand particles is smaller than 0.85 mm and bigger than 0.6 mm. It was concluded that (tensile strength = compressive strength/ 10), while the corresponding tensile strength value using micro cement-micro sand mortar of group (A), i.e., sand/ cement ratio of 3:1 is: (tensile strength = compressive strength/7.82) and by considering nano cement mortar of group (D) with micro sand: micro cement of 3:1, .

5. CONCLUSIONS

In the present study, it has been seen that the mechanical properties, of nano cement mortar as developed in the present work are experimentally investigated. Moreover, the developed nano cement mortar matrix of sand/ cement ratio of 1.5/1 with , 18% nano clay, 10% nano silica and 1.4% naphthalene sulphonate, w: c ratio = 0.34 showed that the 28 days compressive strength of 85.32 MPa, and tensile strength of 18.45 MPa which is higher than the strength of the reference nano cement mortar as developed in the present work having sand/ cement ratio of 1.5/1 with w: c ratio = 0.4 by the ratio of 2.33 and 2.25 respectively. In this context, the measured results showed an increase in tensile strength in comparison with compressive strength of the developed nano cement mortar. Besides, results showed as well that the tensile strength value of the developed nano cement mortar in the present work ranging between (0.0446 and 0.0762) of the compressive strength value. By comparing the plain cement mortar, usually used in producing ferrocement elements, with the cement mortar mixed with the micro/ or nano particles, it was obvious that in a supreme mechanical performance of the cement mortars nano particles. Finally, an empirical expressions to predict the tensile strengths was proposed for estimation purposes.

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PARTIAL REPLACEMENT OF FLY ASH IN M40 PORTALD SLAG CEMENT

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ABSTRACT

Researchers have been considering using marble powder and fly ash to both minimise environmental contamination and save construction costs for the past few years. The purpose of this study is to ascertain the impact of employing marble powder and fly ash as partial replacements for cement in various concrete mixtures. With a constant w/c ratio of 0.43 and partial substitution of Portland Pozzolana Cement (PPC) with Marble Powder and Fly Ash carried out in varying ratios, the M40 grade of concrete was selected. The samples are first prepared in accordance with the orthogonal array, and then mechanical characterizations are carried out. To evaluate the mechanical characteristics of hardened concrete, tests for compressive strength, split tensile strength, and flexural strength have been carried out. A novel multi-criteria decision making (MCDM) technique called Evaluation based on Distance from Average Solution (EDAS) has been used to carry out multi-response optimisation. A pairwise comparison matrix was utilised to establish the relative relevance of the factors that were taken into consideration. Finally, the acquired findings were confirmed using a confirmation test, and the models were validated using analysis of variance (ANOVA). All test data were analysed, concrete mix comparisons were made, and a conclusion was reached.

Keywords: M40 Concrete, Material Replacement, Mechanical Strength, Taguchi, MCDM Optimization, EDAS Method.

INTRODUCTION

A technology connected to the building and construction sector that was created following the discovery of cement is the production of concrete. Cement, fine aggregates, coarse aggregates, and the necessary amount of water are the main components of the commonly used building material known as concrete. Researchers have been considering using various industrial wastes in recent years to both minimise environmental contamination and save construction costs. Numerous studies demonstrated that the use of mineral admixtures can successfully and affordably be

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used to enhance some fresh and hardened concrete properties. The primary application of marbles in building construction is flooring, which results in significant waste production. The amount of trash from marble quarries, which may reach millions of tonnes, is about 20%. Typically, marble waste is dumped in a pit close to a factory or construction site. Because marble powder spreads through the air during the dry season and settles on plants, contaminating both groundwater and surface water, this practise is not regarded as safe in terms of environmental issues. Utilising marble waste in a variety of industries today, including agriculture, glass, paper, and construction, aids in the management of environmental issues. Similar to this, fly ash is a byproduct of burning pulverised coal to produce electricity. Cement is frequently replaced in concrete with fly ash, however despite the many advantages of this substitution, the comparatively sluggish hydration of fly ash results in a considerable loss of early strength.

The goal of the current study project is to determine the ideal proportion of cement substitution with the combined application of fly ash and marble powder in M40 grade concrete based on test findings from several previous trials. A modern multi-criteria decision making (MCDM) technique called Evaluation based on Distance from Average Solution (EDAS) has been used to carry out multi- response optimisation. A pairwise comparison matrix was utilised to establish the relative relevance of the factors that were taken into consideration. To assess the mechanical qualities of concrete with the addition of different amounts of marble powder and fly ash, testing on hardened concrete samples after 56 days included compressive strength, split tensile strength, and flexural strength tests. A pairwise comparison matrix was utilised to establish the relative relevance of the factors that were taken into consideration. Finally, the obtained results were validated using a confirmation test, and the models were validated using analysis of variance (ANOVA).

EXPERIMENTAL ANALYSIS AND METHODOLOGY

A. ***Materials used for fabrication of test specimen are as follows:***

- Portland Pozzolana Cement (PPC)
- Marble Powder (MP)
- Fly Ash (FA)
- Fine Aggregate
- Coarse Aggregate
- Water

1) ***Portland Pozzolana Cement (PPC):***

Portland Pozzolana Cement (PPC) makes concrete more impermeable, denser as compared to OPC. The long-term strength of PPC is higher compared to ordinary Portland cement (OPC). PPC produces less heat of hydration and offers greater resistance to the attack of aggressive waters than normal OPC. PPC can be

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used for all types of construction. Table I shows the physical properties and Table II shows the chemical composition of Portland Pozzolana Cement.

Table:I Physical Properties Of Portland pozzolana Cement.

Name Of The Test	Value	IS Code
Normal consistency	35%	IS:12269:1987
Specific gravity	3.10	IS:12269:1987
Initial setting time	35 min	IS:12269:1987
Final setting time	166 min	IS:12269:1987

Table:II Chemical Composition Of Portland Pozzolana Cement.

Particulars	Proportion
SiO_2	21.77%
Al_2O_3	2.59%
SO_3	2.41%
CaO	57.02%
MgO	2.71%
Fe_2O_3	0.65%

2) *Marble Powder (MP):*

MP is produced from processing plants sawing and polishing of marble blocks. Table III shows the chemical composition and Table IV shows the physical properties of Marble Powder.

Table:III Chemical Composition Of Marble Powder

Particulars	Proportion
SiO_2	21.12%
Al_2O_3	5.62%
Fe2O3	3.24%
CaO	62.94%
MgO	2.73%
Density,(g/cm3)	2.80

Table:IV Physical Properties Of Marble Powder

Particulars	Proportion
Fineness	3
Brightness (Hunter Y)	92
Retained on 325 Mesh Screen	0.03%
Moisture	0.12%
Acid Insoluble	2%
Specific Gravity	2.7
Hardness	3

3) *Fly Ash (FA):*

The burning of harder, older anthracite and bituminous coal typically produces Class F type FA. FA is pozzolanic in nature and contains less than 7% lime (CaO). FA

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produced in modern power stations of India is of good quality as it contains low Sulphur and very low unburnt carbon i.e. less loss on ignition. FA is one of the naturally-occurring products from the coal combustion process and is a material. Table V shows the physical properties and Table VI shows Chemical composition of Fly Ash.

Table:V Physical Properties Of Fly Ash

Parameters	Constituent/ Properties
Bulk Density (gm/cc)	0.9-1.3
Specific Gravity	1.6-2.6
Plasticity	Lower or non-plastic
Shrinkage Limit (Volume stability)	Higher
Grain size	Major fine sand
Clay (%)	Negligible
Free Swell Index	Very low
Classification (Texture)	Sandy silt to silty loam
Water Holding Capacity (WHC) (%)	40-60
Porosity (%)	30-65
Surface Area (m^2/ kg)	500-5000
Lime reactivity (MPa)	1-8

Table:VI Chemical Composition Of Fly Ash

Compounds	Percentage in FA
SiO2	38-63
Al_2O_3	27-44
TiO_2	0.4-1.8
Fe_2O_3	3.3-6.4
MnO	0.5
MgO	0.01-0.5
CaO	0.2-8
K_2O	0.04-0.9
Na_2O	0.07-0.43
Loss of Ignition	0.2-5.0

4)Natural Fine Aggregate (NFA):

Regionally accessible sand confirming to IS specifications turned into used as the satisfactory combination in the concrete coaching. The specific gravity of NFA is 2.66. The bulk density of NFA is 1415 Kg/m^3**.**Water absorption of sand is 13.89%. Table VII shows the size variation of fine aggregate.

Table:VII Size Variation Of Fine Aggregate

Fine aggregate	Size variation
Coarse Sand	2.0mm – 0.5mm
Medium sand	0.5mm – 0.25mm
Fine sand	0.25mm – 0.06mm
Silt	0.06mm – 0.002mm

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5)Natural Coarse Aggregate (NCA):

The NCA has undergone the sieve analysis test, and the operations are carried out in accordance with the IS code. The aggregate has therefore taken sizes ranging from 10 mm to 20 mm. Aggregate's specific gravity was discovered and employed in the mix design process. The coarse aggregate's fineness modulus ranges from 6.0 to 6.9 for sizes between 10 and 20 mm. Gravel kinds are listed in Table VIII for NCA.

Table:VIII Types Of Gravel

Coarse aggregate	Size
Fine gravel	4mm – 8mm
Medium gravel	8mm – 16mm
Coarse gravel	16mm – 64mm
Cobbles	64mm – 256mm

B. *Mixing and Casting*

M40 grade of concrete was designed as per the Indian Standard code of practice (IS 10262 (2009)). All the materials such as PPC, NCA, NFA, MP and FA of particular quantity are added in the concrete mixture machine. All the materials mixed properly in dry condition. Required amount of water has been added slowly it forms a homogenous mixture. Cubes and cylinders were casted for 56 days for each concrete mix based on the L9 orthogonal array. The size details of test specimen are shown in table 9.

Table:IX Test Specimen Size Details

Tests	Sample size	Nos.
56 days compressive strength of cube	(150 X 150 X 150) mm	9
56 days split tensile strength of cylinder	(100mm diameter X 200mm height)	9
56 days flexural strength of beam	(10 X 100 X 50) mm	9

C. *Curing*

Mould has been removed after 24 hours of casting period. Specimens are marked clearly after removed from the mould. All specimens are taken to the curing tank and place there safely for 56 days. Curing is to provide concrete with adequate moisture and temperature to cement hydration for a sufficient period of time. Proper curing of concrete is crucial to obtain design strength and maximum durability, especially for concrete exposed to extreme environmental conditions at an early age. Curing process is controlling the rate and extent of moisture loss from concrete during cement hydration. The strength of concrete, its durability and other physical properties are affected by curing and application of the various types as it relates to the running weather condition in a particular locality, as curing is only one of many requirements for concrete production.

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D. ***Hardened Concrete Test***

Various tests on hardened Concrete are done to ensure the design strength of concrete and quality of concrete construction is achieved. There are several reasons for testing of hardened concrete is important. Tests can be investigating the fundamental physical behaviour of concrete such as elastic properties and strength characteristics. Prepared composites are tested by using a capacity of 600 KN universal testing machine (UTM BSUT 60JD) and with a cross head speed of 10mm/min.

1) ***Compressive Strength Test:***

Structural design codes are based on compressive strength. The compressive strength is defined as the resistance to failure under the action of compressive forces. Especially for concrete, compressive strength is an important factor to determine the performance of the material during construction. The strength of concrete is required to calculate the strength of the members. Tests have been conducted of the test specimen for 56 days. Cube specimens (150 X 150 X 150) mm cured in in water has taken out. It has been tested immediately after drying. Compressive strength (MPa) was found out using the expression:

(i) Compressive strength = P/A
Where P is Load in kN and A = Surface area of the cube

2) ***Split Tensile Strength Test:***

The tensile strength of concrete is one of the basic and important properties. The concrete is very weak in tension due to its brittle nature and is cannot expected to resist the direct tension. The concrete occurs cracks when subjected to tensile forces. Thus, it is necessary to determine the tensile strength of concrete to determine the load at which the concrete members can crack. Wet cylinder specimen (200 mm height X 100 mm diameter) has been taken from water after 56 days of curing. It has been tested immediately after drying. Split tensile strength (MPa) was found out using the expression:

(ii) Split tensile strength = $2P/\pi DL$
Where, P is Load in kN, D is diameter of the cylinder and L is length of the cylinder

3) ***Flexural Strength Test:***

To determine the Flexural Strength of Concrete, which comes into play when a road slab with inadequate sub-grade support is subjected to wheel loads and / or there are volume changes due to temperature / shrinking. Wet beam specimen (10 X 100 X 50) mm has been taken from water after 56 days of curing. It has been tested immediately after drying. The flexural stress in a three-point bending test is found

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out by using formula:

(iii) $\sigma f = 3FL/2bd^2$

Where σf is the flexural strength, F is the maximum load applied, L is the distance between the supports, and b and d are breadth and thickness of the specimen respectively.

Table:X Input Parameters

Factors	**Symbol**	**Level 1**	**Level 2**	**Level 3**
cement	A	320 kg/m^3	340 kg/m^3	360 kg/m^3
Fly ash	B	5 %	15 %	20 %
Marble powder	C	5 %	15 %	20 %

E. *Calculation of Weights Between Criterions by Pair-Wise Comparison*

In this study, based on the experience, relative importance of output responses was determined by using the geometric mean approach of the AHP method. The Saaty nine-point preference scale is take on for fabricating the pair-wise comparison matrix shown in Table 2. Criteria weights of fabricated composite sample performance characteristics were determined by using following equations [18]-

(iv) $$GM_i = \left(\prod_{j=1}^{n} b_{ij}\right)^{1/n}$$

(v) $$w_j = GM_i / \sum_{j=1}^{n} GM_i$$

Table:XI Pair-Wise Comparison Table Between criterions

	Compressive strength	Split tensile strength	Flexural strength
Compressive strength	1	3	3
Split tensile strength	0.3	1	0.3
Flexural strength	0.3	3	1

Using above-mentioned equations criteria weights were obtained as w = [0.60, 0.13, 0.28]. Therefore, compressive strength followed by flexural strength and split tensile strength are criteria with the greatest importance, respectively. This is justified since quality characteristics are of prime importance for customers while manufacturers are striving to secure high quality usable parts. Although this is subjective approach for determination of the relative importance of criteria, consistency check of determined criteria weights was performed. For 3 considered criteria, i.e. for random index (RI) of 0.58, consistency index (CI) and consistency ratio (CR) values of 0.037 and 0.064 were obtained, respectively. CI and CR values show that determination of criteria weights is reasonable since for consistency the value of CR $\leq$ 0.10. The weights obtained for each quality characteristics will be used in the EDAS method for optimization of the process parameters.

RESULTS AND DISCUSSION

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Samples are prepared by using Taguchi's experimental design which is shown in Table XII. L9 orthogonal array was used as design of experiment. The experimental results for compressive strength, split tensile strength and flexural strength are listed in Table XII.

Table:XII Orthogonal Array Design For Experimental Runs And Results

RunNo.	A	B	C	essive strength(MPa)	ensile strength(MPa)	ural Strength(MPa)
1	320	5	5	54.96	5.34	6.05
2	320	15	15	52.39	5.22	5.91
3	320	20	20	51.45	5.07	5.48
4	340	5	15	54.60	5.59	6.37
5	340	15	20	52.73	5.36	5.95
6	340	20	5	54.14	5.49	6.02
7	360	5	20	53.03	5.27	5.98
8	360	15	5	53.51	5.32	6.08
9	360	20	15	51.87	5.28	5.92

The first step demonstrates forming of the normalised decision-making matrix and Determine the average solution according to all criteria using equation (vii) and (viii). The further step is to generate the positive distance from average (PDA) and the negative distance from average (NDA) matrixes according to the type of criteria i.e. benefit criteria in this case using equation shown in table. Determination of the weighted sum of PDA and NDA for all alternatives was done in next step using equation shown in table XIII. After finding weighted sum of PDA and NDA, normalization is done using equation. finally, the appraisal score (AS) was calculated for all alterative using equation and ranking was done according to the decreasing values shown in table XIV.

Table:XIII Positive Distance From Average And Negative Distance From Average Of All Output Responses

Expt. No.	Compressive strength		Split tensile strength		Flexural Strength	
	PDA_{ij}	NDA_{ij}	PDA_{ij}	NDA_{ij}	PDA_{ij}	NDA_{ij}
1.	0.0334	0.0000	0.0031	0.0000	0.0134	0.0000
2.	0.0000	0.0149	0.0000	0.0194	0.0000	0.0095
3.	0.0000	0.0326	0.0000	0.0476	0.0000	0.0826
4.	0.0266	0.0000	0.0501	0.0000	0.0664	0.0000
5.	0.0000	0.0085	0.0069	0.0000	0.0000	0.0034
6.	0.0180	0.0000	0.0313	0.0000	0.0089	0.0000
7.	0.0000	0.0029	0.0000	0.0100	0.0022	0.0000
8.	0.0061	0.0000	0.0000	0.0006	0.0179	0.0000
9.	0.0000	0.0247	0.0000	0.0081	0.0000	0.0084

Table:XVI Weighted Sum Of Pda And Nda, Normalized Values Of Sp And Sn, Appraisal Score And Rank Of All Output Responses

Expt. No.	SP	SN	NSP	NSN	AS	RANK
1.	0.0241	0.0000	0.5958	1.0000	0.7979	3
2.	0.0000	0.0140	0.0000	0.7081	0.3541	7
3.	0.0000	0.0481	0.3035	0.0009	0.1522	9
4.	0.0404	0.0000	1.0000	1.0000	1.0000	1
5.	0.0009	0.0060	0.0222	0.8749	0.4485	6

ISBN: 978 – 81 – 959860 – 0 -2

6.	0.0173	0.0000	0.4277	1.0000	1.0000	2
7.	0.0006	0.0030	0.0149	0.9369	0.4759	5
8.	0.0085	0.0001	0.2106	0.9983	0.6045	4
9.	0.0000	0.0181	0.0000	0.6229	0.3115	8

Based on the total relative importance values of alternatives, it is observed that fabricated concrete specimen obtained in trial 4 is determined as the best sample according to the ranking, specimen obtained in trial 6 is the second best choice, and concrete specimen obtained in trial 3 is the least preferred specimen.

Now the appraisal score (AS) calculated for all alterative was used to plot mean effect for SN ratios. Based on this study, one can select a mixture of the levels that provide the larger average response. In Figure 1, the combination of A2 B1 C1 shows the largest value of the SN ratio plot for the factors A, B andCrespectively.

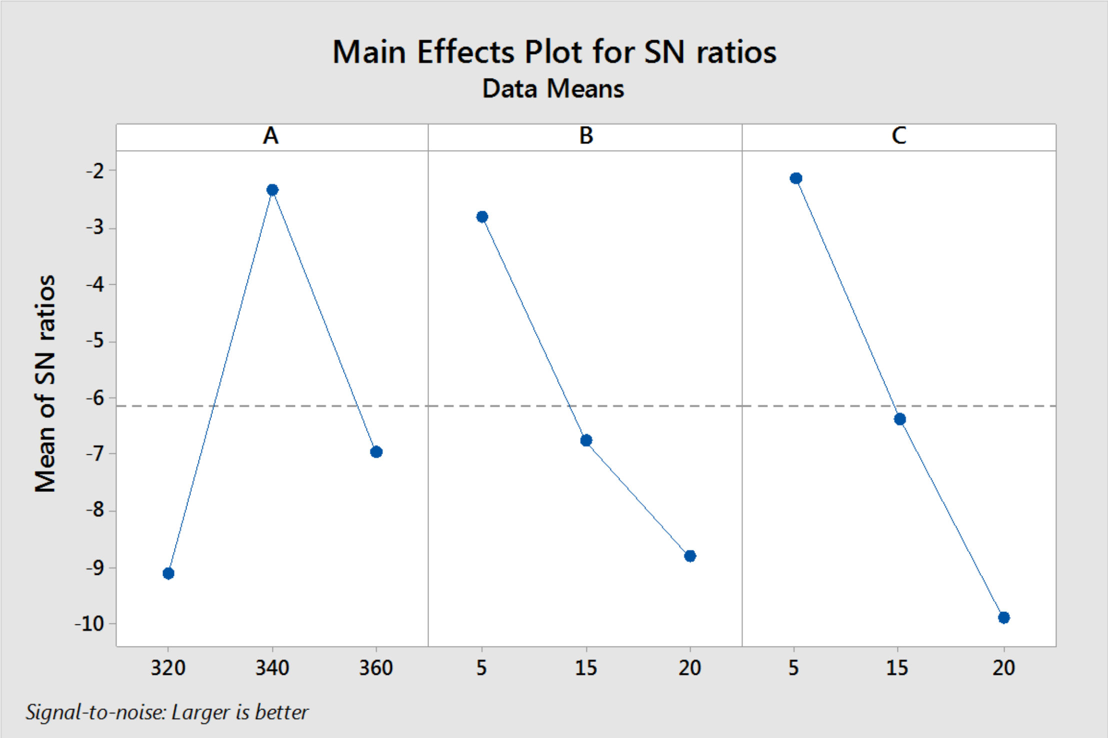

Fig. 1 Main Effect Plot for SN ratios

Table:XV Response Table For Signal To Noise Ratios

Level	A	B	C
1	-9.110	-2.804	-2.111
2	-2.322	-6.785	-6.383
3	-6.984	-8.828	-9.922
Delta	6.788	6.024	7.811
Rank	2	3	1

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Table XVI gives the results of the analysis of variance (ANOVA) for the cement, fly ash and marble powder using the calculated values from appraisal score of alternatives of Table XIV. According to Table XVI, factor C, marble powder with 40.75% of contribution, is the most significant controlled parameter for the concrete specimen fabrication followed by factor A, cement content with 32.12 % and factor B, fly ash with 25 % of contribution if the maximization of compressive strength, split tensile strength and flexural strength simultaneously considered. Here, S = 1.5509, R-Sq = 97.86%, R-Sq(adj) = 91.46%

Table:XVI Analysis Of Variance For Sn Ratios

Source	DOF	Seq SS	Adj SS	Adj MS	F	P	% Contribution
A	2	72.343	72.343	36.171	15.04	0.062	32.12
B	2	56.311	56.311	28.155	11.71	0.079	25.00
C	2	91.786	91.786	45.893	19.08	0.050	40.75
Residual Error	2	4.811	4.811	2.405			2.14
Total	8	225.250					

A. *Confirmation experiment*

After obtaining the best level of parameters, in order to verify the improvement of output quality characteristics, a confirmation test is performed. The total relative importance of alternatives estimated is expressed from the output of confirmation experiment using the formulae given in equation (xx) [18, 20].

(XX) $$\mu_{predicted} = a_{2m} + b_{1m} - 3\mu_{mean}$$

where a_{2m} and b_{1m} are the individual mean values of the total appraisal score of alternatives with optimum level values of each parameters and μ_{mean} is the overall mean of total appraisal score of alternatives [18, 20]. The predicted mean ($\mu_{predicted}$) at optimal setting is found to be 1.2316.

Table:XVII Initial And Optimal Level Performance

Optimal setting	Predicted OptimalS/N ratio	Experimental Optimal S/N
A2 B1 C1	1.2316	1.1551

CONCLUSIONS

The current study investigates the formation of concrete using marble powder and fly ash in place of PPC. Recent multi-criteria decision making optimisation algorithms have been used to identify the best concrete mix. Concrete made with marble powder and fly ash was examined for its compressive, split tensile, and flexural strengths. Using the EDAS approach, the outcomes of every test were improved, and conclusions were reached. The experimental investigation may be used to draw the following findings.

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1. Based on the results of 56 days of compressive, split tensile, and flexural tests, it was discovered that marble powder could be substituted with PPC to increase strength by 5% compared to the control specimen.
2. The predicted values found using the Taguchi linked EDAS method and the freshly created EDAS optimisation approach are almost identical.
3. Table XVIII lists the optimal factor settings for fabricating concrete specimens by substituting marble powder and fly ash for PPC using two optimisation methods:

Table:XVIII Optimal Parameters Using Two Optimization Approach

Algorithm	Optimal Setting	Cement	Marble Powder	Fly Ash
EDAS Method	A2 B1 C3	340 kg/m^3	5 %	15 %
Taguchi-EDAS	A2 B1 C1	340 kg/m^3	5 %	5 %

The industry will find the best combinations of PPC, marble powder, and fly ash for building by using the ideal values. Industry will be able to create more optimised concrete that can be utilised in a variety of applications if unit process predictions are more accurate.

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A STUDY ON COMPRESSIVE STRENGTH OF CONCRETE BY PARTIAL REPLACEMENT OF COARSE AGGREGATE WITH COCONUT SHELL AND WITH ADDITION OF FIBER

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ABSTRACT

This research paper discusses the effect of coconut shells and fibers (polypropylene and steel fibers) on M30 gradeconcrete. The fibers used in this work are Polypropylene and Steel Hooked end fibers of 0.5 mm diameter and 60mm length. As the percentage of coconut shell replacement with coarse aggregate increases the strength properties decreases. With the addition of fibers like polypropylene and steel to the concrete with coconut shell, the strength properties of concrete increases some extent but not higher than the conventional concrete.

***Keywords**: coconut shell, compressive strength, steel fibers, polypropylene, replacement of coarse aggregate.*

INTRODUCTION

Concrete is a composite material which composed of aggregates, cement and water. Concrete is used more than any other manmade material in the world. The large scale production of concrete in construction activities using conventional coarse aggregate such as granite immoderately reduces the natural stone deposits and affecting the environment hence causing ecology imbalance.

Extraction and processing of aggregates is also a major concern for environment. Therefore consumption of alternative waste material in place of natural aggregate in concrete production not only protects environment but also makes concrete a sustainable and environment friendly construction material. Different waste material like rubber, fly ash, glass, bottom ash, artificial sand etc., has been used as alternative for replacing natural aggregates. Apart from the above mention waste material, a few studies shows that agriculture waste coconut shell can also are used as coarse aggregate for concrete.

Properties of Coconut Shell

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1. It has added advantage of high lignin content. High lignin content makes the composites more weather resistant.
2. It has low cellulose content Coconut shell has high strength and modulus properties.
3. due to which it absorb less moisture as compare toother agriculture waste.
4. Coconuts being naturally available in nature and since its shells are non-biodegradable; they can be used readily in concrete which may fulfill almost all the qualities of the original form of concrete

OBJECTIVE

It is proposed to study the compressive strength of M30 grade concrete by partial replacing (5%, 10%, 15%) of coarse aggregate with coconut shell and addition of fibers to achieve target strength. The fibers steel hooked end and polypropylene fibersare added at 2% by weight of concrete.

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MATERIALS

The following materials are used in this project

3.1). Cement :

Ordinary Portland cement 53 grade KCP cement was used. The following results were obtained from tests on Cement

Table 1: Results of the cement tests

S.NO	CHARECTERSTICS	RESULTS
1.	Normal consistency	31%
2.	Initial setting time	30min
3.	Final setting time	210min
4.	Fineness	4.8%
5.	Specific gravity	3.15

3.2). Fine Aggregate: Sand conforming to Zone-II was used as the fine aggregate. The specific gravity of fine aggregate was 2.60

3.3). Coarse Aggregate: The coarse aggregates are taken by the size is 20mm passingthrough sieve of size 12.5 and normal grading is used. The specific gravity is 2.4.

3.4). Coconut Shell: The coconut shells are obtained from a local coconut field. Theyare sun dried before being crushed manually. The particle sizes of the coconut shell range from 12 to 20 mm. The surface texture of the shell was fairly smooth on concave and rough on convex faces.

Figure 1 coconut shells

3.5). Fibers:

The fibers used are Polypropylene Fibers(polymer fiber) and Steel Hooked end fibers of 0.5 mm diameter and 60mm length. The addition fibers increase the strength properties of concrete. Steel fiber helps in reducing crack formations in the concrete.

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Figure 2 polypropylene fiber **Figure 3** steel hooked end fiber

***3.6). Water*:** For curing and casting, water available in laboratory which is free of anyforeign material is used.

3.7). Dr S Bond: self-curing agent used for concrete curing. Used for concrete structures, cement mortar surfaces, road dividers, curbing areas, retaining walls and all internal and external masonry surfaces, dam surfaces and other cement related products.

Figure 4 Dr.S.Bond self-curing agent

2. TEST PROCEDURE

Casting:

(1) Concrete blocks of size 150mm x 150mm x150mm were casted.

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(2) The concrete in the cube must be fully compacted with compacting bar or concretevibrator. After 24 hours these moulds are removed and test specimens are kept to curing.

(3) For curing, the specimen is coated with self-curing agent and the specimen istested after 7 and 28 days.

(4) Minimum 4 specimens of each mix proportion containing different percentages ofcoconut shells (0%, 5%, 10% and 15% by weight of aggregates) and fibers will be casted.

Table 2: M30 grade concrete Mix Proportion

Cement(kg)	Fine aggregate(kg)	Coarse aggregate	w/c ratio
425	595	1147.5	0.5

Compression test on concrete is carried out using compression testing machine. For compression test of concrete cube specimens of 150 mm X 150 mm X 150 mm are used. These specimens are tested by compression testing machine after 7 days curing or 28 days curing.

Compressive strength = $\frac{P}{A}$

Figure 5 Compressive strength test

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3. TEST RESULTS

The following test results were obtained from the compression test on concrete

Table 3: Test results of compressive strength test

S.NO	MIX DESIGNATION	COMPRESSIVE STRENGTH	
		7days	28days
1	Nominal mix	28.45	31.6
2	Mix1	16.7	18.9
3	Mix2	13.54	15.49
4	Mix3	9.89	15.93
5	Mix4	20.19	21.28
6	Mix5	16.75	17.96
7	Mix6	14.48	16.7
8	Mix7	21.9	22.42
9	Mix8	17.53	18.6
10	Mix9	15.51	16.7

Nominal mix: concrete with 0% coconut shell and 0% fibers Mix 1: 5% replacement of coarse aggregate with coconut shell.

Mix 2: 10% replacement of coarse aggregate with coconut shell.Mix 3: 15% replacement of coarse aggregate with coconut shell.
Mix 4: 5% replacement of coarse aggregate with coconut shell + polypropylene fiberswith 2% weight of cement.
Mix 5: 10% replacement of coarse aggregate with coconut shell + polypropylenefibers with 2% weight of cement.
Mix 6: 15% replacement of coarse aggregate with coconut shell + polypropylenefibers with 2% weight of cement.
Mix 7: 5% replacements of coarse aggregate with coconut shell + steel fibers with 2%weight of cement.
Mix 8: 10% replacement of coarse aggregate with coconut shell + steel fibers with 2%weight of cement. Mix 9: 15% replacement of coarse aggregate with coconut shell + steel fibers with 2%weight of cement
From the tabulated results the compressive strength of concrete decreases with the increasing the percentage of coconut shell as replacement of coarse aggregate in the nominal mix. The following charts were prepared to compare the compressive strength of different concrete mixes.

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CONCLUSION

As the percentage of coconut shell replacement with coarse aggregate increases the strength properties decreases.

The compressive strength of concrete is increased by 20% with the addition of fibers to the concrete with coconut shells.

With addition of steel fibers the compressive strength of coconut shell replaced concrete increased by 22 %, when compared to plane coconut shell concrete.

Curing agent gives better results for 7 days curing and for 28 days it does not give satisfactory results.

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HIGHWAY CONSTRUCTION ON WEAK SOIL USING EPS GEOFOAM AND GEOMEMBRANES

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ABSTRACT

The expanded polystyrene EPS-geofoam layer construction process and performance evaluation used in the repair and rehabilitation of road work are illustrated in the current study. After seeing significant settling and distress of approach roads close to Cross drainage (C-D) works built on the bypass route of an important National Highway Project in India, the application of EPS geo-foam was recommended. On one side of the C-D work, EPS-geofoam was employed as a substitute for earth backfill in approaches to a newly constructed culvert on the same bypass route, and for comparison's sake; The other side of the C-D work was kept with backfill made of already-existing earth. EPS-Geofoam was simple to work with, simple to install, and efficient to use both in terms of equipment and labour. Additionally, after six months of observation, it was discovered that Pavement Quality Concrete (PQC) built over earthfill material had developed longitudinal cracks as a result of excessive settlement, while PQC built over EPS-geofoam remained intact and showed no signs of distress. The study's findings advocate using EPS-geofoam in similar circumstances in accordance with the suggested construction rules and the cross-sectional details and design recommendations.

KEYWORDS :- EPS-geofoam, Humepipe culvert, Geotextile, pavement, numerical analysis, embankment, Hume pipe, earthen backfill, performance evaluation, long-lasting, and reasonably priced.

1. INTRODUCTION

Infrastructure construction for roads plays a critical part in a nation's economic growth. Construction of a road may occasionally be required over soft or loose soils (compressible soils), which are thought to be inadequate for supporting additional or repetitive loads. Engineers and designers must look into alternative materials that are appropriate in these conditions and do not delay the project's construction in order to address these issues. Due to its light weight and strong compressive strength for

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supporting traffic loads, EPS-geo-foam has been identified as an appropriate substitute material for traditional earthen materials to guard against overloading to underlying soils as well as neighbouring structures.. Because EPS-geofoam is a designed product and comes on site having completed extensive QA/QC testing, its use does not necessitate time-consuming quality assurance/quality control (QA/QC) testing. To meet the needs of particular projects, EPS-geofoam is made in blocks that may be sliced into a variety of forms, sizes, and compressive resistances. It can be manufactured as an engineered product to achieve the necessary compressive resistance. The following are some characteristics of geofoam that make it advantageous for use in civil engineering construction:

- Geofoam, commonly known as "thermo-cole," is a cellular plastic substance that is readily available. blocks or a cellular honeycomb structure. According to ASTM D 4439, geofoam is a stiff cellular foamed polymer that is utilised in geotechnical engineering applications and can be block-shaped or flat.
- In geotechnical engineering, EPS-geofoam is being tested as an alternative to different soil fill materials in situations where a lightweight material is needed to lessen strain on retaining walls, abutments, or foundations or stresses on the underlying soils.
- The EPS-geofoam may be used as specialised treatment alternatives when subsurface explorations reveal that a project's underlying soils are soft or unstable. This will enable completion of the desired final product.

2. HISTORICAL PROGRESSION

The invention of expanded polystyrene (EPS) occurred in the latter half of the 20th century. All across the world, EPS-geofoam has been successfully employed. Norway, the Netherlands, the US, Japan, Germany, and Malaysia are a few of the nations that have used EPS-geofoam. In Europe, EPS has been utilised in highway construction since the early 1970s. Both the first road embankment project and the first road insulation project in Norway employed EPS-geofoam (Frydenlund and Aaboe 2001). The first EPS-geofoam projects in the Netherlands were initiated in the early 1970s (Van Dorp 1988). The use of EPS-geofoam in the United States began in 1996 in New York, while it was employed considerably earlier than in the majority of other nations. The original EPS foam In 1985, a 470 cubic metre embankment fill was used in Japan (Miki 1996). Although EPS-geofoam was first applied in the 1960s as frost protection layers in pavement, it wasn't until March 1995 in Germany that it was employed to reduce the differential settling of a bridge approach (Hillmann 1996). Similar to that, EPS-geofoam was first made available as a lightweight fill material in Malaysia in 1992 (Mohamad 1996).

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3. THE CHARACTERISTICS OF EPS FOAM

Expanded polystyrene (EPS), often known as "EPS- geofoam," is a general term for expanded polystyrene that has been compressed into low-density cellular plastic blocks for use as a stable, safe, and ecologically friendly filler. The first step in the manufacturing process is to steam-treat polystyrene resin beads that contain a hydrocarbon blowing agent. The blowing agent stretches the beads as the polymer softens to create "pre-puff." Then, these already-expanded beads are put into sizable rectangular block moulds. The final result is formed when the beads expand further and fuse together in the moulds after being filled with steam. The schematic diagram of the EPS-geofoam production process is shown in Figure 1 (Elragi, 2000). Geofoam has a lifespan of between 70 to 100 years. Since the early 1990s, the term "geofoam" has been used to refer to any synthetic geotechnical material made through the use of a gas (blowing agent) expansion process that produces a texture with lots of closed cells. A material with the qualities of light weight, insulation, and energy absorption is EPS-geofoam. On the other hand, some types of soil can be compared to it in terms of strength and stiffness. Elgari (2006) conducted a thorough literature study on the characteristics of EPS-geofoam and its applications in civil engineering, and he is heavily cited in this article. The mechanical characteristics of geofoam that are deemed relevant in terms of its geotechnical applications are summarised in Table 1 below. Table 1. Geofoam's density, compressive strength, damping, insulation, and cohesion qualities are used in one or more of several engineering applications, including basement insulation, wall construction, and slope stabilisation. While using geofoams, pavement failures caused by differential icing, for example, should be taken into consideration even though a small number of failures have also been reported in the literature (Horvath 1999), which are related to fire, buoyancy, or floatation. Numerous engineering applications, such as basement insulation, wall construction, and slope stabilisation, make use of geofoam's density, compressive strength, damping, insulation, and cohesion properties. Even though only a few failures related to fire, buoyancy, or floatation have been reported in the literature (Horvath 1999), pavement failures brought on by differential icing, for instance, should be taken into account when using geofoams. It needs sufficient protection against UV radiation, buoyancy, termite attacks, chemical attacks from strong acids, heat, and concentrated loads from a maintenance perspective. The lifespan of an EPS-geofoam can be 100 years if the right circumstances are provided in terms of environment and loading. The benefits of EPS-geofoam in various civil engineering applications are as follows:

- Extremely low weight minimises lateral or bearing loads; predictable performance due to engineering.
- It may be installed, utilised, and applied in a variety of weather situations.
- It increases installation effectiveness.
- The cost-effective EPS-geofoam materials are available in a range of densities to fulfil strength requirements.

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4. DESIGN AND CONSTRUCTION CONCERNS FOR GEOFOAM

EPS-geofoam has been used in design for a number of geotechnical applications, such as backfill in retaining walls.

Definition of the issue and case study goals

The current case study was conducted on a bypass with a length of 12 km that includes close to 35 Hume pipe culverts and C-D works. In the period between one and a half years and six months before to the observation, these culverts had already been built. As soon as these culverts were finished, the approach road was also built to give access for building**.**

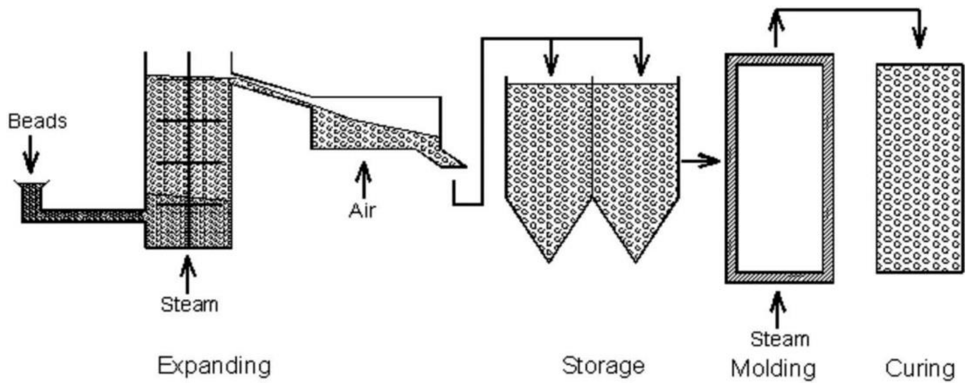

Figure 1 shows the production process for EPS-geofoam [source: online (Elragi 2006)].

Construction process and design

The proposed design for a four-lane divided carriageway with paved shoulder and no service road is shown in Figure 3. It will have a 7.0 m roadway width, a 1.5 m paved shoulder, a 0.5 m kerb shyness, and a 2.0 m earthen shoulder with a 4.0 m median width. It should be mentioned that a 1200 mm thick geofoam layer above the foundation soil is recommended, followed by a 500 mm subgrade (sand layer), 150 mm granular sub base (GSB), 150 mm dry lean concrete (DLC), and 310 mm pavement quality concrete (PQC).

For the construction purposes, the site was first pre- pared by levelling the original ground level (OGL) using motor grader, and the level of compaction to be achieved (relative compaction >95%) was confirmed by conducting field density test using sand replacement method (as per IS 2720- Part 28 1974) (Figure 4(a)) and comparing it with the MDD (maximum dry density) value obtained in the laboratory using heavy compaction test (as per IS 2720- Part 8 1983). The same OGL was levelled using a grader and a levelling tool once the desired compaction had been achieved. OGL was covered with a layer of 4-6 inches of sand before the EPS-geofoam block was put in place. The geomembrane sheet has been laid over the sand levelling process, and attached on each corner by nailing or other ways in accordance with the planned

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pattern. Two workers could easily carry and arrange a typical EPS-geofoam block measuring 0.6 m x 1.2 m x 2.4 m and weighing 36 kg at a density of 20 kg/m3. A total of 12 of these EPS blocks were delivered to the site, and they have been

Figure 2 shows the settling and distress in the C-D culvert approaches.

staggeredly positioned over levelled geomembrane such that vertical joints are not in a straight line. The EPS-geofoam blocks were positioned in straight lines and levelled to maintain verticality. If there are any gaps, they were filled with sand. The process of placing the EPS blocks was regarded complete once the empty spaces between the blocks had been filled and packed. Next, the geomembrane over which the blocks had been arranged was folded and wrapped, leaving no exposed areas of the EPS blocks. The EPS blocks were enclosed as one large unit after being wrapped in geomembrane. Blocks of EPS-geofoam have been placed and wrapped in geomembrane. It had an earthen material covering over it. Layer-by-layer compaction was used to fill the space between the earthy material (sand) and the EPS block material in line with a predetermined technique. The positioning of EPS- In accordance with the right design rules found in NCHRP Report 529, Guideline and Recommended Standard for Geofoam Applications in Highway Embankments, geofoam block was constructed to meet the design criteria for embankment fill near approaches. In Figure 4(b–d), the step-by-step construction process is shown. The considerations listed below are crucial for project selection and design and should be taken into account when Figure 4(b–d) shows the step-by-step construction process. The following are some crucial project selection and design considerations that should be taken into account while

(1) In order to prevent long-term creep deformation, the vertical load acting on the EPS should not be larger than the compressive strength at 1% strain, which is normally 5.8 psi (40 KPa) by specification.
(2) Regular groundwater elevation is typically lower than the EPS fill's bottom because buoyancy forces will cause the EPS blocks to float.
(3) Additional analysis and construction methods, such as the following, may be used if

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EPS blocks are buried below groundwater:

(i) An analysis to produce an acceptable factor of safety against uplift by balancing buoyant forces with enough overburden.

(ii) A study of the kind and quantity of any contaminants in the groundwater that might have an impact on how long the EPS lasts.

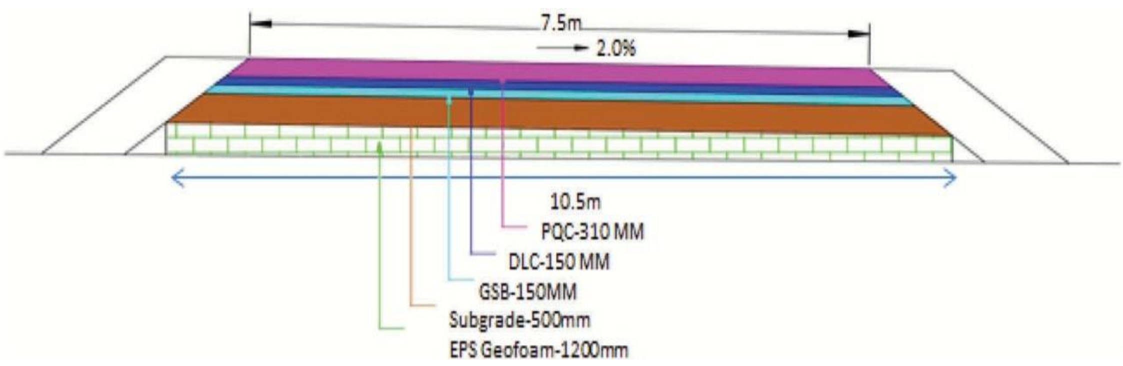

Figure 3 shows the cross-sectional details of the roadway and the subgrade EPS-geofoam layer. Field density calculated using the sand replacement method (a). (a) Laying the geomembrane and sand layer. (c) Placing a block of geofoam atop a geomembrane. (d) Covering geofoam with geomembrane to protect it from termites and water damage.

(a) Field density using sand replacement Method (b) Laying of sand layer and ge - membrane

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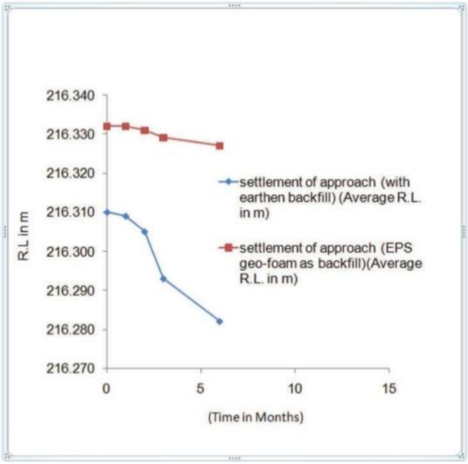
(c) Laying of Geo-foam block overgeomembrane (d) Wrapping of geo-membrane over geo- foam for protection Against water and termilites

Figure 4 shows how to build an EPS-geofoam subgrade layer.



Comparison of settlement of the approach having geo-foam and earthen

5. FIELD FINDINGS

Geofoam was employed at the chosen position on one side of the culvert in accordance with the suggested design shown in Figure 3, and existing guidelines were followed on the opposite side, where earth material was used as fill material in the subgrade layer. It was done with the intention of observing and evaluating the effectiveness of the suggested design employing geofoam in comparison to the current traditional method with earthen materials.

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6. DISCUSSION

It should be noted that the approach where earthfill material was employed experienced significant settlement, and cracks were also seen along the culvert. Following these observations, the following observations have been made:

(1) EPS-geofoam offers a superior substitute to the traditional method, which uses local soil as an earthen fill for building. It has been discovered that the performance of the EPS-geofoam employed at the bottom is significantly greater than that of conventional earthfill in areas with soft, loose, or compressible soil foundations or in areas close to structures where suitable compaction equipment cannot be mobilised.

(2) Without the use of machinery or equipment, EPS-geofoam was readily handled and arranged in the necessary layers and thicknesses according to the layout and design. Geofoam layer preparation takes a lot less time than earthen layer preparation, which calls for the use of materials (borrow local resources), machinery (spreading and compacting equipment) and labour for site quality control (field compaction test, etc.)

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(3) When compared to the pavement layer resting on earthen back fill on the opposite side of the culvert, less settlement was seen in the first, second, third, and sixth months after the installation of pavement layers utilising EPS-geofoam.

FEM-BASED NUMERICAL ANALYSIS

According to the issue statement, numerical analysis of a four-layered rigid pavement was carried out using the PLAXIS 2D code for the comparative study and performance assessment of the pavement layer with and without geofoam. A finite element software programme called PLAXIS has been utilised specifically for reviewing and analysing the degree of stability and deformation induced by various factors in geotechnical engineering projects. This software's straightforward graphical input techniques allow for the rapid creation of complex finite element models, and the improved output results option offers a thorough explanation of computational mathematics. The calculations are carried out entirely automatically and rely on reliable numerical techniques.

The typical cross section of a pavement structure with wheel load is shown in Figure 6. It is evident that a geofoam layer was used during construction on the D-side of the Hume pipe box culvert, whereas embankment layers were provided according to standard design principles on the H-side of the structure.

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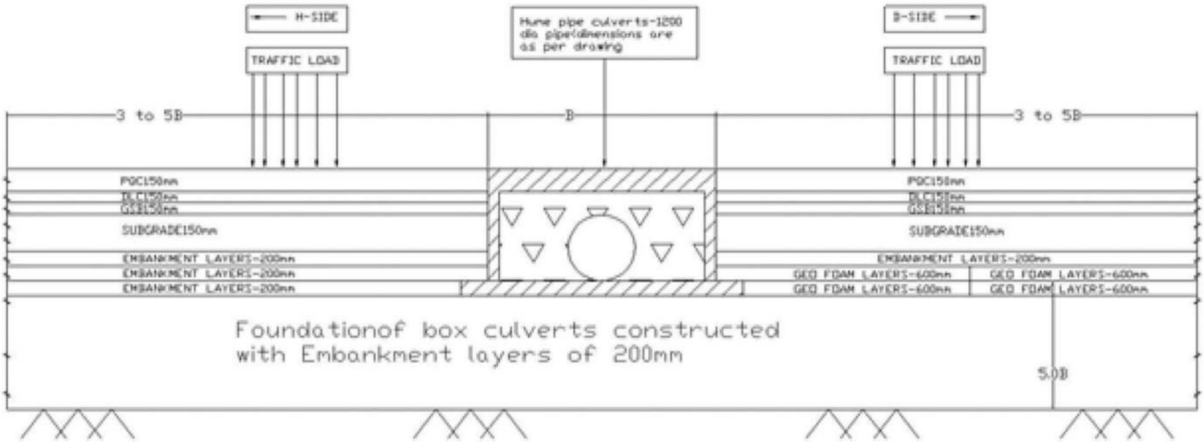

Figure 6. Typical cross section of the rigid pavement

7.CONCLUSION

In terms of design, the suggested cross-sectional details using geofoam material as an alternative to standard earthfill exhibit extremely good performance with regard to resistance to settlement and deformation of culvert approach both experimentally and statistically. As a result, using EPS-geofoam as a repair method for settlement on cross drainage (C-D) structure methods has been developed. From a construction standpoint, it has been discovered that EPS-geofoam is convenient to handle and simple to place when used as an alternative to earthfill in culvert approaches. From the observations, it may be reasonable to draw the conclusion that EPS embankments buried for a typical life cycle of 100 years will not degrade.

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RECYCLED RUBBER TYRE AS COARSE AGGREGATE REPLACEMENT IN SELF-COMPACTING CONCRETE

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ABSTRACT

The solid waste disposal is a major environmental issue on cities around the world. The volume of polymeric waste like tyre rubber is increasing at a fast rate. The waste tyre rubber becomes an environmental problem due to its non-biodegradable nature. up to now a small part is recycled and millions of tyres are just stockpiled. In the past few decades, due to the exponential increase of the world’s population, the number of discarded waste tires has become a serious ecological and environmental problem. Decomposition of waste tire rubber can take longer than 50 years, and every year the number of discarded tires is rapidly growing. With the inclusion of waste tire rubber into self-compacting concrete this global problem can be reduced. Waste tire rubber can be incorporated in self-compacting concrete by partially replacing the coarse aggregate, reducing consumption of gravel and preserving the natural materials. In addition, recycling and reusing waste tire rubber avoids the need for tire landfilling, as one of the major ecological problems of the near future. This paper presents an overview of the literature investigating recycled waste tire rubber used as a coarse aggregate replacement in self-compacting concrete.

Keywords: self-compacting concrete; coarse aggregate; recycled rubber; aggregate replacement.

1. INTRODUCTION

Every year all over the world, a steady stream of large volume of waste tires is generated due to the continual increase in the number of all kinds of transport vehicles. Since the last two decades in India, transportation vehicles have been increasing tremendously. Tires are bulky, and 75% of the space a tire occupies is void, so that the land filling of scrap tires has several difficulties as whole tire land filling requires a large amount of space. Because of these difficulties and the resulting high costs, tire stockpiles have turned up across the country. These waste tires represent a significant environmental, human health, and aesthetic problem. The unique properties of scrap tires have made the wiping out of waste tire stockpiles difficult. d because of the overwhelming number of disposed tires, landfills are being cluttered with scrap tires and causing additional exposure to potential environmental threats, such as mosquitoes, mice, other insects, rats, and an increased risk of fire hazards.

Due to the fact that the waste tire rubber, as a non-biodegradable material, has a

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relatively long lifetime, interest in replacing natural river aggregate in concrete mixtures with rubber derived from waste tires, i.e., rubberized concrete (RC), has attracted the attention of civil engineers and building industry to provide environmental-friendly concrete with recycled tire rubber

Furthermore, common ways of disposing of the scrap tires, such as landfilling and burning, may cause grave ecological problems, either because of the fast depletion of the site or air pollution, respectively. According to the European Tyre and Rubber Manufacturers Association, the number of end of life tires has grown from 2.48 to 2.88 million tonn's from year 2004 to year 2013. Still, thanks to different types of associations across the world that promote a circular economy and sustainable development, recycling of waste tires and reuse of tire derived rubber has become very popular in the last few years. Recycling of waste vehicle tires has become very popular topic among scientists and engineers.

Overall, the world produces around 5 billion tonn's of concrete a year. From an ecological point of view, by implementing rubber derived from waste tires in concrete, the amount of disposed waste tires would become smaller and provide a source of eco-friendly concrete. From an engineering point of view, adding waste tire rubber into concrete could produce a material with improved dynamic and durability properties, such as ductility, damping capacity, chloride-ion penetration resistance, carbonation resistance etc.,

Similar to traditional concrete, self-compacting rubberized concrete however has lower levels of emitted radiation and thus safer to building users. Because of its high ductility, improved impact resistance, and energy dissipation properties. Because of its improved impact resistance and ductility, other researchers have suggested that self-compacting rubberized concrete could be used for structural elements subjected to dynamic loads. Rubberized concrete has been used in several applications so far, i.e., road barriers, sidewalks, and pavement. Before this can be accomplished, it is suggested that experimental investigation on self-

Compacting rubberized concrete needs to be carried out.

In this paper we are trying for Replacement of coarse aggregate of standard concrete mix with chipped shape scrap tire waste as 0%, 12%, 23%, and 30% respectively. The resulting concrete specimens are tested for the physical properties of concrete such as crushing strength, splitting strength and bending strength. It was concluded that 23% alteration of coarse gravel with reshaped rubber gravel is the optimum replacement percentage.

The main objective of this paper is to provide an overview of coarse aggregate replacement with recycled rubber in self-compacting concrete. The fact that coarse aggregate makes approximately 45% of weight of the self-compacting concrete can be used as a motivation to thoroughly study the influence of partially replacing natural aggregate with waste tire rubber.

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2. EXPERIMENTAL WORK

2.1 Material Properties:

2.1.1 Cement:

PPC of grade 43, conforming to Indian Standards (IS): 8112-1989 was used. Specific gravity of cement was found to be 3.15, Normal consistency was 32%, Initial setting time was 42 min and final setting time was 6hours.

Fig-1 Cement

2.1.2 Fine Aggregate

The M-sand which was available locally that passed in 4.75mm sieve corresponding to IS 383, 1970 was used as fine aggregate. This fine aggregate satisfies the Zone-II category grouping. Table 1 shows the sensible properties of fine aggregate and coarse aggregate. Table 1. Sensible Properties of Fine Aggregate and Coarse Aggregate.

Fig-2 fine aggregate

Table 1 Physical Properties Of Fine Aggregates

PROPERTIES	TEST RESULTS
Specific Gravity	2.64
Fineness modulus	2.82
Water absorption	0.98%
Silt content	4.6%
Bulk density	3%

2.1.3 Coarse Aggregares:

The 20 mm well graded and smaller size were made use in this study. The gravel was tested according to the Indian Standards 383 – 1970.

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Fig-3 Coarse aggregate

Table 3 Physical Properties of coarse Aggregates

PROPERTIES	TEST RESULTS
Water absorption	0.94%
Specific gravity	2.77
Grading ratio 20mm to 12.5mm	2:1
Aggregate crushing value	28%

2.1.4 Recycled Rubber:

Waste tire rubbers generally square in shape and, chipped type obtained from local market with max size of 20mm without removing of steel wire was used as rubber aggregate and the physical properties of rubber aggregate were determined in table.

Fig-4 Recycled rubber

Table 4 Properties of Rubber Tyre Pieces

PROPERTIES	VALUES
Type	Lorry scrap tire with steel wire
Ash content	5.43%
Tensile strength	17.71kg/cm2
Specific gravity	1.40
Water absorption	0.01%

3.EXPERIMENTAL RESULTS AND DISCUSSION

3.1 WORKABILITY

The workability of the concrete was measured immediately after its manufacture in terms of slump in accordance with IS: 7320-1974 for testing fresh concrete. It is noted

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that slump has been fall off due to increase in percentage of rubber aggregates at same w/c ratio in control and all replaced samples of concrete mix. In control specimen, slump is seen to 92 mm and when the coarse aggregates are replaced with 30% tire chips then the slump is about 6 mm which becomes about zero slump value. Figure 8 shows the slum values at different values of scrap tire rubber.

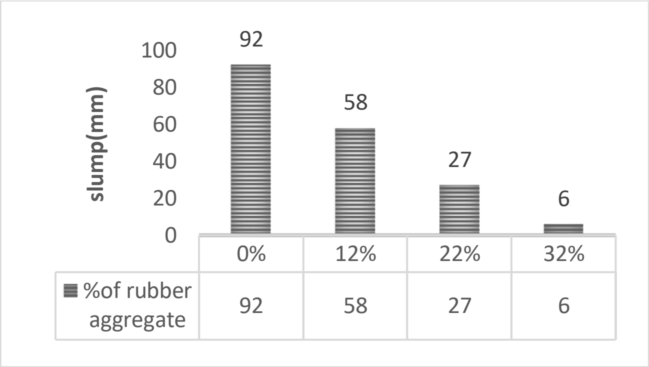
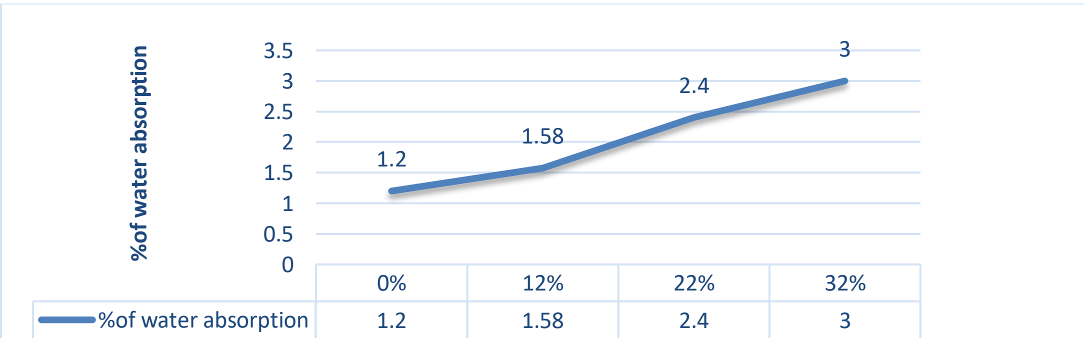


Fig-5 Sump values of different percentage of rubber aggregate

3.2 WATER ABSORPTION

ASTM C642-81 explains the method to determine water absorption in concrete. Cubes (150mm x150mm x150 mm-set of 3 samples each) were casted and cured. Water absorption test carried out on concrete cubes and it was found that it will be increases by increasing the content of scrap tire rubber in place of coarse aggregate to 32% because the weak bond between the cement pastes and the rubber aggregate as a result the vacuums will be increases this leads to the water to penetrate through the interface zone of cement matrix and rubber aggregate. Also, formation of internal voids due to rubber replacement causes water absorption. At the age of 28days, the amount of water absorption for control mix was found 1.2% as shown in figure 12. Percentage increase at 12%, 22%, and 32% replacement of rubber aggregate by control specimen was found 36%, 102% and 158%respectively.



Graph 1 Water absorption values

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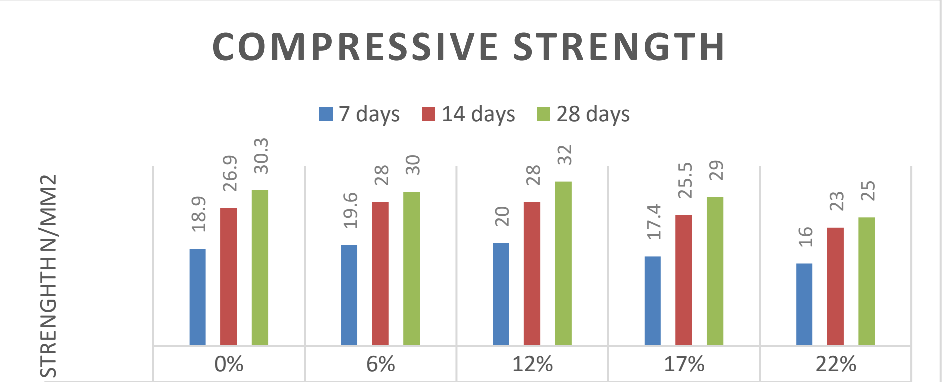
3.3 COMPRESSIVE STRENGTH

The Universal Testing Machine (UTM) was used to perform the crushing test on the cube and cylinder specimens. After 7, 14 and 28 days of curing, the cube specimens of size 150x150x150mm were studied. For each mix and each test, 3 specimens were tested and analyzed. The compressive strength was calculated using the formula

Fc= P/A

Where, Fc is the compressive strength in MPa; P is the applied ultimate load; A is the sectional area in mm2.

The compressive strength values after 7,14 and 28 days of curing is given in below graph.



	0%	6%	12%	17%	22%
7 days	18.9	19.6	20	17.4	16
14 days	26.9	28	28	25.5	23
28 days	30.3	30	32	29	25

Graph 2 Compressive strength values

3.4 SPLIT TENSILE STRENGTH

The malleable property of concrete was found out using the splitting strength test. After 7 and 28 days of curing the test was carried out on the cylinder specimens of size 150x300mm respectively using the Compression Testing Machine (CTM). The splitting strength was calculated using the formula

$$FCT = 2P/\pi dl$$

where, F is the Split tensile strength in MPa; P is the Compressive load on the cylinder specimen in N; l is the length of the circular solid in mm; d is the diameter of the cylinder in mm.

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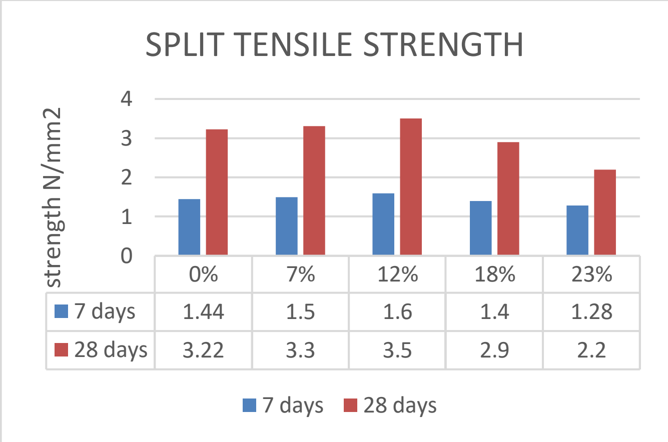


Graph 3 Split tensile strength values

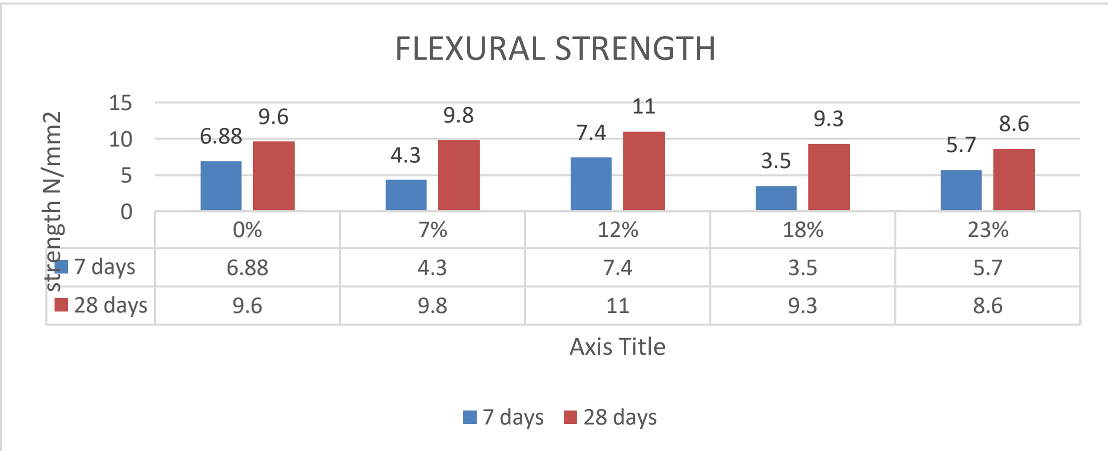
The graph above shows the split tensile strength test results. It was observed that the strength had marginal increase in 7% and 12% rubber tire replacement and decreased in the 18% and 23% rubber tire replacement. At 7 days, the strength of 10%was 1.5 N/mm2 which was up to 12.85% increase related to the normal concrete mix. At 28 days, the strength of 12% was 3.5 N/mm2 which was up to 11.80% increase related to the normal concrete mix.

3.5 FLEXURAL STRENGTH

The flexural energy of the concrete was found out by conducting the flexural energy test. The prism specimens of size 100x100x500mm cured for 7 and 28 days are tested in this experiment. The bending strength of the prism specimens was found using the two-point loading method after 28 days of curing. The bending strength is determined using the formula

$$FB=PL/bd2$$

Where Fb is the flexural strength in MPa; P is the ultimate load applied; L is the length of the span in mm; b is the breadth of the specimen in mm; d is the height of the specimen in mm;



Graph 4 Flexure strength values

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4.CONCLUSION

Based on the experimental investigation, the following can be concluded:

The study illustrate that it is possible to design rubberized concrete with varying percentage of scarp rubber by coarse aggregate such as 0%, 10%, 20%, 30%.Higher content of waste tire rubber (chipped shape) produces the light weight concrete. Introduction of recycled rubber tires into concrete mix leads to decrease in slump and workability for the various mix samples. Minor decrease in flexural strength was observed on using waste rubber as coarse aggregate. The highest reduction was related to 30% replacement of rubber used. The reduction in flexural strength at 28 days of age was about 26.83%.Density decreases as the percent of rubber aggregate increases, for various percentages of mixes. Water absorption increases as percentage of rubber aggregate content increases. It is observed that the specific gravity and bulk density of rubber aggregates are less as compared to natural coarse aggregates.Rubberized concrete can be used in non-load bearing members with medium strength requirement.12% replacement of coarse aggregate by reshaped rubber chips resulted in increase in the crushing strength of the concrete as related to the normal concrete mix.The split tensile strength is increased in 12% coarse aggregate replacement with reshaped rubber chips when related to the normal concrete mix. The 12% replacement of coarse gravel with reshaped rubber chips also showed increase in the flexural energy of the concrete specimens as related to the normal concrete mixThe hole made on the surface of the reshaped rubber showed promising results on the mechanical characteristics of the concrete.

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PREPARATION OF ECO-FRIENDLY BRICKS WITH RUBBER AND PLASTIC

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ABSTRACT

Summary Plastics are key resources in the circular economy and recycling at the end of their useful life with the creation of economic value and minimal environmental impact is key to their sustainable management. The study also presents the results of experimental work on bricks made from non-recyclable waste thermoplastic granules with a weight fraction of 20%, 4 kg of fly ash, cement and sand making up the remainder. The bricks were cured under water for 28 days and fired for 2 hours at a temperature ranging from 90°C to 110°C. The key properties of these bricks have been found to be light weight, porous, low thermal conductivity and significant mechanical strength. At a low temperature sufficient to melt the plastic waste diffusing into the body of the bricks. The compressive strength after adding the plastic waste is the same as the normal strength of the brick. Also, it reduces the water absorption capacity of the brick compared to the nominal brick. The values were lower than normal bricks. A mathematical model is developed to predict the compressive strength of bricks with different plastic contents.

Keywords: Plastic waste, rubber, water absorption, compressive strength

1. INTRODUCTION

Plastic is a common material used by everyone around the world today. Plastic plays a predominant role in reuse in this age due to its compactness and lightness. Commonly used plastic items are covers, bottles and food Packaging. The big problem with plastic is its degradation. Plastic is made from chemical polymers and is not biodegradable. Although plastic is a very useful material that is flexible, strong and rigid, after use it becomes waste and pollutes the air and the earth. Recycling is the processing of waste materials into new products to avoid wasting potentially useful materials. The increasing popularity of using low cost, lightweight, environmentally friendly building materials in the construction industry has created a need to investigate how this can be achieved while benefiting the environment and complying with material requirements and standards using the components of the plastic recycling process. For the production of plastic bricks, it is an optimal way to control the decomposition problem of waste

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plastic. In this study, plastic waste from cement and sand incorporation factories is used to manufacture sand bricks. The bricks are then tested for compressive strength and water absorption. Chemically treated polyethylene fibre, PET in the form of small particles by replacing natural coarse aggregates.

2. MATERIALS

2.1. Cement

Cement was made by heating limestone (calcium carbonate) with small amounts of other materials (such as clay). Tests were conducted on various physical properties of the cement and the results are presented in the material test data. The cement serves as a binder in tabulated in table1.

Table 1 Physical Properties of Cement

Sl. No.	Tests	Values
1	Initial setting time	30 minutes
2	Final setting time	600 minutes
3	Fineness	Not less than 90%
4	Specific gravity	3.10 to 3.15
5	Standard consistency	30% to 35%

2.2*Fine aggregates:*

Silica material has been used as a fine aggregate in concrete and mortar. Natural river sand is the most preferred choice for fine aggregate. a period of millions of years. It is extracted from river beds. River sand is now becoming a rare commodity. The river was a clean water, superior sand far better for construction than any other sand used in construction. River sand mining is an important economic activity in India and river sand constitutes a crucial raw material for the construction industry.

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Table 2. Physical Properties of Fine aggregates

Physical properties	Value
Specific gravity	2.62
Shape of grains	Rounded

3. METHODOLOGY

3.1 Sand to Plastic Ratio:

Plastic material needs to be collected from factory waste, hospital and industrial waste, as well as from food containers and plastic bottles. Fall under the plastic type LDPE The measurement of materials used to make bricks is called batching. After the material collection, we separate the types of plastic and eliminate all other waste present in the collected material

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and check whether the water content in the collected sample is processed for incineration after the completion of batching, the waste plastic was subjected to incineration where the plastic bags were dropped into the container one by one and melted. This would be done in a closed container to prevent toxic gases from being released into the atmosphere. These have a temperature of 90, 110 degrees Celsius Is essential for producing consistent and strong bricks. The purpose of mixing is to ensure that the mass becomes homogeneous, uniform in colour and consistency. There are generally two types of blending, manual blending and mechanical blending. Mixing this we have adopted manual mixing. Until all of the plastic fraction needed to make plastic bricks of one mix ratio is added. These plastic liquids are then thoroughly mixed with a paddle before hardening. The mixture has very short setting time. To the molten state; sand is added. Therefore, the mixing process shouldn't take any longer after the proper mixing is done, we pour the mixture into the required shape. Take the brick out of the mould after 2 days and then harden completely. Were allowed to dry after moulding for a period of 24 hours. The samples were stored in a curing tank and allowed to cure for a period of 28 days.

4. EXPERIMENTAL ANALYSIS

4.1. Compressive strength:

The compressive strength tests of the sample brick are calculated for 3 aspects after 7, 14 and 28 days of curing used the UTM in the tests. After the curing time has elapsed, the bricks are stored for testing the samples, the bricks are placed in the calibrated compression testing machine with a capacity of 3000 KN (kilo Newton) and evenly loaded at a speed of 2.9 k N/min. Reaching the maximum load is considered a load failure with sample, resulting in no additional increase in the reading on the test machine

4.2. Water absorption:

Bricks must not absorb more than 12% water by weight. Cool the bricks to room temperature and weigh (W1). Immerse in completely dry and heavy stone (W1) in clean water at a temperature of 27 ± 20o C for 24 hours. Remove the stones and remove any traces of water and weigh them immediately. (W2) For this test, the brick must be placed vertically in water with one end submerged. The depth of immersion in water is 2.5 cm, then the whole assembly should be kept in a warm and ventilated room of 20, 30 o C until complete evaporation. When the water from the slab is absorbed by the brick and the excess water evaporates and evaporated, add a similar amount of water to the bowl and soak up and evaporate as before. The determination of the brick after the experiment should be the percentage of white spots in the surface of the brick.

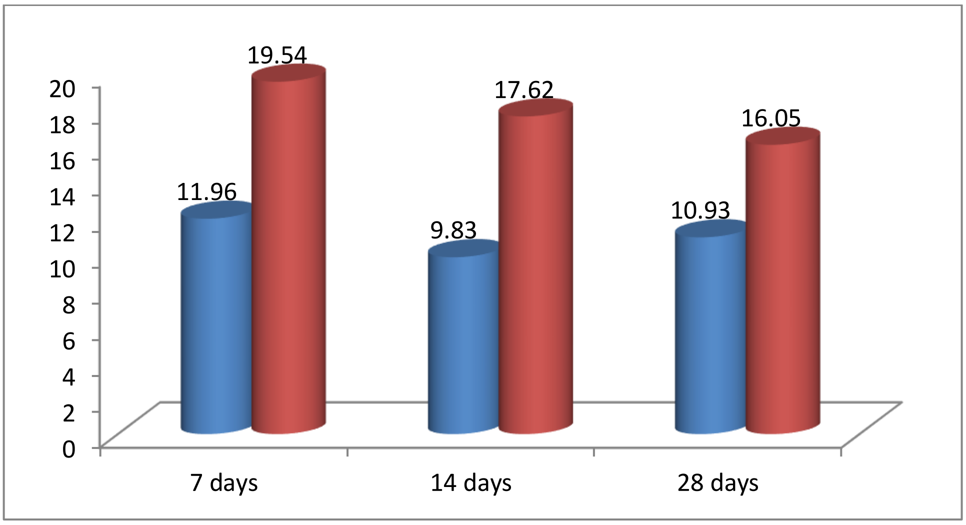
5. RESULTS AND DISCUSSION

5.1 Compression Strength:

The tests on Compressive strength of the specimen brick shall be calculated for 3 aspects after 7, 14 & 28 days of curing using the formula as follows,

Table 3 Compressive strength of plastic brick

Blocks	7 days	14 days	28 days
Compressive strength of Ordinary paver block(N/mm2)	11.96	9.83	10.93
Compressive strength of Plastic paver block(N/mm2)	19.54	17.62	16.05



Graph 1 Compressive strength of bricks at 7,14 and 28 days

5.2 Water absorption:

Bricks must not absorb more than 12% water by weight. Cool the bricks to room temperature and weigh (W1). Immerse in completely dry and heavy stone (W1) in clean water at a temperature of 27 ± 20o C for 24 hours. Remove the stones and remove any traces of water and weigh them immediately. (W2) For this test, the brick must be placed vertically in water with one end submerged. The depth of immersion in water is 2.5 cm, then the whole assembly should be kept in a warm and ventilated room of 20,30 o C until complete evaporation. When the water from the slab is absorbed by the brick and the excess water evaporates. and evaporated, add a similar amount of water to the bowl and soak up and evaporate as before. The determination of the brick after the experiment should be the percentage of white spots in the surface of the brick.

Table 4 water absorption for plastic brick

Mix	**Composition**	**Water Absorption (%)**
Trial Mix 1 Trial Mix 2 Trial Mix 3 Trial Mix 4	Without Plastic Replacement	1.65 **2** 1.7 **3** 1.79 **4** 1.85
Trial Mix 5 Trial Mix 6 Trial Mix 7 Trial Mix 8	With Plastic Replacement	1.80 1.72 1.65 1.60

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6. CONCLUSION

Plastic waste that is available everywhere can be effectively used to make bricks. Plastic bricks can help reduce pollution and make the environment clean and healthy. Bricks, Plastic sand bricks reduce the use of clay in brick production. Plastic sand bricks provide an alternative to bricks for customers at affordable prices. We conclude that plastic sand bricks are for the construction industry useful compared to fly ash bricks and third grade clay bricks.

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UTILISATION OF SUGAR CANE BAGASSE ASH IN CONCRETE AS PARTIAL REPLACEMENT OF CEMENT

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ABSTRACT

This research addresses the suitability of sugarcane bagasse ash (SCBA) in concrete used as partial cement replacement. Two grades of concrete M15 and M20 were used for the experimental analysis. The cement was partially replaced by SCBA at 0%, 7%, and 10%, by weight in normal strength concrete (NSC). The innovative part of this study is to consider two grades of concrete mixes to evaluate the performance of concrete while cement is replaced by sugarcane bagasse ash. The cube specimens having size 150 mm X 150 mm X 150mm were used and tested after curing period of 14, 21 and 28 days. It was observed through the experimental work that the compressive strength increases with incorporating SCBA in concrete. Results indicated that the use of SCBA in concrete (M20) at 7% increased the average amount of compressive strength by 14% as compared to the normal strength concrete. The outcome of this work indicates that maximum strength of concrete could be attained at 7% replacement of cement with SCBA. Furthermore, the increase of flexural strength and the SCBA also gives compatible slump values which increase the workability of concrete.

Keywords: sugar cane bagasse ash (SCBA), specific gravity, pozzolanic material, agricultural waste, cement, sand, compressive strength & Slump test.

1. INTRODUCTION

Sugarcane is main food crop in tropical and subtropical countries. It is the major resource for the sugar production. Sugarcane bagasse (SCB) is the waste created after juice extraction from sugarcane. The bagasse ash (SCBA) is acquired through the control burning of sugarcane bagasse. The SCB creates the environmental nuisance due to direct disposal on the open lands and forms garbage heaps in that area . According to research, that one ton sugarcane generates the 280 kg of bagasse waste. It generates economics as well as environmental related issues, to solving this issues, enormous efforts have been global towards the bagasse waste management i.e. handling, disposed-off and application. To reduce the environmental burden, the usage of waste materials in concrete is a significant aspect, the sugarcane bagasse ash (SCBA) is a

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waste material of sugar industry, which has a good potential to utilize in concrete as cement replacement. Sugarcane is main crop and besides that high worth crop of south Asia normally termed as cash-crop. It is important to sugar and production related to it. Furthermore, globally, the researchers are concentrating on usage of both industrial and agricultural waste, as raw material sources for the industry, the appropriate usage of this waste material would not only be economical benefits, but may also result in foreign exchange wages and environmental pollution control.

Cement is the most widely consumable material in the infrastructure development works. It is considered as a durable material of construction. However, the environmental issue of cement has become a rising concern, as cement industries are accountable around 2.5% of total worldwide waste emissions from industrial sources. It is need of time to rise the use of cement replacement materials in the concrete which can reduce the significant amount of cement consumption, because the production of cement required huge energy and conferring to Asma. It is also accountable for 5% of global anthropogenic $CO2$ release and their usage can also improve the properties of concrete. The burning of organic waste of sugar industry known as bagasse, produces the considerable amount of ash named as sugarcane bagasse ash (SCBA). SCBA is freshly acknowledged as a pozzolanic material; though, there is partial research statistics accessible to the effects of SCBA on the behavior of concrete.

Therefore, it was highly recommended to conducting research on the bagasse and their impact on concrete behaviour. Generally, the bagasse waste is disposed to the landfills or disposal sites where ever present in the country and rare studies has been conveyed yet. The bagasse ash can be used as partial cement replacement in concrete. Meanwhile, in the present era there is a huge rise in the production of sugar worldwide, and almost 1500 Million tons of sugarcane are yearly produced in all over the world, which leaves around 40 - 45% bagasse afterward juice removal. So, a normal yearly production of bagasse is projected as 600Million tons, which is a bulky waste from sugar industry. For the construction industry the concrete is one of the most important item which is prepared for mixing of cement, fine aggregates and coarse aggregates and within the concrete the role of cement is very vital. Without cement, one cannot build reinforced structures. However, the high used of cement are an important concern of world environmental professionals. Considering the facts, one of the effective way to reduce the environmental impact is to use mineral admixtures, as a partial cement replacement in concrete, which will have the possible to cost reduction, energy conservation, and waste emission minimization.

Therefore, realizing the significance of the issue, this research work is carried out to find out the optimum percentage cement replacement of SCBA in M15 & M20 grades of concrete, because grades M15 or M20 are widely used for reinforced concrete works. Grades M40 used for very heavy reinforced concrete/pre-cast/pre-stressed and M30 used for heavy reinforced concrete/pre-cast. Hence, the object of this research is to

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evaluate the performance of concrete while incorporating sugarcane bagasse ash as cement replacement in different mixes proportions.

2. MATERIALS

2.1. *Cement*

Ordinary Portland Cement 53 was chosen for experimentation, owing to the high initial strength and quicker setting time. The physical properties as provided by the manufacturer are tabulated in table1.

Table 1. Physical Properties of OPC 53 Cement

Physical Properties	values
Fineness	7.5%
Initial setting time	28min
Final setting time	600min
Specific gravity	3.15

2.2 Coarse Aggregates

Locally available coarse aggregates having a maximum size of 20mm, and 12.5 mm size were used in this work. The aggregates were tested as per Indian Standard Specifications.

Table 2. Physical Properties of coarse aggregates

Physical Properties	*Value*
Specific gravity	2.17
Water absorption	1.63%
Bulk density	1550kg/m3
Fineness modulus	4.829

2.3 sugarcane bagasse ash (SCBA)

Sugarcane bagasse brought from local sugarcane juice shop and was burnt in a closed drum (uncontrolled burning), SCBA was obtained after passing through 300µm standard sieve.

Table 3. Physical Properties of SCBA

Physical Properties	Value
Specific gravity	1.971
Fineness	2.516%
Colour	Black
Particle shape	Powder form

Table 4. Typical chemical composition of bagasse ash

S.No.	Component	Percentage
1.	SiO2	65
2.	Al2O3	3.95
3.	Fe2O3	9.17
4.	CaO	12.6
5.	MgO	0.6
6.	SO3	0.1

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7.	L.O.I	9.02

3. METHODOLOGY

3.1. Specimen preparation and curing:

For the experimental analysis total 18 concrete specimens were casted. The size of each specimen was taken as 150 mm x150mm x150 mm cubical in shape. Concrete mixes were prepared as M15 & M20 grades then, concrete cubes were kept for the curing purpose as shown in figure 1, for the period of 14 ,21 and 28 days. While preparing the concrete cubes, the slump test was also checked for the each grade for NSC and after replacing the SCBA in concrete. Afterward, cement is replaced by SCBA as per percentage given in the table 5 and same shall be cured for the mentioned period of time. For the each grade of concrete the cubes were casted to check the average results. After the completion of the required curing period every specimen was checked for the compressive strength in the compressive strength machine as shown in figure 2. After the necessary investigations tested samples will be placed outside of the laboratory

Table 5. Quantity of specimens.

% of SCBA	**Mix proportions**	
	M20(1:1.5:3)	**M15(1:2:4)**
0	3	3
7	3	3
10	3	3
Sub total	9	9
total	18	

Fig.1. Specimen in curing tank.

4. RESULTS AND DISCUSSION

4.1 Slump test:

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The slump test was performed for the concrete with and without SCBA to check the consistency of NMC and the observed result are reported in table 6

Table 6. Slump values of different grades of concrete.

S.no	Mix proportions	OPC % Replacement with SCBA	Average slump value (mm)	Increase(%)
1	M20(1:1.5:3)	0	27.89	-
2		7	42.5	34
3		10	51.12	45
4	M15(1:2:4)	0	31.94	-
5		7	37.48	15
6		10	44.64	28

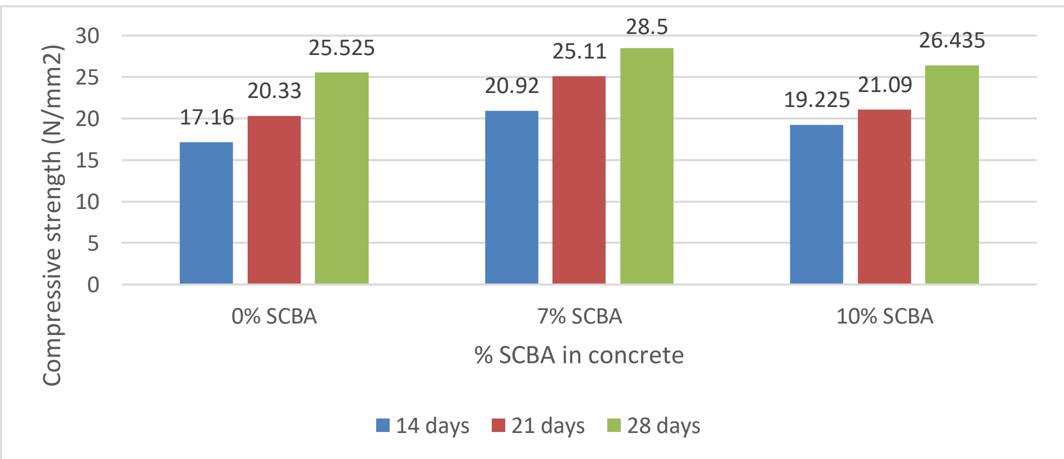
After the execution of slump test for concrete grade M15 & M20, the continuous rise in the slump value were recorded, when cement replaced by SCBA. The range for slump test was targeted in between 25 mm to 75mm (as recommended by ACI). It is prominent that slump value represent the workability of fresh mix concrete and the observed values fall in the category of low and medium degree of workability. Therefore, the usage of super plasticizer (SP) is not essential in this case.

4.2 Compressive strength of concrete

The compressive testing machine was used to test the entire concrete cylinders for crushing strength at 14 , 21 and 28 days respectively. The compressive strength for concrete grade M20 (1:1.5:3) and M15 (1:2:4) were investigated for the control mix and while cement was partially replaced by SCBA. The results of compressive strength test at different curing periods are provided in table 7 and 8. Through the laboratory observations it was perceived that early age strength is lower than the later age strength, because concrete gain its strength.

Table.7. Compressive strength of concrete for M20 (1:1.5:3)

OPC % Replacement with SCBA	Compressive strength (N/mm2)		
	14 days	21 days	28 days
0	17.16	20.33	25.525
7	20.92	25.11	28.5
10	19.225	21.09	26.435



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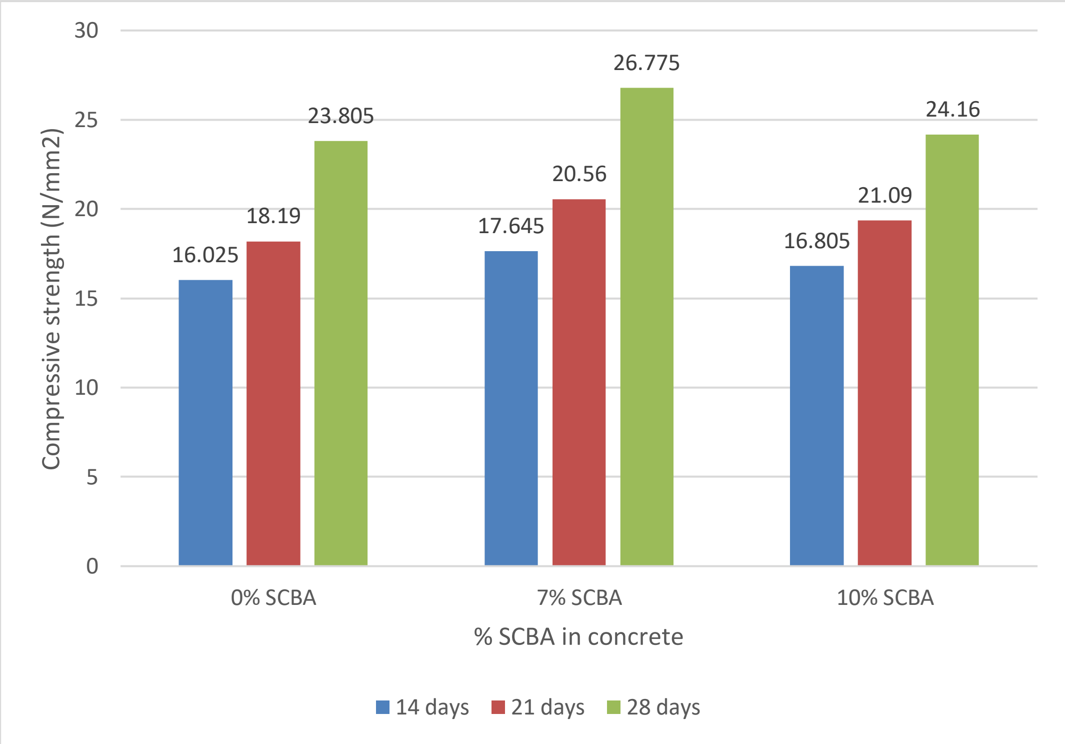
Graph 1 Compressive strength of concrete grade M20

Table .8. Compressive strength of concrete for M15 (1:2:4)

OPC % Replacement with SCBA	Compressive strength (N/mm2)		
	14 days	21 days	28 days
0	16.025	18.19	23.805
7	17.645	20.56	26.775
10	16.805	19.35	24.16



Graph 2 .Compressive strength of concrete grade M15

Subsequently, experimental analysis has done for concrete grade of M15. The result of compressive strength test for grade M15 has been presented in figure 4. The higher results were recorded at 28 days curing period, when cement is replaced with SCBA in concrete at 7% then the average amount of compressive strength will increase about 11.50% as compared to the normal strength concrete. Furthermore, for the both grade (M20 and M15) of concrete while containing SCBA, the compressive strength were detected as lower at the early ages but improves significantly by increasing the curing period. This phenomena of gaining strength with increasing curing time is comparable with previous findings while using cement replacement materials.

5. CONCLUSION

This research was successfully carried out, to the establishment of SCBA as an

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alternative cement replacement material in concrete. After the detailed investigation the following conclusions have been drawn:

• SCBA in concrete gives the higher compressive strength as compared to the normal strength concrete, hence optimal results were found at the 7% replacement of cement with SCBA.

• The usage of SCBA in concrete is not only a waste-minimizing technique, also it saves the amount of cement.

• The replacement of cement with SCBA increases the workability of fresh concrete; therefore, use of super-plasticizer is not essential.

• It is recommended that future research should be performed to assess the use of SCBA in concrete for several properties of concrete for example modulus of elasticity, flexure test, split tensile test, drying shrinkage etc.

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CASE STUDY ON NEIGHBORHOODS FEATURES PLAY AN IMPORTANT ROLE IN INDIVIDUAL LOW-COST HOUSING IN INDIA

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ABSTRACT

Residential and neighborhoods satisfaction is a key measure of housing quality and condition, which has a significant impact on people's quality of life. The elements that influence their happiness are critical inputs in determining the success of housing initiatives. Using a case study of a fast-growing state of Penang and a less-developed state of Andhra pradesh, this study analyses how elements such as dwelling units, housing services, and neighbourhood facilities and environment affect individuals' satisfaction in private low-cost housing in India. The information was gathered from 795 households in Vijayawada and Guntur who live in low-cost housing developments built by private developers. The data was subjected to descriptive and factor analyses. The study's findings show that neighbourhood variables are the most important determinants of residential satisfaction. The satisfaction levels with developer-provided residential units and services are often greater than with neighbourhood facilities and the environment. Poor public transit, a dearth of children's playgrounds, community halls, car parks, security, and handicap facilities are all contributing reasons to low levels of satisfaction with neighbourhood facilities and environment. Due to the business motive of private developers, less attention has been paid to the provision of neighborhood amenities and the environment. This suggests that the government should actively monitor the implementation of low-cost housing initiatives in order to improve housing quality for people.

Key words :- Low cost Housings, neighbourhood

1. INTRODUCTION

Both the public and private sectors work to construct low-cost housing in India. Low-cost housing is defined as housing with a selling price of less than 5laksh per unit and is targeted at households with monthly earnings of less than Rs15000. The government, on the other hand, has lately amended these boundaries. The government's commitment to low-cost housing dates back to the First Malaysia Plan (1966–1970), while the

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private sector's involvement dates back to the Second Malaysia Plan (1971–1975), when the government recognised the need and importance of the private sector's role in ensuring the country's adequate supply of low-cost housing (Ghani & Lee, 1997).

The state and federal governments are responsible for public low-cost housing programmes, which are overseen and monitored by the Ministry of Housing and Local Government. Governments are involved in putting the plan into action.

a) Housing programmes,

(b) Housing in Land and Regional Development Authority area,

(c) Government and Institutional Quarters and

(d) State Economic Development Corporation.

Private developers, co-operative societies, and individuals or groups of individuals make up the private sector housing sector. Private developers responsible for nearly all private-sector housing delivery in the Seventh Malaysia Plan (1996–2000), accounting for 97 percent of total private-sector housing achievement. High-, medium-, and low-cost housing are all developed by private housing developers. The Housing Developers' Act (Control and Licensing) 1996 governs them. Since the Second Malaysia Plan, when the federal government sought private developers' cooperation in the provision of low-cost housing by making it essential for developers to build at least 30% low-cost dwellings in their housing developments, private sector engagement has increased (Ghani & Lee, 1997). the private sector performed well, constructing 68 percent of the total houses in india . However, the success of housing programmes is determined not only by the availability of housing units, but also by other factors that influence inhabitants' needs. Many housing developments have failed due to a lack of understanding of the factors that influence residential satisfaction. Residential satisfaction is a measure of how well people's housing demands are met. As a result, it serves as a reference for policymakers who want to keep track of how housing regulations are being implemented. The study aims to address a gap in the literature by examining residential satisfaction in private low-cost housing estates in Malaysia. The goal of this research is to look into the level of residential satisfaction and the elements that influence it in India low-cost housing estates utilising case studies from Vijayawada and Guntur. With a population of 1.5 million people and an urbanisation rate of 80%, Penang is one of the most developed states in india. Vijayawada , on the other hand, is one of the less developed states, with a population of one million people and a 50% urbanisation rate. The study's findings will aid in determining general satisfaction with low-cost housing developed by private developers and monitoring the country's housing policy execution.

The correlations between independent variables are divided into three categories: dwelling units (a wide range of housing attributes), developer services, and neighbourhood amenities and the environment. They are investigated using a dependent variable (overall residential satisfaction). The main components of characteristics that influence residential satisfaction are also investigated. Overall residential happiness is directly associated to housing units, developer services, and neighbourhood facilities and environment, according to the general hypothesis evaluated in the study.

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The study's conceptual framework will be built on a review of theories and notions of residential satisfaction as well as empirical evidence from prior studies. Finally, the paper explores the implications of its findings for housing policies and gives recommendations for improving low-cost home development initiatives now in place.
The study's conceptual framework will be built on a review of theories and notions of residential satisfaction as well as empirical evidence from prior studies. Finally, the paper explores the implications of its findings for housing policies and gives recommendations for improving low-cost home development initiatives now in place.

2. CONCEPTUAL FRAMEWORK

For the following reasons, residential satisfaction has been an important and popular research issue. To begin with, home satisfaction is acknowledged as a key component of people's quality of life. Second, people's perceptions of housing and neighbourhoods influence how they respond to their surroundings and serve as a foundation for public policy feedback. As a result, understanding the elements that influence residential happiness is crucial for a better understanding of household satisfaction. Residential satisfaction theories assume that the gap between a household's actual and desired housing and neighbourhood settings is measured (Galster & Hesser, 2000). They base their decisions on their wants and goals when it comes to living situations. The methods used in research on home satisfaction differ depending on the study's objective. Varady and Carrozza (2000) looked at residential satisfaction in public housing as a trend rather than a single point in time.
a period of time William (1997) conducted a comparative study of housing satisfaction in urban and rural areas. areas in the suburbs Alison et al. (2002) concentrated their research on the impact of neighbourhood characteristics like crime. On residential satisfaction, community spirit, social connection, kindness, and relatives in the region. More Recent studies on residential satisfaction have centred on a more reliable method of measuring the variables that influence satisfaction. Housing satisfaction using the ordered logit regression model (Varady & Carrozza, 2000) and the logit regression model (Varady & Carrozza, 2000).
Except for a research by Savasdisara, Tips, and Suwannodom (1989), which focused on private housing estates, the majority of the studies above focused on public housing.

3. METHODOLOGY

India's housing policy mandates that 30% of new housing developments be low-cost housing. Private housing developers are responsible for the majority of new housing estates. As a result, the study focuses on low-cost housing satisfaction in private housing estates across the country. Due to a lack of study funds and time, only two states were chosen as case studies: Vijayawada, which represents a fast-growing state, and Guntur, which represents a slow-growing state.
The study's data comes from primary sources, which were gathered through a personal

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interview technique. The interviewer used this strategy to elicit information from the respondents by asking predetermined questions.

The questionnaire for the survey was created using structured questions. The questions were written in such a way that they were straightforward, basic, and known to the respondents to eliminate bias caused by questionnaire design. Housing satisfaction is measured on a five-point Likert scale, with 1 indicating very dissatisfied, 2 indicating dissatisfied, 3 indicating neutral, 4 indicating satisfied, and 5 indicating very satisfied. In Vijayawada, 575 respondents were chosen proportionally and randomly from 10,500 units of private low-cost housing, whereas in Guntur, 223 respondents were chosen similarly from 2600 units. The questionnaires were distributed and collected between June and December of 2015.

4. RESULTS AND DISCUSSION

As previously stated, the purpose of the study is to look into the degree of residential satisfaction and the factors that influence it in Malaysian private low-cost housing estates utilising case studies from Penang and Terengganu. The results are then analysed and presented, beginning with background information and progressing through basic descriptive statistics for all satisfaction measures as well as factor analysis.

Table 1 Satisfaction with dwelling units

Dwelling features	Vijayawada	Guntur
Living area	3.20	3.06
Kitchen area	2.72	2.25
Dining room area	2.53	1.88
Bedroom area	3.79	3.64
Washing room area	3.66	3.10
Room arrangement	3.39	3.59
Air circulation	3.62	3.43
Number of socket	2.54	3.16
Level of socket	3.69	3.21
Clothes line facilities	2.06	1.55
Garbage line	3.39	3.27
Noise	3.19	3.50

Table 2 Satisfaction with Services by developers

Services	Vijayawada	Guntur
Pipe repairs	3.42	2.78
Electrical wiring	3.32	3.29
Water supply	3.54	3.50
Garbage disposal	3.95	3.43
Safety	2.49	2.69

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Table 3 Satisfaction with nighnourhood facilities and environment

Facilities	Vijayawada	Guntur
Preschool	3.53	3.28
Primary school	3.80	3.23
Secondary school	3.82	3.09
Clinic/hospital	3.56	3.28
Telephone	2.99	2.55
Market	3.05	2.72
Children's playground	2.70	2.01
Public transport	2.55	1.38
Parking lot	2.85	2.42
Place of worship	3.74	3.68
Community hall	2.75	2.59
Facilities for handicapped	1.46	2.15
Police station	3.30	2.95
Fire brigade	3.18	3.00
Nursery	3.35	3.15

5.CONCLUSION

Residents in both states were generally satisfied with their housing units, developer services, and neighbourhood amenities and surroundings. Some variables and housing developments, however, have varying levels of pleasure. Some characteristics revealed that the residents were particularly dissatisfied. The key criteria that were unsatisfied were related to neighbourhood facilities and environment, such as public transportation, community hall, parking lot, and disabled facilities. Aside from that, citizens in both states felt unsafe in their homes, particularly in regards to the dining room, kitchen, and clothesline facilities.

The primary activity areas of dwelling units, educational facilities in the neighbourhood, and central facilities in the neighbourhood are the main variables that define residential satisfaction in Vijayawada. The key elements identified in Guntur include neighbourhood safety infrastructure, educational and health amenities in the neighbourhood, and developer technical services. As a result, the majority of the items listed above are related to educational and central institutions, as well as neighbourhood safety infrastructure. It is thought that neighbourhood variables, which impact residents' needs and expectations, play a significant role in influencing resident happiness India's private low-cost housing. The outcomes of the study corroborate previous research on satisfaction levels with identical dwelling unit, service, and neighbourhood amenities. However, due to regional and cultural differences, they differ in several aspects.

As previously stated, inhabitants of low-cost housing developments created by private housing developers showed unhappiness with some aspects of dwelling units, developer services, and neighbourhood amenities, according to the survey. These issues have an impact on their living conditions and quality of life. Due to the business motive of private developers, less attention has been paid to the provision of neighbourhood amenities and the environment. The government should oversee low-cost housing programmes produced by private developers to guarantee that the demands of the low-income population are addressed, in order to ensure that their housing is not simply a house, but a home in a livable neighbourhood. Simply providing housing or achieving the goal, The number of housing units for a certain time period does not indicate the success of housing policies and programmes. The compatibility of the living environment, services, and related amenities to the needs of inhabitants is critical to the success of housing programmes. As a result, housing development design should be integrated with other land uses in order to effectively execute a good public transportation system to meet the needs of the low-income group. The requirements of inhabitants should be addressed over their actual need for housing while developing low-cost housing projects.

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PROPERTIES OF CONCRETE BY PARTIIAL REPLACEMENT OF CEMENT WITH HYPO-SLUDGE

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ABSTRACT

In the process of manufacturing of cement emits a lot of Carbondioxide which leads to a lot of pollution and also causes global warming. In the process of reducing the pollution and also to reduce the waste, a paper industry waste call Hypo-sludge was used in the replacement of cement in the concrete. The Hypo sludge in concrete mix which contains cementations properties like silica and magnesium. In this research cement is replaced with fly ash and Hypo sludge. By adding 10 percent, 12 percent, 14 percent, 16 percent of hypo sludge, compressive and split tensile strength of concrete and also performance of Hypo sludge concrete are studied. From the experiment, compressive strength and split tensile strength of Hypo sludge concrete increases up to optimum dosage. By selecting the ingredients properly and the mix proportioning and by following the good construction practices almost impervious concrete can be obtained.

Key Words: Micro Silica, Hypo-Sludge, Tensile strength and compressive strength.

1. INTRODUCTION

1.1 GENEREL

Approximately 1.82 million tons of paper waste is being produced by the paper industries all over the world. This waste was so difficult to dispose and also creates a lot of problems on this process. The paper was only recycled few times only before they become too weak and short, the broken paper separated and they become into sludge waste. The sludge was act as cement because of silica and magnesium properties which helps in the mixture of concrete. Formation of cracks is the main reason for the concrete failure. Micro silica in concrete contributes to strength and durability two ways: as a pozzolan, micro silica provides a more uniform distribution and a greater volume of hydration products; as a filler, micro silica decreases the average size of pores in the cement paste. The resulting material, which is produced by chemical reaction of cement and water looks like a stone type of construction. The concrete is strong in compression and weak in tension. Used as an admixture, micro silica can improve the properties of both fresh and hardened concrete. Used as a partial replacement for cement, micro silica can substitute for energy-consuming cement without sacrifice of quality. Concrete is basically made of cementations materials which have to properly bind themselves together, as well as with other material to form a solid mass. The durability of concrete depends on the movement of water and the gases through it. The permeability is the indicator of concrete's ability to transfer the water and gaseous substance into cementitious material.

2. LITERATURE REVIEW

Y. Suneel Kumar (2017) In this research work M30 grade mix is prepared as per IS code of practice. In this experimental work hypo sludge partially replaced by cement. Compressive, flexural and split tensile strength of concrete will be decreased with increasing % of replacement, and workability decreases with the addition of fibers.

K. Sathiya and M. Palanisamy, 2010 Over 300 million tones of industrial wastes are being produced per annum by chemical and agricultural process in India. These materials pose problems of disposal and health hazards. The wastes like phosphogypsum, fluorogypsum and red mud contain obnoxious impurities which adversely affect the strength and other properties of building materials based on them.

Santosh Ahirwar (2018) In this research work hypo sludge is partially replaced by OPC cement with different percentages of dry weight of cement. The experiment was conducted on M40 grade concrete as per relevant IS code of practice based on that test results are obtained. The target strength attained mix of 10% of hypo sludge in concrete. After that increasing percentage strength will decreases.

Ritesh Patil and M.Jamnu (2014) Researching the different mechanical properties of concrete that contains hypo sludge. Hypo sludge had been used as a replacement for cement. The percentages of substitution used during the present study were 10%, 15 %, 20%, 25%. On 3days, 7days and 28days, compressive strength of cubes was found. The specimens' 28th day flexural resistance and split tensile strength were found on the beams and cylinders respectively. Replacement of the hypo sludge is found to have beneficial effects on the concrete's mechanical properties.

3. MATERIALS AND PROPERTIES

2.1 CEMENT:

The most common cement used is an Ordinary Portland Cement (OPC). The Ordinary Portland Cement of 53 grade conforming to IS:8112-1989 is used. Many tests were conducted on cement; some of them are specific gravity, consistency tests, setting time tests, compressive strengths, etc.

Table 1 Properties of cement

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S.NO	PROPERTIES	RESULTS
1	SPECIFIC GRAVITY	3.11
2	CONSISTENCY	31%
3	FINENESS MODULUS	7.6%
4	INITIAL SETTING TIME	55 MIN
5	FINAL SETTING TIME	450 MN

2.2 Coarse Aggregates

There are many building materials which are used in the construction industry. **Coarse Aggregate** is one of the most important and massively used building material in the **Construction Industry.** The fractions from 20 mm to 4.75 mm are used as coarse aggregate. The Coarse Aggregates from crushed Basalt rock, conforming to IS: 383 are used. The Flakiness Index and Elongation Index were maintained well below 15%.

Table 2 Properties of coarse aggrigates

S.NO	PROPERTIES	RESULTS
1	SPECIFIC GRAVITY	2.8
2	BULK DENSITY	1450
3	FINENESS MODULUD	3.3

2.3 Fine Aggregates

Those fractions from 4.75 mm to 150micron are termed as fine aggregate. The river sand and crushed sand is used in combination as fine aggregate conforming to the requirements of IS: 383. The river sand is washed and screened, to eliminate deleterious materials and over size particles Fine aggregate Fills voids between aggregates. It forms the bulk and makes mortar or concrete economical. It provides resistance against shrinking and it is naturally available.

Table 3 Properties of fine aggregates

S.NO	PROPERTIES	RESULTS
1	SPECIFIC GRAVITY	2.45
2	BULK DENSITY	1375
3	FINENESS MODULUD	2.7

2.4 Hypo-Sludge

Hypo sludge contains, low calcium and maximum calcium chloride and minimum amount of silica. Hypo sludge behaves like cement because of silica and magnesium properties. This silica and magnesium improve the setting of the concrete. The hypo sludge was taken from the Ganesh paper industry located near Ongole.

Table 4 Properties of hypo sludge

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S.NO	PROPERTIES	RESULTS
1	SPECIFIC GRAVITY	2.23
2	CATEGORY	INDUSTRIAL WASTE
3	COLOUR	GRAY

3. METHODOLOGY

3.1 DESIGN MIX

A mix M40 grade was designed as per IS 10262:2009 and the same was used to prepare the test samples. The design mix proportion is shown in Table 5.

Table 5 mix design

S.NO	CONCRETE GRADE	MIX DESIGN				% OF HYPO SLUDGE REPLACED
		WATER	CEMENT	FINE	COARSE	
1	M-40	0.30	0.90	0.45	2.20	10%
2		0.30	0.88	0.45	2.20	12%
3		0.30	0.86	0.45	2.20	14%
4		0.30	0.84	0.45	2.20	16%

3.2 Casting Of Cubes

As per the mix design the casting of cubes is takes place with different ratios as per the above table. the cube of 150mm*150mm*150mm and also the cylinders were filled with the concrete mix we made in required number. The concrete was placed in the molds and then tampered with a tamping rod which helps to reduce the void and air gaps. The molds were left to dry. After drying cubes were placed for curing for the compression and split tensile tests.

3.3 Compression & Split Test

Three specimens were tested for the determination of average compressive and split strength. Test was performed on compression testing machine having capacity of 200 MT. The specimens are taken each one from the time group and the test was done.

4. RESULTS

4.1 Compression Test

Table 6 for compressive strength

GRADE	MIX DESIGN	COMPRESSIVE STRENGH		
		7 DAYS	14 DAYS	28 DAYS
M-40	M40+10%	28.29	19.39	24.06
	M40+12%	32.41	33.21	35.28
	M40+14%	48.33	35.88	33.64
	M40+16%	49.21	47.52	46.57

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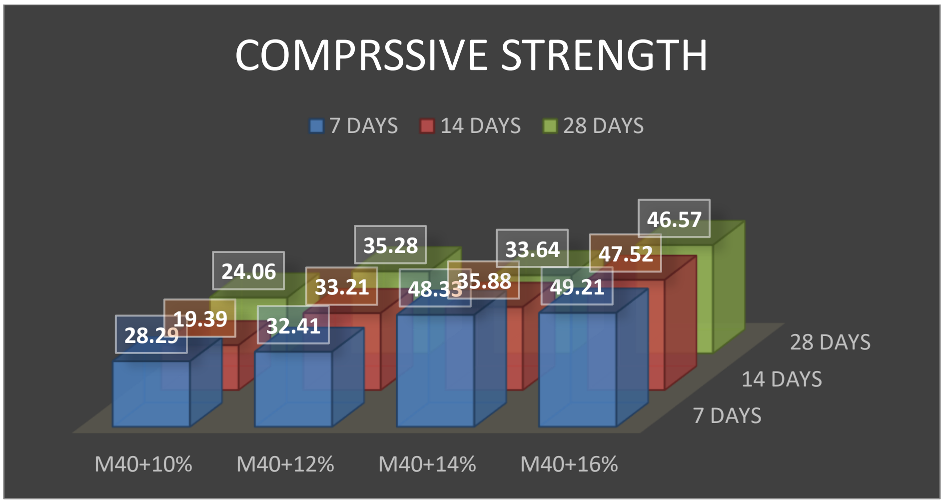
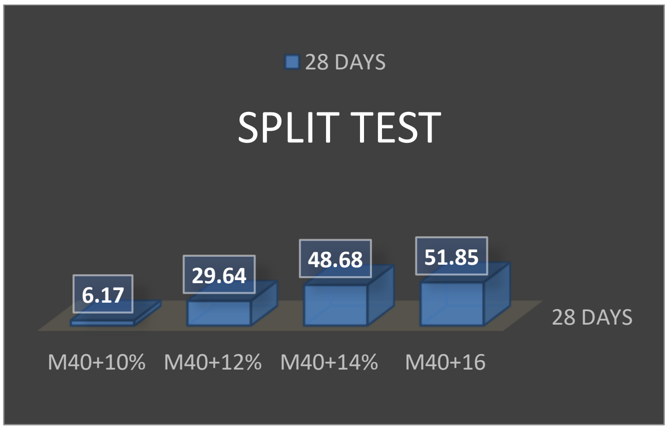


Graph 1 compressive strength

4.2 Split Test

Table 7 Table for split test

MIX DESIGN	SPLIT STRENGTH FOR HYPO SLUDGE CONCRTE
M40+10%	6.17
M40+12%	29.64
M40+14%	48.68
M40+16%	51.85



Graph 2 split test

5. CONCLUSION

Concrete has been recommended as a construction material in wide range. present in construction, prior to strength, the durability of concrete also has importance. The minimum cement content to satisfy the strength and durability requirements. This results in usage of cement in huge content. The cement production results in evolution of lots of carbon dioxide resulting in environment mortification. By the initial test results of Micro Silica and Hypo Sludge it will give beneficial results. Use of hypo sludge in concrete can save the paper industry disposal costs and produces a 'greener'

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concrete for construction. This research concludes that hypo sludge can be innovative supplementary cementitious Construction Material but judicious decisions are to be taken by engineers. Finally I conclude our project with full satisfaction of completing the project Casting of conventional cement concrete cubes has been done Casting of concrete cube added with industrial waste(Hypo-Sludge) has also been done Comparison of results has been done Testing of concrete cubes with various methods like compression and split test has been done for both cubes up to 16% of hypo sludge concrete, the compression strength has been increased, so upto 20% cement has been replaced by hypo sludge By replacement of hypo sludge the cost of construction should be minimized By effective utilization of waste product in concrete to also reduce the environmental effects. If silica is added means the strength will be considerably increased because of lack of silica in hypo sludge Considerably this Type of Concrete Will Be Used for Road Works Effectively with Less Consumption of Cement.

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Sumit A Balwaik*; S P Raut** Vol. 1, Issue 2, pp.300-309 .

AN EXPERIMENTAL STUDY ON CARBON FIBERBASED CONCRETE BY PARTIAL REPLACEMENT OF CEMENT WITH EGG SHELL POWDER

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ABSTRACT

Cement manufacturing industry is one of the carbon-dioxide emitting sources beside deformation and burning of fossil fuel. The global warming is caused by emission of greenhouse gages, such as emitted Co2 to the atmosphere. The global cement industry is contributed about 7% of greenhouse green gases emission to earth atmosphere. The work examines the possibility of using carbon fiber as partial replacement as 0% ,5% , 10% , 15% and for its compressive strength up to 7 , 14 & 28 days of age and was compared with those of conversion concrete. Leaving the waste material has been emphasized waste can be used more efficiently and the environmental problem. Hence the reuse of waste material has been emphasized waste can be used to produced new produced new products or can be used admixture so that natural resources are used more efficiently and the environment is protected from waste deposits. Carbon fiber and eggshell powder material is very fine powder material obtained from the industries during sawing and shaping, and not recycling its cause's environmental problem in the world. The possibility of using it carbon fiber separately as partial replacement of cement on concrete where studied and evaluated based upon % replacement of cement on concrete where studied and evaluated based upon % of the partial cement replacement with both carbon fiber & egg shell powder.

Keyword-Egg shell powder, Carbon fiber powder, and Tensile strength and Compressive strength.

1.INTRODUCTION

Municipal building interest in using waste or recycled materials in concrete is increasing due to the emphasis placed on sustainable building. Glass is an inert material that could be recycled and used many times without changing its chemical properties. In addition to using manufactured or carbon fiber waste and eggshell ash powder crushed into a specific size for use as cement in various applications.

2. MATERIALS

2.1 Cement:

The cement used in this study is Orang Kuat Localized Ordinary Portland Cement (CEM I 42.5 N), manufactured by YTL Cement, which meets the BS EN Specification for Portland Cement (BS12/BS EN 1971:2000 and ASTM C 15095 Type I) fulfills.

3.1 Aggregate:

The coarse aggregate which are taken in this are in 10mm size. Meanwhile, the fine aggregate used ranged from 75 µm to 4.76 mm. In this study, the fine aggregate was oven dried at a temperature of 110 °C for 24 hours to eliminate its unsafe moisture. The aggregate was then kept dry and free from contamination and the aggregate used in this study conformed to BS specification for concrete aggregate (BS EN 12620).

2.3 Eggshell Powder:

Egg shell waste was supplied by Egg Tech Manufacturing SdnBhd, PuncakAlam, Selangor. The eggshell was carefully rinsed and washed to remove organic residues from the egg. The eggshell was then dried in the oven at a temperature of 105°C for 24 hours. The clean eggshell was collected and ground with a grinder. Ground eggshell powder (ESP) was prepared by sieving through a 150 µm sieve. Figure 1 shows the eggshell powder used as a filler in the concrete mix in this study. ESP and OPC are shown in Table 1.

Fig. 1 Egg shell powder

Table 1. Chemical composition of ESP and OPC

ELEMENT	OPC	ESP
Calcium Oxide (CaO)	60.1	52.10
Magnesium Oxide (MgO)	2.1	0.06
Silica Dioxide (SiO2)	21.8	0.58
Alumina (Al2O3)	6.6	0.06
Ferric Oxide (Fe2O3)	4.1	0.2
Chloride (Cl)	-	-
Sulphur Trioxide (SO3)	2.2	0.62
Potassium Oxide (K2O)	0.4	0.25
Sodium Oxide (Na2O)	0.4	0.15
Loss on Ignition (LOI)	2.4	45.42

2.4 Carbon Fiber:

Carbon fibers are a form of excessive-overall performance fiber to be had for civil engineering application. It is likewise known as graphite fiber or carbon graphite, carbon fiber includes very skinny strands of the detail carbon. Carbon fibers have excessive tensile energy. Carbon fibers have excessive elastic modulus and fatigue energy than the ones of glass fibers. Considering provider life, research shows that

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carbon fiber bolstered polymers have extra ability than agamid and glass fibers. They are also incredibly chemically resistant and feature excessive temperature tolerance with low thermal growth and corrosion resistance. Each fiber is five–10 mm in diameter. To deliver a feel of the way small that is, one micron (um) is 0.000039 in. One strand of spider internet silk is commonly among three and eight mm. Carbon fibers are two times as stiff as metal and 5 instances as sturdy as metal, (in keeping with unit of weight). The maximum critical elements figuring out the bodily residences of carbon fiber are diploma of carbonization (carbon content, commonly extra than 92% via way of means of weight) and orient tation of the layered carbon planes (the ribbons). Carbon fiber bolstered plastic is over four instances stiffer than Glass bolstered plastic, nearly 20 instances extra than pine, 25 instances more than aluminium.

Fig. 2 Carbon fiber

2.5 Water:

ASTM C1602 (2012) allows the use of potable and non-potable water as mixing water in concrete. In this study, water is used for curing and mixing the concrete.

3. METHODOLOGY

3.1 Mix Design:

In this study, the desired concrete strength is 60 MPa after 28 days with a water/cement ratio of 0.32 and 1% superplasticizer. As a control, a base control mix of concrete without eggshell powder (0% ESP) was designed and four mixes were prepared with different eggshell percentages in cement weight, namely 5% ESP, 10% ESP and 15% ESP.

Table 2. Mix design

Materials (kg/m3)	0% ESP	5% ESP	10% ESP	15% ESP
w/c ratio	0.32	0.32	0.32	0.32
Cement	72.	684	648	612
Coarse aggregate	915	915	915	915
Fine aggregate	610	610	610	610
Egg Shell Powder	0	36	72	108
Carbon Fiber	1	1	1	1

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3.2 Sample Preparation:

A total of 24 cubes measuring 100mm x 100mm x 100mm were prepared and tested to determine the compressive strength of all the mixes. Each test result was obtained using the average value of 3 cubic samples. The form was smeared with a thin layer of oil before fresh concrete was poured into the form to facilitate the demoulding process. The mould is filled with 3 layers. Compaction is done by vibrating on a vibrating table for each layer to ensure the concrete is well compacted.After 24 hours, the sample was demoulded and cured in a water tank until test aging.

3.3 Slump Test:

Slump test was carried out in accordance with BS 1881102 to determine machinability of a concrete mix, whether it can be mixed, transported, placed and compacted in situ. The workability of the concrete is based on its slump height and the type of slump observed.

3.4 Compression Strength Test:

Compressive strength tests were carried out in this study using a compression machine in accordance with BS 1881116 to determine the compressive strength of the concrete cube at 7 and 28 days of age.

$f = P/A$ (1)

Where f is compressive strength (MPa)

P is maximum load carried (N)

A is average cross-sectional area of the specimen (mm2).

3.5 Rebound Hammer:

The rebound hammer test or surface hardness test is known as non-destructive testing (NDT) which is performed in accordance with BS1881Part202 to determine the relative compressive strength and uniformity of concrete based on the hardness at or near its exposed surface. In the rebound hammer method, the rebound hammer piston is pressed against the concrete surface, causing a spring-loaded mass to strike the concrete surface with constant energy. At the same time, a spring-controlled mass springs back. This rebound strain on a graduated scale is a measure of surface hardness. This metric is known as the bounce number or bounce rate. A low rebound number or rebound index means that the concrete has low compressive strength and low stiffness. An average of twelve concrete bucket rebound count readings should be taken for each test point.

Table 3. Classification of concrete quality based on average rebound number

Average Rebound Number	Quality of Concrete
> 40	Very Good
30 – 40	Good
20 – 30	Fair
< 20	Poor and/or Deleminated

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3.6 Ultrasonic Pulse Velocity:

The Scanning Ultrasonic Pulse Velocity Test is one of the NDTs performed in accordance with BS 1881: Part 203 to determine the velocity of propagation of longitudinal stress wave pulses through concrete by determining the quality of the concrete and detecting damage to structural members. Equation 2 shows the method for measuring the transit time of an ultrasonic pulse penetrating concrete. The quality of the concrete can also be determined using the norm in Table 4 by the value of the impulse speed.

V = $ % (2)

V = Pulse velocity (km/s)

L = Path length for vibration to travel between two transducers (mm)

t = Time taken for pulse go through concrete structure (μs)

Table 4. Classification of the quality of concrete based on pulse velocity

Pulse Velocity (km/second)	Concrete Quality (Grading)
Above 4.5 Below 3.0	Excellent
3.5 to 4.5	Good
3.0 to 3.5	Medium
Below 3.0	Doubtful

4. RESULTS AND DISCUSSIONS

4.1 Influence Of Esp On The Workability Of Concrete:

In this study, the influence of ESP on the workability of concrete was determined using the slump test. The slump test result is tabulated in Table 5, and the relationship between slump test and concrete mix is shown in Figure 3. It can be seen that the mix with 0% ESP has the highest slump depth of 50 mm and the mix containing ESP falls below the acceptable range of 75 ± 25 mm. Similar results were reported by Tan, Doh and Chin [11], with ESP containing concrete producing a 73 mm slump height within the acceptable range. Among the ESP compounds, the 15% ESP compound has the lowest slump height of 45mm.showed that the amount of settlement decreases with the percentage of eggshell substitute in the concrete increases. This is due to the high water absorption of the eggshell powder, which consumes the water and limits its flowability. More finely ground eggshell powder has a larger water surface area, which absorbs more water and more adversely reduces the workability of the concrete mix.

Table 5. Slump height of specimen

Concrete Mix	Slump Height	Slump Type
0%	ESP 50	True Slump
5%	ESP 48	True Slump
10%	ESP 47	True Slump
15%	ESP 45	True Slump

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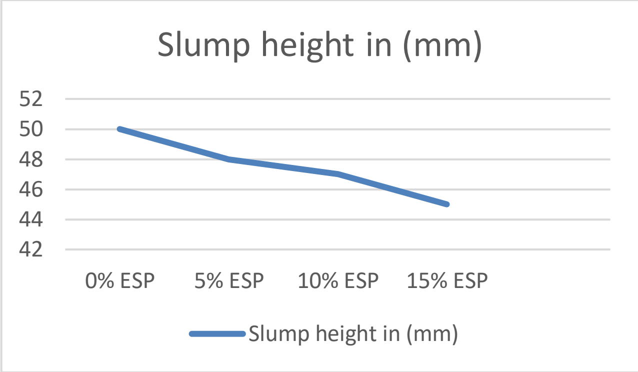

Graph 1 Relationship between slump height and concrete mixture

Fig. 3 True slump

4.2 Influence Of Esp On Compressive Strength Of Concrete:

It can be seen that all mixes reached the desired strength of 60 MPa after 28 days and also exceeded 70% of the desired strength after 7 days of water. The compressive strength of all concrete mixes will continue to increase with increasing curing time until followed by 5% ESP, 0% ESP and 15% ESP with 68.1 MPa, 67.1 MPa and 62.5 MPa after 28 days. It has been pointed out that the compressive strength of concrete increases as the proportion of ESP substitute increases. However, further increasing ESP decreases compressive strength at all cure ages. In this study, the 15% ESP mix has the lowest compressive strength after 7 and 28 days of curing compared to others.From this it can be concluded that the optimal percentage of 10% ESP improves the compressive strength of concrete. This result is similar to that reported by Jhatial [12], where the optimal eggshell powder cement replacement was 10%, thereby achieving the maximum compressive strength and the decrease in compressive strength value as the percentage of eggshell was further increased. According to Doh and Chin [13], replacing more than 10% ESP had greatly reduced the compressive strength of the concrete. This is because the eggshell has the function of the filler in the concrete and

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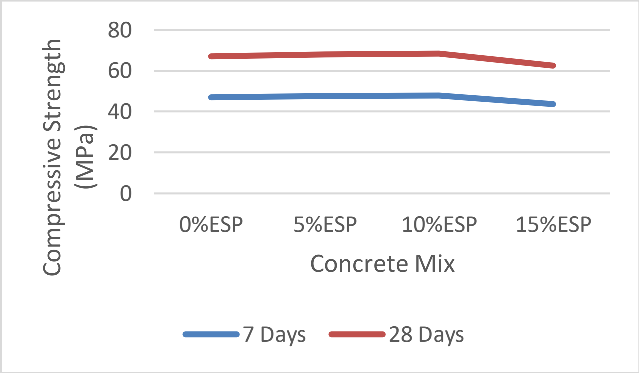
the behaviour of ESP concretes is very similar to limestone.to replace the concrete. Limestone reacts with alumina cement pastes to form a calcium monocarboaluminate hydrate phase and contributes to the change in strength. As more limestone is replaced, the pores become larger and consequently the strength of the concrete decreases. The internal structure of the concrete has been greatly reduced, so the bond between the cement and the aggregate is weak.



Graph 2 Compressive Strength of Concrete Mixture

4.3 Influence Of Esp On Rebound Hammer:

The RH test is shown in Figure 6. The average number of rebounds represents the mean value of the concrete surface hardness [16]. The results showed that rebound numbers increase as the percentage of eggshell powder replacement increases. Concrete containing the 10% ESP sample produced the highest rebound count after both 7 and 8 days of curing, followed by 5% ESP and then 0% ESP. other mixtures in all degrees of maturity. According to Babu and Akhilchandran [17], the values of the rebound number depend on the hardness of the concrete surface. The harder the concrete surface, the higher the recorded rebound number. Based on the report by Yahya et al. [18] the quality of the concrete can be specified using the rebound numbers obtained through the reference table. For the concrete mix after 7 days curing, all the concrete mixes have average rebound numbers ranging from 20 to 30, and the quality of the concrete can be considered normal.For 28 days, the concrete surface with 10% ESP samples is considered to have a very good hard layer if the average rebound number was greater than 40, while the concrete grades of other ESP mixes are between 30 and 40 also have a good layer.

However, the non-destructive compressive strength of concrete can be interpreted using regression analysis and the result was compared to the compressive strength results from destructive tests to assess the prediction for concrete strength [19]. Figures 7 and 8 show the correlation between concrete compressive strength and rebound hammer using regression analysis for all mixes after 7 days and 28 days curing. Based on Figures 7 and 8, the rebound hammer shows the highest strength compared to actual compressive strength after both 7 days and 28 days of curing time. However, the R2 shows a good correlation with 0.807 after both 7 days and 28 days of curing. According to Babu and Akhilchandran [17], the concrete surface becomes harder and with it the compressive strength of the concrete as the rebound value increases. In this study, the actual

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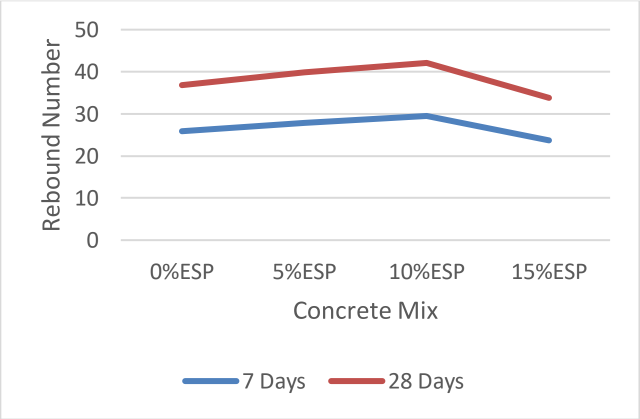
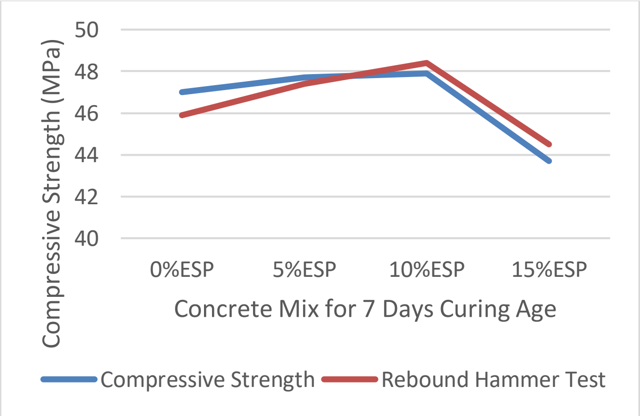
compressive strength of the concrete mix increases with increasing percentage of eggshell powder replacement in the concrete. Both the actual compressive strength and the rebound hammer showed that the concrete with 10% ESP produced the highest compressive strength, among other things, and further increasing the ESP decreases the compressive strength in all ages of hardening, since 15% ESP of the concrete mix. The compressive strength is said to be directly proportional to the rebound hammer resulting in a regression coefficient, R2 value of 0.807. The maximum percentage difference in compressive strength between the destructive test and the regression analysis was 2.29% and the minimum was 0.59%. The estimated results were found to be close to the actual compressive strength results and the error is small. Based on previous research by Shih et al. [20] the results of the rebound hammer test are estimates of concrete compressive strength that average more than 20% of the mean absolute percentage error compared to the actual compressive strength obtained by destructive testing. This happens because the rebound hammer is not very reliable and there are many factors that affect the accuracy of the result. The nature of the concrete surfaces influences the number of rebounds determined in the tests. TestingWhen performed on rough surface concrete, this generally results in the surface paste being crushed, resulting in a lower rebound number [21]. The rebound number and the actual pressure resistance were strong, and have accurate expression. This means that predicting compressive strength and concrete quality from non-destructive rebound hammering techniques can be reliable.



Graph 3 Rebound Number



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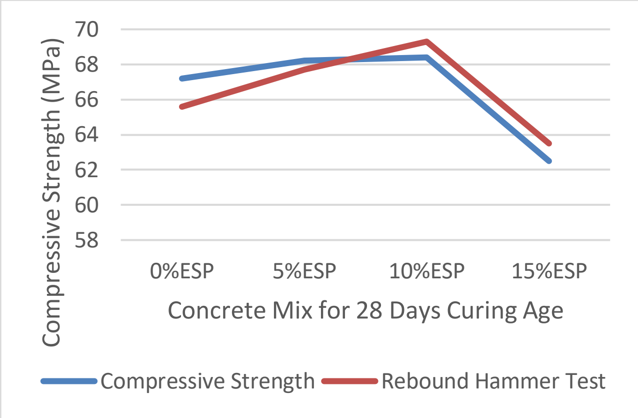
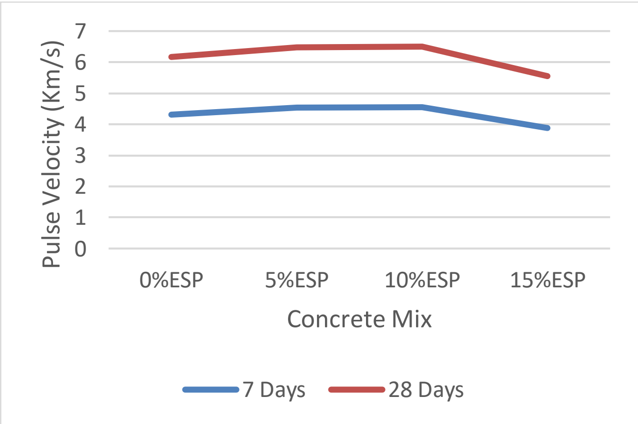
Graph 4 Correlation between actual compressive strength and rebound hammer at 7 days of curing age



Graph 5 Correlation between actual compressive strength and rebound hammer at 28 days of curing age

4.4 Influence Of Esp On Ultrasonic Pulse Velocity:

In this study, Ultrasonic Pulse Velocity (UPV) is a non-destructive test performed to determine the homogeneity and integrity of concrete. The time required for the ultrasonic pulse to traverse the concrete structure was tested and measured. Figure 9 shows the result of the average of the impulse velocity passed through each concrete mix in live mode. It can be seen that the pulse rate increases as the percentage of eggshell replacement increases at both 7 days and 28 days of curing. Concrete quality is increasing day by day. Day through the 28 day cure time making it stronger and more durable so the UPV will also increase.The 10% ESP concrete mix has the highest impulse speed among other concrete mixes, which is 4.55 km/s at 7 days and 6.50 km/s at 28 days. The impulse speed decreases and has the lowest value when the concrete is mixed with 15% ESP.



Graph 6 Average Pulse Velocity

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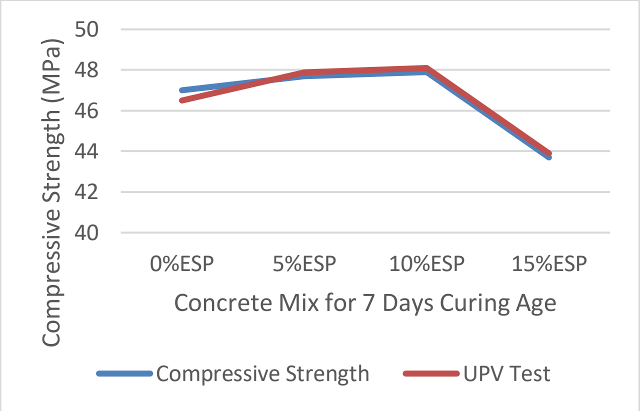
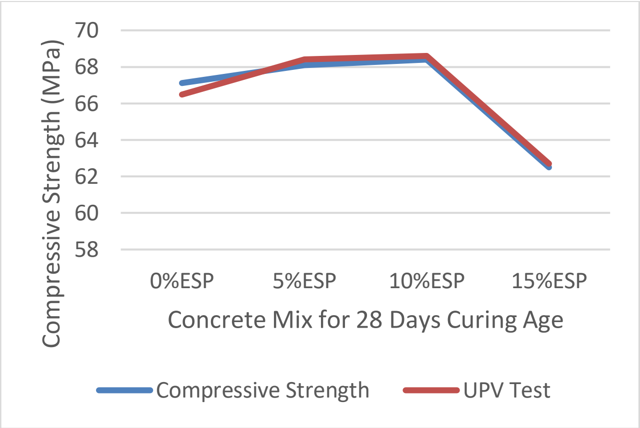


Graph 7 Correlation between actual compressive strength and UPV test at 7 days of curing age



Graph 8 Correlation between actual compressive strength and UPV test at 28 days of curing age

5. CONCLUSION

Increasing the replacement percentage of eggshell powder in the concrete mix results in lower workability of the concrete. The workability of concrete is directly affected by the increased water absorption of eggshell powder, replacing eggshells in concrete reduces the workability of concrete. The incorporation of eggshell powder into concrete has a major impact on compressive strength. The partial replacement of cement with eggshell as a filler in the concrete mix increases the strength of the concrete .Concrete with 10% eggshell powder has the highest compressive strength at 68.4 MPa. While further increasing the eggshell powder in the cement substitute up to 15% ESP results in a decrease in compressive strength. The value of the rebound index was dependent on the hardness of the concrete surface. Increased rebound index related to increasing the proportion of eggshell in the concrete mix up to 15% replacement. The rebound number showed that the concrete mix with 10% ESP had a good hard cap, while all other concrete mixes achieved a good concrete cap. the small, which is 2.29% by regression analysis. In general, the rebound number will increase with compression increases the strength of the concrete. The optimal cement replacement of the eggshell powder was 10%, which gave the highest compressive strength. A further increase in cement replacement resulted in a decrease in compressive strength.

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SOIL TABILIZATION AND THE INFLUENCE OF GEO-JUTE FABRICS

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ABSTRACT

The main challenge facing the construction industry today is soil stabilisation. In this project, our main goal is to use geo-jute fibre to enhance the engineering qualities of soil. The current investigation's goal is to ascertain Geo-Jute's efficacy as a soil stabiliser. With a view to reducing building costs, the focus is on the efficient use of the byproduct Geo-Jute. In the case of pavement and earthen slopes, it improves the engineering qualities. Jute fibres typically have a high strength and limited extensibility. Jute's moisture content aids in enhancing its frictional ability. The findings demonstrate an increase in soil characteristics such permeability, dry density, and shear strength. When jute geotextile was used, the settlement decreased, showing a significant improvement in the engineering behaviour.

INTRODUCTION

One classifies soil as a complicated material. It is also required to test and classify different types of soil in order to evaluate their stability, physical characteristics, and issues with foundation design, construction, pavement design, embankment design, excavation, and earth dam design.

Soil stabilisation is used to ensure the subgrade is stable, which in turn affects the stability of the pavement. Jute fibre can be added to soil in order to improve its engineering qualities. Jute fibre is preferred because it is more resilient, has a high tensile strength, can endure heat and rotting, and has a porous structure that improves drainage and filtration. Jute is also readily available regionally, affordable, eco-friendly, and biodegradable.

When soil masses are reinforced, they become stronger, more ductile, and more capable of bearing weight. They also experience less settlement and lateral deformation.

Jute material Greater extensibility, compressive strength, and less settling are all characteristics of stabilised soil.

Jute poses no threat to the environment and is biodegradable. Jute fibre was employed in this work in varied amounts, and its impact on shear strength was examined.

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MATERIALS USED

In this project the material used as stabilizer is Geo Jute. Various tests performed on this material are also discussed in the following process and experimentally it is proved by the research that the soil changes its property after adding the Geo Jute. Major materials used are;

The red soil used in the investigation was the natural soil collected from Marudhamalai, Coimbatore district. The soil sample was collected from a depth of 60cmafter removing the top surface soil from natural ground surface.The soil plays a major role in determining the depth of the foundation required to keep a building safe. The soil bearing capacity (SBC), dry density of the soil plays a major role in design of any kind of foundation. Hence study of soil plays a very important role in civil engineering projects

JUTE:

The jute was procured from the local market.
The diameter of the jute fibre used was 20mm. These fibres were cut in the length of 25mm for conducting our research.Generally, jute fibres are available in threaded form. These are mechanically, woven fibres with very fine threads.

LABORATORY TESTS:

The properties of the clay were determined byconducting various laboratory tests such as:

a) Sieve analysis
   Specific gravity test
- Wet sieve analysis
- Hydrometer analysis

b) Atterberg's limit test Liqiud limit Plastic limit
c) Standard proctor test
d) Unconfined compression test

RESULT AND DISCUSSION:

LIQUID LIMIT:

It is the water content at which the soil changes from liquid state to plastic state or minimum water content at which soil just begins to flow. It is the ratio which signifies the relative consistency of a cohesive soil in the nature state.

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SOIL SAMPLE RATIO WITH JUTE	LIQUID LIMIT VALUE
5%	30
10%	35
15%	36
20%	42.5
25%	47.5

PLASTIC LIMIT:

It is the water content at which soil changes from plastic state to semi-solid state or minimum water content at which soil rolled into threads of 3mm diameter just crumbles. The water content at which a soil changes from a
-plastic consistency to a liquid consistency.

SOIL SAMPLE RATIO WITH JUTE	PLASTIC LIMIT VALUE
5%	17
10%	18.14
15%	19.21
20%	20.077
25%	21.45

The proctor compaction test is a laboratory method of experimentally determining the optimal moisture content at which a given soil type will become most dense and achieve its maximum dry density. It is a laboratory geotechnical testing method used to determine the soil compaction properties, specifically, to determine the optimal water content at which soil can reach its maximum dry density. The soil is usually compacted into the mold to a certain amount of equal layer, each receiving a number of blows from a standard weighted hammer at a specific height. The graphical relationship of the dry density to moisture content is then plotted to establish the compaction curve. The maximum dry density is finally obtained from the peak point of the compaction curve and corresponding moisture content, also known as the optimal moisture content.

Weight of empty can (g)	Weight of can and wet soil (g)	Weight of can and dry soil (g)	% Water content
140	290	280	7.14%
130	162.34	158.20	14.68%
122	190.22	177.80	20.76%
126	278.10	256	25.67%
86	194.80	168.60	41.87%

MDD kg/m³	1710.1	1802.2	1836.8	1745.8	1645.3
W.C %	7.14	14.68	20.76	25.67	41.87

CONCLUSION

The protection of environment is a vital issue in the world. The demand of jute is raised for environment friendly for future.In this investigation we have used jute fibre pieces

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in different proportion to study its effect on various geotechnical properties of soil. The results of the testing clearly shows that the engineering properties of the soil importance considerably due to stability with jute fibre geotextile.As the maximum density increases generally optimum moisture content (OMC) of the soil will be increasing. Based on the observation, the density increase with the increase of jute.
Since maximum dry density was obtained at 1 % addition of jute. It is obtained that by increasing the jute fibre content percentage of MDD decreases and OMC increases. Geo jute has many potential applications in civil construction works. The engineering properties of jute are suitable for separation, reinforcement, drainage and filtration and can be suitably used in overcoming geotechnical problems of weak soil. Since, the jute is used as vegetable, geo-textile, biogas, biodegradable products which have impact on the environment. There are lots of scopes for future research in this economy, environment friendly issue.

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PROPARATION OF LIGHT WEIGHT AGGREGATE CONCRETE BY BTHE PARTIAL REPLACEMENT OF FINE AGGREGATE WITH PLASTIC LIMIT

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ABSTRACT

The inclusion of an artificial aggregate manufactured using plastic waste to develop a light-weight concrete was studied. Five separate mixes were designed, progressively increasing the amount of artificial aggregate and measuring the fresh and hardened concrete properties, and it was found that the slump and density of the concrete decreased as the amount of artificial aggregate in the concrete increased. Both the compressive and the tensile Then the mix that was most suitable to the requirements of the study in terms of density and compressive strength was chosen for further investigation in stage two. Fifteen percent of the natural aggregate by weight was replaced in this optimal mix, which equals more than thirty-seven percent of the volume given the lower density of the manufactured aggregate compared to natural aggregate. A larger number of specimens and more detailed testing was undertaken for stage two when compared to stage one, including establishing the compressive stress-strain relationship and the modulus of elasticity of the newly developed concrete mix. The results indicated that plastic aggregates manufactured following shredding, extrusion processes can be used to obtain a lightweight concrete (1800 Kg/m3) while having relatively good compressive strength properties (20 MPa at 28 days). These results were higher than other results previously reported in the literature on the replacement of coarse aggregate with plastic, but were marginally lower than results reported in the literature for studies where fine aggregate was replaced with plastic.. It was concluded that the concrete mix reported herein can be used for a wide spectrum of applications such as non-structural facades and sound barriers for highways.

Keywords: Concrete, plastic waste, manufactured aggregate, light-weight concrete, Sustainability

1. INTRODUCTION

Concrete is the most common construction material in the world and is com posed of four basic ingredients: water, cement, gravel as coarse aggregate, and sand as fine aggregate. Aggregate resources are the most extracted mineral resource in the world, and the global construction market consumed the equivalent of USD 360 billion in 2018 alone [1]. The “mining of sand and gravel is the most disastrous activity as it threatens the very existence” of rivers and other natural environments [2], and can have significantly adverse societal effects in the community or in the region [3]. As an example, 4.1 million cubic meters of concrete were produced in New Zealand in 2018, which resulted in approximately 5.1 billion tons of aggregate if 1250 Kg of aggregate per cubic meter of concrete is assumed [4]. Reducing the amount of virgin aggregates being mined is critical if natural ecosystems are to be preserved for future generations. Plastics are ubiquitous in society in almost every field and the production of plastic products, especially single-use plastic products, has strikingly increased during the 20th century and in the first two decades of the 21st century. In 2017, 64.4 million tons of plastic were produced in Europe and 348 million tons were produced worldwide, with 60% of that amount being used by only two market sectors, being the packaging industry and the building and construction industry [5]. Plastic waste can be processed following three methods, which are recycling, incineration (often combined with an energy recovery process), and land filling, in order of preference [6]. In the same year of 2017, 27.3% of the plastic waste collected in Europe was disposed of in landfills [5] and in the USA the situation is far worse, where in 2015 there was 35.4 million tons of plastic produced of which 75.4% finished its useful life in landfills [7], and with the reporting of such data subsequently discontinued with the change of US Government administration in 2016. On a global scale, only 9.5% of all the plastic ever produced up to 2015 has been recycled and 79% of this plastic is in landfills, although the amount of plastic waste currently going into landfills has reduced to 58%[8]. Most types of plastics are non-biodegradable and are chemically uncreative to the environment, so these plastics can remain in the environment for decades or even centuries. Some types of plastic can also release toxic elements into the environment, such that dumping plastic waste into landfills is not a viable solution. While incineration of plastic waste completely eliminates the waste and can be a source of power, this process typically releases carbon dioxide and other poisonous chemicals and produces toxic fly ash and bottom ash. Recycling is therefore the best solution to treat plastic waste, with one of the most commonly used methods being the reuse of plastic waste into the construction and building industry. Research on the use of plastic waste in cement mortar and in concrete is extensive [9, 10, 11], with various reviews of the topic having been compiled recently [12, 13, 14, 15]. The inclusion of other waste materials in concrete for sustainability purposes has also been intensively investigated, such as fly ash [16, 17], geo polymer aggregates made with fly ash [18], waste glass [19], or bio char [20], but the focus of the research reported herein was on plastic waste. The most common method to introduce plastic waste into concrete mixes requires the plastic to be categorized by the different types, and to be cleaned before being shredded into particles of different shapes and sizes [13, 21, 22]. The commonly reported result of incorporating plastic into concrete as an aggregate replacement is the reduction of workability, density and mechanical performance of the resulting concrete mix, without significantly improving the durability of the material [23, 24, 25]. An improvement in abrasion resistance was reported in the past when using PET plastic as an aggregate replacement due to the more rough texture of the plastic particles compared to the texture of natural aggregates [13, 26]. The increment in water absorption of concrete with plastic waste as an aggregate replacement was widely reported as a result of the elevated air content that is entrained during mixing, with the increment in entrained air

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caused by inadequate blending of the natural and artificial aggregates due to differences in density, where the plastic waste aggregate typically floated in the cement paste while the natural aggregates sank [27, 28, 29, 30]. Finally, the use of plastic aggregate increased drying shrinkage due to the lower restraint provided by the plastic aggregate when compared to that of the natural aggregate, and increased the resistance to chloride ion penetration [31, 32, 33, 34]. The main source of the problems associated with incorporating plastic waste into concrete is the chemical incompatibility between plastic and cement paste, given that plastic is hydrophobic and cannot chemically bind with the cement paste, and therefore the bond strength between the plastic surface and the cement paste is low [14]. This behavior results in key properties decreasing as the amount of plastic incorporated within the concrete mix is increased [14].The majority of the reported research existing in the literature has focused on introducing plastic waste into the concrete mix by first sorting, cleaning and shredding the plastic waste but without further altering this plastic waste via processes such as heating or chemical treatments. Only one product comparable to that used in the current study has been found in the literature, that was developed using 30% cleaned, sorted and shredded liner low-density polyethylene (LLDP) as a binding matrix combined with 70% virgin sand [35, 36, 37], whereas the product used in the current study is made of 100% plastic waste without the addition of any virgin material. The aggregate product used in this study was made of 100% plastic waste, with the manufacturing process involving shredding, extrusion of the plastic waste. The mechanical and physical properties of the plastic waste were altered through this manufacturing process to produce the resultant aggregate, with the appearance and mechanical properties of the manufactured aggregate being distinctly different from those of typical smooth plastic. All seven grades of plastic as defined by ASTM D7611 [38] were used during the manufacturing of the artificial aggregate, but always using 80% of PolyOne fins and 20% of the other types, with the mechanical and physical properties of the manufactured aggregate found to be consistent regardless of the proportions of plastics grades used. The final product has a specific gravity of 0.85 kg/m3 and negligible water absorption.

2. RESEARCH MOTIVATION AND OBJECTIVE

The objective of the study reported herein was to obtain a concrete mix with a density of 1800 kg/m3 , a 28 days compressive strength of 20-25 MPa, and al1-day compressive strength of 10 MPa. The reason for targeting a relatively high compressive strength at an early age was to accelerate the production of precast concrete panels and other precast concrete elements, which was the main market being targeted. The installation of non-structural concrete elements such as shade panels, façade panels and highway sound barriers is streamlined when using light weight concrete, improving the construction efficiency and reducing the demands on foundation and anchoring elements. The targeted concrete mix was not to be used for structural or infrastructure applications

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Table 1. Physical properties of Portlan cement

Specific surface area (m^2/kg)	339
Initial setting time (min)	115
Final setting time (hr:min)	2:38
Soundness (mm)	1.3
SO_3 (%)	2.5
Specific gravity (g/cm^3)	3.15

3. MATERIALS AND METHODS

3.1. Cement

Concrete test specimens were made using the same materials used in a local ready-mix plant, with a maximum nominal greywacke aggregate size of 19 mm. Portland cement Type GP as defined by NZS 3122 [39] was used. The physical properties of the cement are reported in Table 1. Silica fume, with a silica content of 93% and surface area of 23 m2 /g was also added as a supplementary cementations material.

3.2. Natural aggregate

Two types of natural coarse aggregates were used, being greywacke Kaipara Brookby (KB) 13 (defined as having 86% of the aggregates passing between 13.2 mm and 19 mm and in accordance with the New Zealand standard of concrete production [40], and greywacke KB 07 (also known as Premium All Passing 7 or PAP7). One fine natural aggregate was used, commonly referred to as McCallum's Offshore natural sand (MC 01). The sieve analysis carried out in compliance with the New Zealand standard for testing of water and aggregates [41] for both PAP7 and MC 01 is reported in Figure 1. Both aggregates comply with the grading requirements specified in the New Zealand standard [42]. The specific gravity of the KB aggregates is 2680 Kg/m3 and the specific gravity of the MC 01 sand is 2650 Kg/m3 , as obtained using the corresponding standards [41]. 3.3. Artificial aggregate The aggregate is manufactured in two broad sizes, being a coarse aggregate and a fine aggregate, with a picture of both materials being reported in Figure 2. A sieve analysis (also known as gradation test) was performed in accordance with the New Zealand standard [41] to understand the fineness of both the coarse and the fine aggregates. The sieve analysis curve for the fine aggregate is reported

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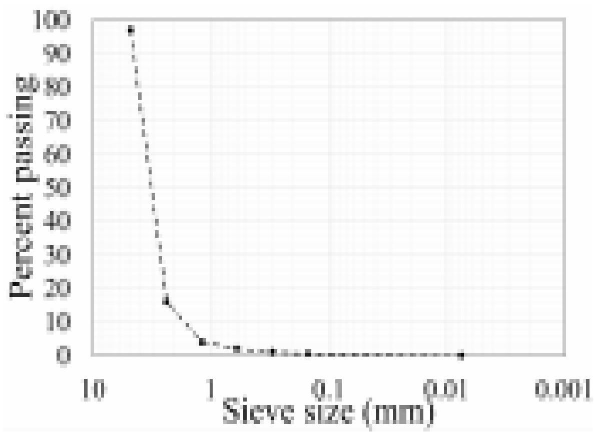

Fig. 3. Sieve analysis of the artificial fine aggregate

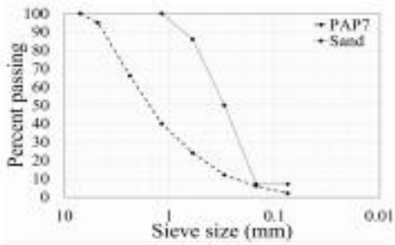

Fig. 1. MC01 sand and PAP7 sieve analysis

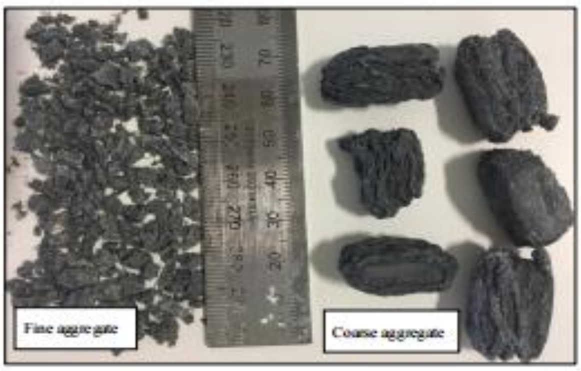

Fig. 2. Pictures of the manufactured aggregate

in Figure 3. The size of approximately 80% of the fine aggregate was between 2.36 mm and 4.75 mm. Of the remaining 20%, the size of over 12% was between 1.18 mm and 2.36 mm and the rest was relatively evenly spread, which indicated that the fine aggregate was relatively coarse and that the aggregate featured a poor grading distribution. The size of 80% of the coarse aggregate was between 13.2 mm and 19.0 mm, which was similar to the size grading distribution of the 13mm natural aggregate

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(KB13) and in compliance with the New Zealand standard [41]. Appropriate concrete mixes need a widely distributed fine aggregate for the concrete to be workable, which was not the case for the fine artificial aggregate. Chemical admixtures Standard is of-the-shelf air entraining agent, super plasticizer and water reducer chemical admixtures were used in the mixes.

4. TRIAL MIXES

A total of five mixes were designed and batched according to the New Zealand Standard on Concrete Production [40], and various fresh and hardened properties were investigated following the New Zealand Standard for testing of concrete[43, 44]. The ingredients used in each mix are reported in this section, together with the results from the investigated properties of the trial mixes.

Recipes The ingredients used in each trial mix are reported in Table 2, together with the quantity of each ingredient. The water cement ratio and the amount of coarse natural aggregate were kept constant at 0.405 and 320 kg. The mass amount of PAP7 and sand was progressively reduced while increasing the mass amount of artificial aggregate (both coarse and fine aggregate in the ratios described in Table 2) until the maximum replacement level of natural aggregate by artificial aggregate was 15% by mass (for mix 5). Given that the density of the artificial aggregate was smaller than 0.25 times the density of the artificial aggregate, the volume of artificial aggregate was 37.1% of the total volume of aggregate for mix5. Both the super plasticizer and the water reducer were maintained constant at 2 litter and 0.9 litter respectively.

4.1. Fresh concrete properties

Yield and slump tests were undertaken on the fresh concrete for the 5 mixes in accordance with the NZS 3112.1 standard[43], with the results being reported in Table 3. The relationship between artificial aggregate content, slump and entrained air are visually represented in Figure 4. The objective was to obtain a fresh mix with a slump of at least 100 mm, but when more artificial aggregate was included in the fresh concrete the workability of the fresh mix decreased, as previously observed by others[14]. This effect could be exacerbated by the narrow particle size distribution of the artificial fine aggregate. Altering the water to cement ratio was not a desired option, because a higher ratio would compromise the strength of the concrete. A decision was made to include an air entraining agent, given that the maximum amount of super plasticizer and water reducer before excessive bleeding could be expected had already been added. The air entraining agent stabilized the percentage of entrained air to 10% for mix 5. Extensive research has been conducted on the effect of introducing pieces or fibres of plastic in the concrete mix, with a thorough review recently being published [14]. The main conclusion from the review study was that there is high variability depending on the type and shape of plastic included in the mix. However, the product used in the current study differed because the water absorption increased as a result of the manufacturing process, which reduced the slump. This slum production could be partially mitigated by using chemical additives significantly below the limits suggested by the suppliers, as shown in Figure 4. A similar behavior was observed in the only study with a material similar to that used in this project [37].4.3. Hardened properties

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Cylinders of a nominal radius and length of 100 mm and 200 mm respectively were tested.

Table 2. Mix recipes

Material	Density (kg/m³)	Mix number 1	2	3	4	5
Cement (kg)	3150			400		
Water (kg)	1000			162		
w/c	-			0.405		
Fume silica (kg)	2100			20		
KB13 mm (kg)	2680			320		
PAP7 (kg)	2680	410	410	360	360	320
MC01 Sand (kg)	2650	495	495	445	445	405
Coarse artificial aggregate (kg)	800	30	75	60	100	120
Fine artificial aggregate (kg)	800	30	25	60	60	65
Artificial aggregate (% of total aggregate by weight)	-	4.7	7.5	9.6	12.5	15.0
Artificial aggregate (% of total aggregate by volume)	-	11.6	18.6	23.7	30.9	37.1
Water reducer (l)	1000			2		
Super-plasticiser (l)	1000			0.9		

Table 3. Fresh concrete properties for the trial mixes

Mix	Artificial aggregate (%)	Slump (mm)	Entrained air (%)
1	4.7	130	5.8
2	7.5	170	3.5
3	9.6	110	6.5
4	12.5	110	9.5
5	15.0	110	10.0

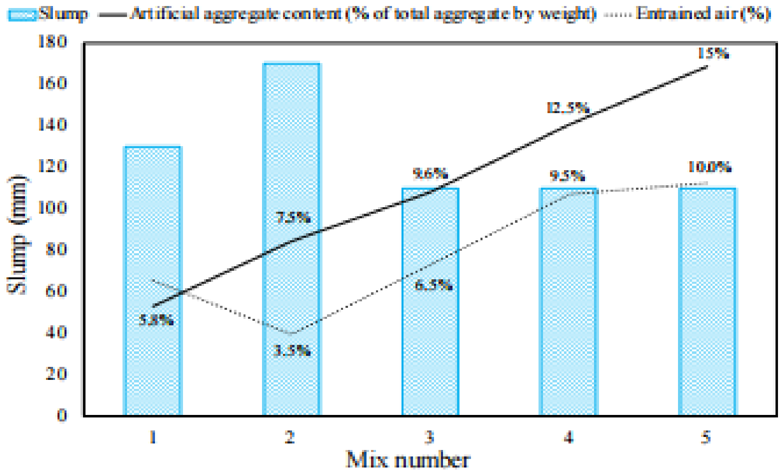

Fig. 4. Relationship between artificial aggregate content, slump and entrained air

Similarly, beams with a square cross section of 100 mm per side and a length of 500 mm were tested in the same machine using the four point bending test described in the same standard[44]. Three cylinders and one beam for each

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mix were tested at each time period. The compressive and the flexural strength were measured at 1, 7 and 28 days after being stored in a water bath at 21±3 degrees, in compliance with the standard. The results are reported in Table 4 together with the quantity of artificial aggregate content (Ag.) expressed as a mass percentage of the total aggregate weight, and the dry density in kg/m3 . A visual representation of the relationship between compressive strength, amount of artificial aggregate, and density is reported in Figure 5, with the standard deviation represented by whisker lines .The density decreased as the amount of artificial aggregate was increased and as the quantity of entrained air increased. This reduction of density was accompanied by a reduction of strength but the strength was stabilized for mixes 3 to 5 while steadily increasing the amount of artificial aggregate and keeping the density around the target of 1800 kg/m3 . While the addition of air entraining agents was necessary to obtain a workable fresh mix, the extra entrained air reduced the strength of the hardened concrete. The objective was therefore to find the balance between density, which decreased as more artificial aggregate and entrained air was included in the mix, and mechanical properties, which also decreased when more artificial aggregate and entrained air was used. This balance was achieved in mix 4 and especially in mix 5, with both mixes having similar mechanical properties but with mix 5 having slightly more artificial aggregates, less entrained air, and lower density than mix 4. The finding from several past studies were extracted from a previous review to compare the results obtained in this research with those from previous studies

Table 4. Hardened concrete properties for the trial mixes

Mix	Agg. (%)	Density (kg/m^3)	Compressive strength (MPa)			Flexural strength (MPa)		
			1 day	7 days	28 days	1 day	7 days	28 days
1	4.7	1927	12.0	23.3	27.2	2.4	4.6	4.9
2	7.5	2116	13.2	26.3	36.5	2.5	4.6	5.6
3	9.6	1885	11.6	21.4	22.8	2.4	4.1	4.2
4	12.5	1925	10.6	19.5	22.6	2.0	4.0	4.4
5	15.0	1812	10.0	19.0	22.2	2.2	4.1	4.5

between density, which decreased as more artificial aggregate and entrained air was included in the mix, and mechanical properties, which also decreased when more artificial aggregate and entrained air was used. This balance was achieved in mix 4 and especially in mix 5, with both mixes having similar mechanical properties but with mix 5 having slightly more artificial aggregates, less entrained air, and lower density than mix 4. The finding from several past studies were extracted from a previous review to compare the results obtained in this research with those from previous studies

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[14]. The comparison, reported in Figure 6, was delineated by studies that replaced coarse aggregate (marked with a circle) and those that replaced fine aggregate (marked with a triangle). The results from the current study (marked with a cross) were generally superior to those where only the coarse aggregate was replaced, but the replacement of only the fine aggregate resulted in higher strength concrete, as for example the studies by Juki et al [25]. The strength of the coarse aggregate had a more significant effect of the compressive strength of the concrete because the fracture line is more likely to cross the coarse aggregates than the fine aggregates. Therefore including plastic waste as fine aggregate has a more limited effect on concrete strength. The relationship between aggregate content, density and flexural strength can be seen in Figure 7, similarly to Figure 5. A key finding was that the flexural strength increased with respect to the compressive strength when more artificial aggregate was used. For example, the compressive strength of mix 5 was 82% of that of mix 1, but the flexural strength of mix 5 was 92% of that of mix 1. This behaviour indicated that the artificial aggregate had a significant influence on the flexural strength, and could potentially increase the tensile strength. A possible solution to further increase the mechanical properties while maintaining or even reducing the density and without compromising the mechanical properties of the

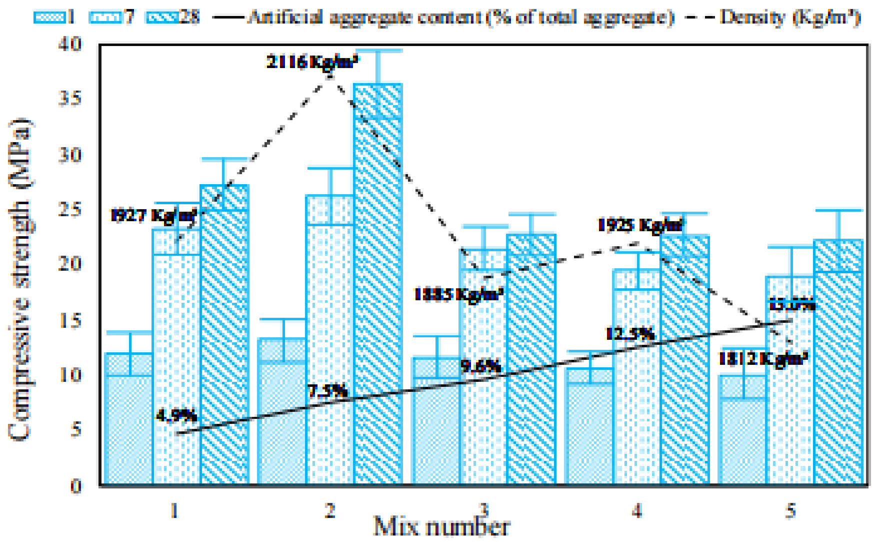

Fig. 5. Compressive strength for the five trial mixes

concrete could be to create a more densely graded fine aggregate (i.e. greater variation in particle size) that would help with the flow ability of the concrete, so that less or no air entraining agent would be necessary. The evolution over time of the mechanical properties is reported in Figure 8 for the compressive strength and in Figure 9 for the flexural strength. The strength evolution over time was similar to that of typical concrete without artificial aggregates, and no effect on the time evolution could be found between the density of the mix or the amount of recycled aggregate or entrained air.

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The results show that mix 5 used the largest amount of plastic aggregate while satisfying the product requirements. The volume of aggregates replaced by the plastic aggregate in mix 5 was 37.1%. More than 19 million tons of virgin aggregate would not be mined if mix 5 was used for only 1% of the concrete produced in New Zealand in an average year [4]. Given the low density of plastic, approximately 9 million tons of plastic could be recycled per year to occupy the same volume as 19 million tons of aggregate. After studying the results from the trial mix, mix 5 was selected to undertake a more detailed study on the mechanical properties of the hardened concrete.

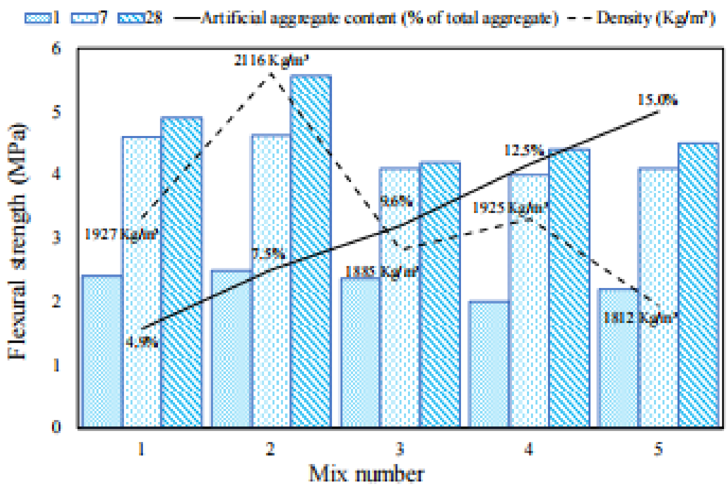

Fig. 7. Flexural strength for the five trial mixes

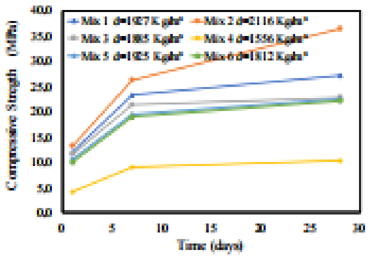

Fig. 8. Evolution of the compressive strength of the trial mixes

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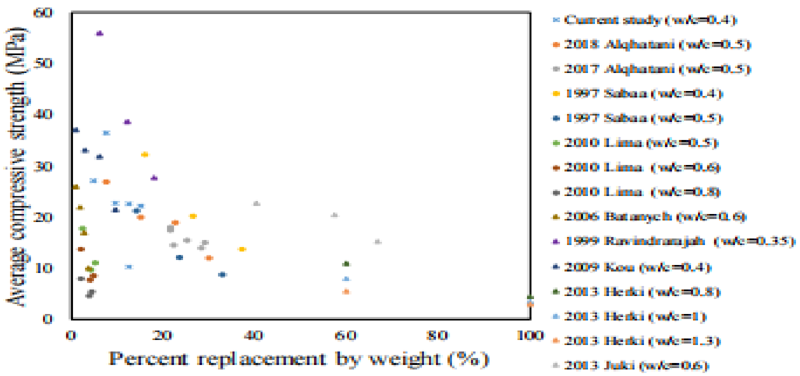

Fig. 6. Comparison between the current study (crosses) with previous studies on replacement of coarse aggregate (circles) and fine aggregates (triangles)

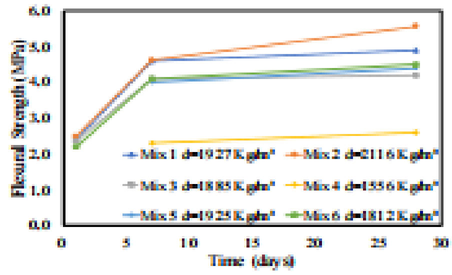

Fig. 9. Evolution of the flexural strength of the trial mixes

Table 5. Hardened concrete properties for the final mix

Age	1 day	7 days	28 days
Compressive strength (MPa)	9.2 ±0.38	17.7 ±0.59	19.7 ±1.58
Split tensile strength (MPa)	1.9 ±0.06	2.3 ±0.12	2.3 ±0.15
Flexural strength (MPa)	2.4	3.6	4.3

Hardened properties A number of cylinders and beams were prepared using the mix 5 recipe as detailed in Table 2. Five cylinders were tested in compression and five cylinders were tested in split tension at an age of 1 and 7 days, and twenty cylinders were tested in compression and twenty in split tension at an age of 28 days. Similarly, one beam was tested at an age of 1 and another at 7 days, while 3 beams were tested at an age of 28 days. The average results are reported in Table 5 together with the standard deviation for the compressive and split tensile strength. Examples of the failures observed during testing are reported in Figure 10. The fracture plane was observed to not cross any piece of the artificial aggregate, either in compressive, in split tensile or in flexural testing. Occasionally, the fracture plane was coincident with the surface of the artificial aggregate. Both observations were in accordance with the behaviour of typical concrete, where the aggregate is typically stronger than the cement paste and the fracture plane does not cross the aggregate but coincides with its surface. A point of difference with typical concrete was that pieces of the artificial aggregate prevented the crack that

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Fig. 10. Pictures of the failure observed during testing

defined the fracture plane from opening beyond a certain width, and the cylinder remained cohesive until considerable damage was observed. Even when the typical hourglass shape took form, after large deformation was applied into the cylinder, small pieces of concrete were still attached to the main body of the cylinder by pieces of aggregate, as can be seen in Figure 10a.

Statistics The results of the compressive and tensile strength of the forty cylinders tested at an age of 28 days are reported in Table 6. The purpose of testing twenty specimens for each test at an age of 28 days was to obtain the specified strength value, in addition to the average strength value and any other statistical value that could be useful, as reported in Figure 11. The specified strength value is typically defined as the lower bound characteristic value or 95 percentile value, which means that 95% of the strength values (or nineteen out of twenty) should be above that specified value. Hundreds or even thousands of data points would be obtained in a typical scenario when developing a new concrete mix by a ready mix plant for commercial use, but that was not a feasible option for this study and therefore twenty specimens were tested instead. A normal distribution can be assumed, given that normal distribution is often assumed in testing of concrete strength. The specified value would then be calculated as the average value minus 1.645 times the standard deviation, which results in a specified compressive strength of 17.1 MPa. This result was consistent with the results from Table 6 and Figure 11, as only one value was below 17.1 MPa.

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Table 6. Details of compression and split tension tests

Compressive strength (MPa)	19.4	20.9	21.2	21.8	19.8	18.1	16.4	17.1	18.2	18.7
	19.8	19.9	21.7	20.4	19.9	18.6	18.4	22.3	19.7	21.8
Split tensile strength (MPa)	2.2	2.1	2.1	2.5	2.3	2.3	2.3	1.9	2.3	2.2
	2.3	2.1	2.5	2.2	2.4	2.1	2.5	2.5	2.2	2.1

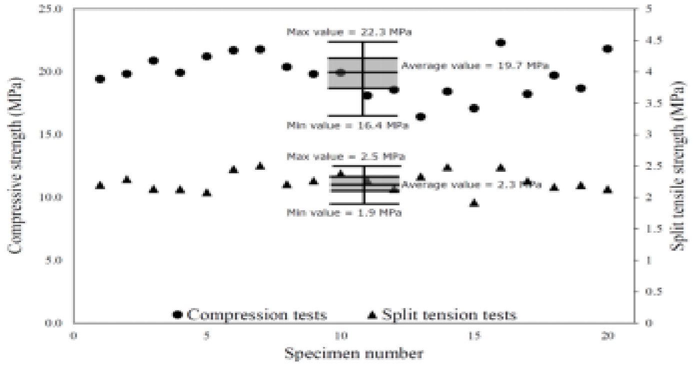

Fig. 11. Statistical values of the cylinder testing at 28 days

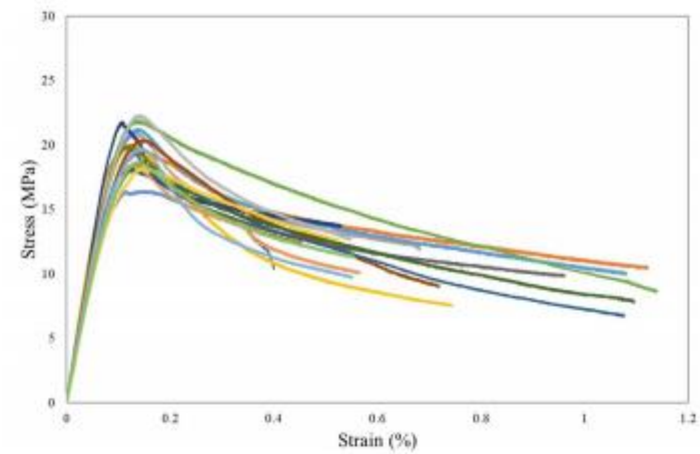

Fig. 12. Full stress strain response for concrete compressive cylinders of the final mix design tested at 28 days

4.2 Stress strain relationships

The stress-strain relationship in compression is reported in Figure 12. The strain at peak stress was similar to what can be expected with typical concrete, but the concrete exhibited a less brittle failure than for typical concrete with a longer post-peak tail, in accordance with observation of the fracture patterns reported earlier. This observation was in line with previous observations regarding the contribution of plastic aggregate to the flexural strength and potentially to the tensile strength of concrete[14]. The modulus of elasticity E of the artificial aggregate was calculated according to the pertinent

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ASTM standard[46]. The value obtained was 20.5GPa, which is similar to that of normal concrete. However, the concrete with artificial aggregate experienced more post-peak deformation capacity than the typical concrete with natural aggregate, which means that the pieces of artificial aggregate that cross the failure plane of the concrete can accommodate the displacement better than can natural aggregate, as also observed before .

5. CONCLUSIONS

Five mixes were developed and an optimal mix was chosen based on the mechanical properties and the density, which fulfilled the requirements of the target specification (density of 1800 kg/m3 , a 28 days compressive strength of 20-25MPa, and a 1-day compressive strength of 10MPa. In this optimal mix, 15% of the natural aggregate was replaced by weight, which equals 37.1% of the volume given the lower density of the manufactured aggregate compared to natural aggregate. The mixes were not recommended for high performance concrete, structural concrete, or for infrastructure projects. A larger concentration of plastic waste in the form of coarse aggregate was used in the current study when compared to past studies that obtained similar mechanical properties. This improvement is due to the innovative method of extruding and pelletizing the plastic waste, as opposed to the methods reported in the literature that entail sorting, cleaning and shredding the plastic waste or to use plastic as a binder with sand to create aggregates. As an example, if mix 5 was used in just 1% of the concrete produced in New Zealand almost 19 million of tons of virgin aggregate would not be mined, and 9 million tons of plastic would be recycled in an average year. Further research on this new aggregate needs to be conducted, especially related to durability. The main conclusions observed from the study are summarized below. While similar observations have been reported in the literature, it is noted that the level of plastic replacement achieved in the current study was significantly higher than the typical replacement levels reported in the available literature.

- Inclusion of the manufactured aggregate reduced the density, but jeopardized the workability of the fresh mix. Additives were necessary to obtain a workable mix.
- Inclusion of the manufactured aggregate reduced the compressive strength, but increased ductility and flexural strength.
- The grading of the artificial aggregate needs to be improved, which could potentially prevent or reduce the use of air entraining agents, resulting in enhanced mechanical properties

6. ACKNOWLEDGEMENTS

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PARTIAL REPLACEMENT OF AGGREGATE WITH RECYCLED FINE AGGREGATE AND REBUTTED TYRE WASTE IN CONCRETE

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ABSTRACT

Due to the day to day innovations and development in construction field, the use of natural aggregates is increased tremendously and at the same time, the production of solid wastes from the demolitions of constructions is also quite high. Because of these reasons the reuse of demolished constructional wastes like fine aggregates and also we are using recycled rubber derived from scrapped vehicle tyres .The fine aggregate waste is not only occurring from the demolition of structures but also from the manufacturing unit. Studies show that the waste that is coming from the automobile industries is very high. So here we are using scrapped vehicle tyres as a fine aggregate in the concrete .This waste material should have to be reused in order to deal with the limited resource of natural aggregate and to reduce the construction wastes.

The fine aggregates which are from demolished structures were partially replaced in place of fine aggregates in the concrete by 10%, 20%, 30%, 40% and 50%. Rebutted tyre waste was replaced in place of fine aggregate by 10% along with the recycled fine aggregate. M25 grade of concrete was designed and tested. Experimental investigations like workability, Compressive strength test, Split tensile strength test, Flexural strength test for different concrete mixes with different percentages of recycled fine aggregate and rebutted tyre waste after 7, 14 and 28 days curing period has done. It has been observed that the workability increases with increase in the percentage of replacement of rebutted tyre waste and recycled fine aggregate increases. The strength of concrete also increases with the rebutted tyre waste and recycled fine aggregate up to 30% percentage.

KEYWORDS: Aggregate with recycled fine Aggregate, Rebutted tyre.

1. INTRODUCTION

1.1 Concrete:

Concrete is a composite material that primarily consists of water, aggregate, and cement. By adding additives and reinforcements to the concrete mixture, the desired physical qualities for the completed material may be achieved. By combining these elements in certain quantities, a solid mass that can be readily shaped into the appropriate shape may be created. Over time, a hard matrix generated by cement binds the remaining materials together to form a single hard (rigid) durable material with a wide range of applications, including buildings, pavements, and so on. The ancient

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Romans were among the first to employ concrete technology on a broad scale, and the Roman Empire made extensive use of concrete technology. The coliseum at Rome was mostly constructed of concrete, as was the dome.

1.2 Historicalbackground:

Despite the fact that high-strength concrete is a relatively new material, its development has been steadily expanding over the years. Concrete having a compressive strength of 34 MPa was deemed high strength in the 1950s in the United States. Commercially, concrete with compressive strengths ranging from 41 to 52 MPa was utilised in the 1960s. Concrete with a compressive strength of 62 MPa was developed in the early 1970s. With the current state of affairs, however, concrete of extremely high strength has entered the construction industry of high-rise structures and long-span bridges in the last fifteen years. IS 456-2000 considers compressive strength more than 110 MPa for use in pre-stressed concrete members and cast-in-place structures.

Recently reacted concrete, on the other hand, may be the one with a compressive strength of almost 250 MPa. Pozzolanic materials back it up completely. The primary distinction between high-strength and nominal-strength concrete is the relationship between the concrete sample's compressive strength and its maximum resistance to any form of load. Although there is no clear distinction between high-strength and normal-strength concrete, the Yankee Concrete Institute defines high-strength concrete as having a compressive strength more than 42 MPa.

1.3 Properties Of Concrete:

Concrete is often a material with a higher compressive strength than tensile strength. Because the tensile stress is smaller, it is usually reinforced using materials that are strong in tension, such as steel. Concrete's elastic behaviour is essentially stable at low stress levels, but when matrix cracking occurs, it begins to decrease. Concrete has a low coefficient of thermal expansion, which causes shrinkage as it ages.

All concrete constructions fracture to some extent as a result of shrinkage and strain. When concrete is subjected to long-duration stresses, it is prone to creep. Various tests will be carried out for the applications to guarantee that the concrete qualities match the criteria. Varied combinations of concrete materials provide different concrete strengths, which are measured in psi or Mpa. Concrete of various strengths is utilised for various building applications. A extremely low-strength concrete can be utilised if the concrete must be light. The addition of lightweight particles, air, or foam to concrete achieves lightweight concrete; nevertheless, the strength of the concrete is lowered as a result. Concrete with a compressive strength of 3000-psi to 4000-psi is frequently used for ordinary operations.Although 5000-psi concrete is more costly, it is commercially accessible as a more durable choice. Concrete with a 5000-psi strength is frequently employed in big civil projects. Concrete with a strength more than 5000 psi was frequently employed for particular construction features. To keep the column diameters modest, high-rise concrete buildings built of lower level columns may employ 12,000 psi or greater strength concrete.

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To reduce the number of spans necessary, bridges can employ concrete with a strength of 10,000 psi in long beams. Other structural requirements may necessitate the use of high-strength concrete on occasion. If the structure must be exceedingly stiff, even stronger than necessary to carry the service loads, high-strength concrete may be selected. Concrete with a strength of 19000-psi was chosen for these business reasons.

1.4 Construction Waste In India:

Solid waste is expanding day by day in today's building sector, owing to the demolition of structures. The use of recycled fine aggregates in current projects is widespread, and it is growing by the day. Most structures employ recycled fine aggregate products as part of the basic construction components. Residential garbage was gathered from structures that had previously been destroyed for renovation. Aggregates, among the various raw materials used in construction, have increased by 5%, to over 21 billion tones, with the largest increases occurring in developing countries such as China and India, where a report prepared by the ministry of environment and forest in 2008 estimated that 0.53 million tones of waste are generated per day. Some academics are also looking at repurposing building trash in order to decrease solid waste and conserve natural basic aggregates. These studies encourage the use of recycled aggregates in concrete mixes, and they found that using recycled aggregates in place of natural fine aggregates yielded positive results.

1.5 Recycled Aggregate Concrete:

By 10%, recycled fine aggregates are used in lieu of fine aggregate, and rebutted tyres are used in place of fine aggregate. Individually, these recycled fine aggregates and rebutted tyres were used to replace fine aggregates, as well as in combinations, in which several fine aggregates were replaced at once in a single mix.

Workability tests were undertaken for several mixtures including varying percentages of recycled fine aggregates and rebutted tyre to determine their appropriateness in the concrete mix. The slump cone test is used to assess the workability of new concrete. Casting cubes are also used to conduct compressive strength tests for 3, 7, and 28 days to investigate the strength fluctuation by varying percentages of waste components. The goal of this research is to better understand how destroyed solid waste behaves and performs in concrete. By 10 percent, 20 percent, 30 percent, 40 percent, and 50 percent, waste recovered fine aggregates are utilised to partially replace fine aggregate. Rebutted tyres are also utilised to replace 10% of the fine aggregate.

1.6 Environmental And Economic Benefits Of Recycled Aggregate Concrete:

The Usage Of Recycled Fine Aggregate As Replacement To Fine Aggregate In Concrete Has The Benefits In The Aspects Of Cost And Reduction Of Pollution From Construction Industry. The Cost Of Concrete Manufacturing Will Reduce Considerably Over Conventional Concrete By Including Recycled Fine Aggregate And Rebutted Tyre Since It Is Readily Available At Very Low Cost And There-By Reducing The Construction Pollution Or Effective Usage Of Construction Waste.

ISBN: 978 – 81 – 959860 – 0 -2

2. MATERIALS

2.1 Materials Used:

2.1.1 Cement

- Ordinary Portland Cement of 53 Grade cement conforming to IS: 169-1989

Ordinary Portland Cement of 53 Grade of brand name Ultra Tech Company, available in the local market was used for the investigation. Care has been taken to see that the procurement was made from single batching in air tight containers to prevent it from being effected by atmospheric conditions. The cement thus procured was tested for physical requirements in accordance with IS: 169-1989 and for chemical requirement in accordance IS: 4032-1988. The physical properties of the cement are listed in Table.

Table 1 the properties of the cement

SL.NO	PROPERTIES	TEST RESULT	IS: 169-1989
1	Normal Consistency	0.32	
2	Initial Setting Time	50 Min	Minimum Of 30 Min
3	Final Setting Time	320 Min	Maximum Of 600 Min
4	Specific Gravity	3.14	
5	Compressive Strength		
	3 Days Strength	29.2 N/Mm^2	Minimum Of 27 N/Mm^2
	7 Days Strength	44.6 N/Mm^2	Minimum Of 40 N/Mm^2
	28 Days Strength	56. 6 N/Mm^2	Minimum Of 53 N/Mm^2

2.1.2 Fine Aggregates:

River sand was used throughout the investigation. The sand was air dried and sieved to remove any foreign particles prior to mixing. Sand conforming to Zone-III was used as the fine aggregate, as per I.S 456-2000. The sand was air dried and free from any foreign material, earlier than mixing.

SL.NO	DESCRIPTION TEST	RESULT
1	Sand zone	Zone -3
2	Specific gravity	2.34
3	Free Moisture	1%
4	Bulk density of fine aggregate (poured density)	1385.16 kg/m3

2.1.3 Coarse Aggregates:

IS: 2386-1963, the aggregates were tested for physical parameters such as gradation, fineness modulus, specific gravity, and bulk density.

Coarse aggregates	**size**
Fine gravel	4mm-8mm
Medium gravel	8mm-16mm
Coarse gravel	16mm-64mm
Boulders	>256mm

ISBN: 978 – 81 – 959860 – 0 -2

SL.NO	DESCRIPTION TEST	RESULT
1	Nominal size used	20 mm
2	Specific gravity	2.7
3	Impact value	10.5
4	Water absorption	0.15%
5	Sieve analysis	20 mm
6	Aggregate crushing value	20.19%
7	Bulk density of coarse aggregate (Poured density)	1687.31kg/m^3

2.1.4 Water:

Water Quality Is Crucial Because Pollutants Can Reduce The Strength Of Concrete And Induce Corrosion Of Steel Reinforcing. It Is Regarded Good For Concrete Production If The Water Is Drinking. As A Result, In This Investigation, Potable Tap Water Was Utilised For Mixing And Curing. According To IS 456 – 2000, The PH Value Of Water Should Be Between 6.0 And 8.0.

2.1.6 Recycled Fine Aggregate:

The aggregate which passes through the 4.75mm sieve is used as a partial replacement to fine aggregate and 10% of rebutted tyre combination with the fine aggregate replacement. The fine aggregates are taken from the demolished structures.

SL.NO	DESCRIPTION TEST	RESULT
1.	Nominalsizeused	4.75 mm
2.	Impact value	9.5
3.	Specific gravity	2.66
4.	Water absorption	0.6%
5.	Sieve analysis	4.75 mm

2.1.7 Rebutted Tyre

The rubber aggregates from discarded tyre rubber in sizes 20-10 mm, 10-4.7 5mm and 4.75 mm down can be partially replaced natural aggregates in cement concrete construction

SL.NO	DESCRIPTION	RESULT
1.	Specific gravity	1.15
2.	Fineness modulus	1.70
3.	Water absorption	1.43%
4.	Sieve analysis	4.75mm

Fig.1 Nominal size used

3. CONCRETE MIX DESIGN

The following points should be remembered before proportioning a concrete mix a per IS-10262-2009.

- Only common and standard concrete grades can be proportioned using this method.

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- The amount of air in concrete is regarded as nil.
- The proportioning is done to obtain a specific characteristic compressive strength at a specific age, as well as workability and durability criteria for fresh concrete.

4. EXPERIMENTAL DETAILS

This chapter discusses the various mix proportions used in the trials, as well as the experimental results achieved in terms of flexural strength, compressive strength, split tensile strength, workability, and durability.

4.1 Flexural Strength Test:

Make the specimen by pouring the concrete in the necessary mould shape of 10x10x50cm prism with proper compaction, then placing the specimen in water for 24 hours to cure.

4.2 Compressive Strength:

Make The Specimen By Putting The Concrete In The Necessary Mould Shape Of 15cm X 15cm X 15cm Cube With Proper Compaction, Then Placing The Specimen In Water For 24 Hours To Cure.

COMPRESSIVE STRENGTH = (LOAD / AREA) In N/Sq.Mm

4.3 Split Tube Tensile Strength:

Make the specimen by putting the concrete in the desired mould shape of 10 cm x 30 cm cylinder with proper compaction, then placing the specimen in water for 24 hours to cure.

4.4 Workability:

- Workability By Slump-Cone Test
- Workability By Compacion Factor Test

5. TEST RESULTS

The concrete grades M25 are designed in this project with a suitable water-cement ratio to provide the requisite concrete strength as well as for various fine aggregate mix replacements.

5.1 Flexural Strength Test:

The flexural test was carried out only on M3 mix since it has the maximum compressive and split tensile strength when compared to M0 mix. The following two beams were cast and tested in total:

Table 2 Flexural test results for concrete 7, 14 and 28 days

S.No	Mix Code	Grade of concrete	Flexural Strength in N/mm2		
			7 days	14 days	28 days
1	**M_0**	M25	**3.25**	**4.75**	**5.3**
2	**M_3**	M25	**3.19**	**4.81**	**5.33**

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5.2 Compressive strength:

After executing the workability tests, a total of 42 cubes with dimensions of 150 x 150 x 150mm were cast and tested for 7 days, 14 days, and 28 days. The following are the results.

Table 3 Results of the M25 concrete grade's compressive strength after 7, 24, and 28 days.

S.No	**Mix Designation**	**Aggregate Replacements %**	**Compressive strength of M25**		
			7 days	**14 days**	**28 days**
1	**M_0**	**0+0**	**22.57**	**26.54**	**32.2**
2	**M_3**	**30+10**	**27.05**	**33.53**	**35.3**

5.3 Split Tensile strength:

The split tensile strength of all the mixes prepared for various replacements acquired by testing the cylindrical specimen for M25 grade of concrete is given below.

Table 4 Split tensile strength results for M25 grade of concrete

S.No	Mix Designation	Aggregate Replacements %	Split Tensile Strength of M25 grade in		
			7 days	14 days	28 days
1	M_0	0+0	1.67	2.18	2.56
2	M_3	30+10	1.71	2.26	2.65

5.4 Workabilty:

The perfect concrete is one that can be worked in any situation, such as being simply poured, compacted, and moulded. The workability is evaluated in this chapter using the following two methods:

5.1.1 Slump Cone Test:

The Test Was Carried Out On Freshly Prepared Concrete Prior To The Moulding Process. Six Different Concrete Mixtures Are Made At Different Times. Workability The Results Of The Slump Cone Test For Concrete Grade M25 Are Displayed In The Table Below.

S.No	**Mix Designation**	**Aggregate Replacements %**	**Workability (Mm)**
			M25
1	**M_0**	**0+0**	62
2	**M_3**	**30+10**	76

5.1.2 Compaction Factor Test:

The compaction factor test was done on the same mix that was slump cone tested for workability. The following table summarises the findings of the compaction factor test for the workability of various M25 grade concrete replacement mixes.

S.No	Mix Designation	Aggregate Replacements %	Workability (mm)
			M25
1	M_0	0+0	0.82
2	M_3	30+10	0.87

6.CONCLUSION

The following results are drawn from experimental research into compressive strength, split tensile strength, and flexural strength, taking into account environmental factors:

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- The workability of concrete increases with the increase in recycled fine aggregate replacement. The workability is further increased with the addition of RBT.
- The characteristics of concrete improved linearly as the percentage of recycled aggregate was raised up to 30%.
- Concrete's characteristics degrade linearly after 30 percent material replacement, implying that strength is achieved on a constant basis.
- In terms of compressive strength, split tensile strength, and flexural strength, the M3 mix of concrete performed better than the other mixes. However, recycled aggregate can be utilised in up to 50% of the mix.
- The use of recycled aggregate has a negative impact on the characteristics of concrete.
- The addition of RBT to concrete, together with recycled fine aggregate, increases its mechanical qualities.
- When compared to normal concrete grades, the split tensile strength of recycled fine aggregate follows a considerably more linear curve.

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PARTIAL REPLACEMENT OF COARSE AGGREGATE WITH COCONUTSHELL AND ADDING OF ASBESTOES FIBER

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ABSTRACT

All countries are focusing on sustainable technology that can be economical and adopted for the use of concrete in a better way. Concrete is most widely used construction material and it posses very low tensile strength, shear strength and brittle characteristics. In order to improve this properties a new construction materials was developed through research and development work called asbestos fiber concrete and coconut shells In order to improve this properties a new construction materials was developed through research and development work called asbestos fiber concrete and coconut shells. M30 grade of concrete was designed. The addition of asbestos fiber and coconut shell to the concrete. To determine the properties like tensile strength, compressive strength and flexural strength were performed a different ages like 7, 14 and 28 days. The addition of asbestos fiber varies from 10%, 11%, 12% and 15% by volume of concrete and coconut shell varies from 0.1%, 0. 3%, 0.5%, 0.7% and 0.9% by volume of concrete. The compressive strength of the coconut shell concrete was reduced as percentage replacement increased. The study results show that coconut shell concrete can be used as light weight concrete. Use of CS shell as aggregate will not only is cost effective and ecofriendly. But also help to resolve the problem of shortage of material such as coarse aggregate.

1. INTRODUCTION

Compressing ordinary concrete causes cracks. Synthetic fiber specially designed for concrete prevents the crushing force by tightly binding the concrete. When synthetic fiber is used, the water cement ratio becomes uniform bleeding because it gives abrasion resistance. Synthetic fiber reduces plastic cracking of concrete. This improves the impact resistance of concrete. The relatively low coefficient of synthetic fibers provides shock absorption properties. Synthetic fibers help the concrete develop optimum long-term shelf life with reduced plastic settling and shrinkage crack formation, reduced permeability and increased resistance to abrasion. Shatter and impact force. Synthetic fibers are compatible with all mixtures of silica fume and cement chemicals. Synthetic Fibers Used As Secondary Reinforcement:

Synthetic fibers that meet certain hardened concrete standards can be used as

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unstructured temperatures or secondary reinforcements. The fiber must have a document that confirms its ability to hold the concrete together after it breaks. The uniform distribution of the synthetic fibers throughout the concrete ensures the critical position of the secondary reinforcement.

The composites can be described as hybrids when used in a combined matrix of two or more types of fibers to produce composite materials that reflect the benefits of each individual fiber. This will eventually provide synergy for the entire structure. This concrete compound is called hybrid fiber reinforced concrete (HFRC). The mechanical properties of concrete have been greatly improved with the use of short and long fibers. This increases the modulus of elasticity of the concrete. This reduces the chances of brittleness and, therefore, reduces the formation of small cracks because small cracks are an important factor in the propagation and formation of large cracks. The possibility of joining or drawing from fiber to fiber is less because this cause requires a great absorption of energy. This is the reason why it provides fracture toughness for HFRC, as well as dynamic loading and cyclic loading.

2. MATERIALS AND METHODOLOGY OF EXPERIMENTAL WORK

1. *Materials*

Deccan cement OPC 53 grade cement was used for this project. We evaluate the quantity required for this work, buy the full quantity and store it in the foundry. The following tests were performed in accordance with the IS code. The fine aggregate used in this investigation was clean river sand and the following test was carried out in sand according to IS: 2386-1968. Ordinary Portland Cement (OPC) is the most important cement type. When tested according to IS 4031-1988, OPCs were classified on the 28th day according to the strength of cement into three grades: 33 grades, 43 grades and 53 grades. 28 days strength is 33N / mm^2, 43N / mm^2 and 53N / mm^2 or more, respectively, and it is called cement of grade 33, 43 and 53 respectively. Used the dried angle coarse aggregates with a maximum size of 20 mm and a minimum size of 10 mm that are locally available used for the experiment. Water is an important ingredient in concrete because it is actively involved in chemical reactions with cement. This is due to the strength imparted to the cement gel and the workability of the concrete. You should carefully check the quantity and quality of the water. Portable water forconcrete is used.

Table 1 Properties of water

S. No	Properties	Value
1	PH	7.25
2	Taste	Agreeable
3	Appearance	Clear
4	Turbidity(NT units)	3.85

Coconut shell is one of the waste material can be used as Aggregate in concrete and also which is available in all countries like India, Indonesia, Srilanka. Coconut shell is a

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separate intermittent staple fiber that can be used for concrete to crack and prevent cracks. It catches shrinkage cracks of concrete and increases the resistance of water penetration, abrasion and impact. It improves compressive strength, ductility andflexural strength while improving the ability to make concrete more uniform and absorb more energy.

Table 2 Properties of coconut shell

Coconut shell	Shell size	16-20mm
	Bulk density	675
	Specific gravity	1.34-1.40 cc/g
	Fineness modulus	7.0
	Water absorption	35%

Asbestos is a term used to refer to six naturally occurring silicate minerals. All are composed of long and thin fibrous crystals, each fiber being composed of many microscopic 'fibrils' that can be released into the atmosphere by abrasion and other processes. Asbestos is an excellent electrical insulator and is highly heat-resistant, so for many years it was used as a building material. However, it is a well-known health and safety hazard, and today, the use of asbestos as a building material is now illegal in many countries. Inhalation of asbestos fiber scans lead to various serious lung conditions, including asbestosis and cancer.

3. TESTS ON CONCRETE

The property of fresh concrete which is indicated by the amount of useful internal work required to fully compact the concrete without bleeding or segregation in the finished product. Workability is one of the physical parameters of concrete which affects the strength and durability as well as the cost of labor and appearance of the finished product. Concrete is said to be workable when it is easily placed and compacted homogeneously i.e., without bleeding or Segregation. Unworkable concrete needs more work or effort to be compacted in place, also honeycombs &/or pockets may also be visible in finished concrete. . Two tests basically have done for workability namely slump test and compaction factor test with fresh mix.

Table 4 compressive strength values for 7 days

Asbestos fibre%	Coconut shell%	Trail-1	Trail-2	Trail-3	Compressive strength for 7days(n/mm^2)
0%	0%	26.12	25.13	25.38	25.85
0.2%	10%	27.24	27.24	27.25	27.24
0.4%	15%	29.12	29.12	29.11	29.12
0.6%	20%	29.79	29.78	29.79	29.79
0.8%	25%	27.12	27.13	27.13	27.13
1.0%	30%	26.22	26.23	26.24	26.23

ISBN: 978 – 81 – 959860 – 0 -2

Table 5 compressive strength values for 14 days

Asbestosfibre%	Coconut Shell%	Trail-1	Trail-2	Trail-3	Compressivestrength for 14days(n/mm^2)
0%	0%	38.12%	38.25%	37.99%	38.10%
0.2%	10%	37.63	37.65	37.64	38.64
0.4%	15%	37.84	37.84	37.85	38.85
0.6%	20%	37.19	37.20	37.19	37.20
.8%	025%	36.12	36.12	36.11	36.12
1.0%	30%	34.27	34.28	34.28	34.28

3.1 SPLIT TENSILE STRENGTH

Table 6 tensile strength values for 7 days

Asbestos fibre%	Coconut shell%	Trail-1	Trail-2	Trail-3	Tensile strength for7 days(n/mm^2)
0%	0%	2.32	2.45	2.56	2.52
0.2%	10%	2.58	2.59	2.60	2.60
0.4%	15%	2.68	2.69	2.69	2.69
0.6%	20%	3.38	3.37	3.38	3.38
0.8%	25%	2.94	2.94	2.95	2.95
1.0%	30%	2.62	2.61	2.62	2.62

Table 7 tensile strength values for 14 days

Asbestosfibre%	Coconutshell%	Trail-1	Trail-2	Trail-3	Tensile strengthfor 14days(n/mm$^{2)}$
0%	0%	2.67	2.58	2.78	2.65
0.2%	10%	2.9	2.9	2.89	2.9
0.4%	15%	2.97	2.96	2.98	2.98
0.6%	20%	3.65	3.65	3.64	3.65
0.8%	25%	2.96	2.96	2.95	2.96
1.0%	30%	2.84	2.85	2.85	2.85

Table 8 tensile strength values for 28 days

Asbestosfiber%	Coconutshell%	Trail-1	Trail-2	Trail-3	Tensile strengthfor 28days (n/mm^2)
0%	0%	3.10	3.19	3.21	3.17
0.2%	10%	3.21	3.22	3.21	3.22
0.4%	15%	3.73	3.72	3.74	3.74
0.6%	20%	4.28	4.28	4.29	4.29
0.8%	25%	3.82	3.82	3.83	3.82
1.0%	30%	3.60	3.64	3.60	3.64

ISBN: 978 – 81 – 959860 – 0 -2

1.1 FLEXURAL STRENGTH:

Table 9 flexural strength values for 7 days

Asbestosfibre%	Coconutshell%	Trail-1	Trail-2	Trail-3	Flexural strength for 7 days(n/mm^{2})
0%	0%	3.10	3.12	3.15	3.14
0.2%	10%	3.19	3.20	3.20	3.20
0.4%	15%	4.30	4.31	4.31	4.31
0.6%	20%	4.89	4.88	4.89	4.89
0.8%	25%	4.49	4.48	4.48	4.48
1.0%	30%	3.95	3.94	3.95	3.95

Table 10 flexural strength values for 14 days

Asbestosfibre%	Coconutshell%	Trail-1	Trail-2	Trail-3	Flexural strength for 14days(n/mm^{2})
0%	0%	3.25	3.36	3.45	3.32
0.2%	10%	3.54	3.53	3.54	3.54
0.4%	15%	4.61	4.63	4.62	4.63
0.6%	20%	4.95	4.94	4.95	4.95
0.8%	25%	4.68	4.68	4.67	4.68
1.0%	30%	3.84	3.84	3.85	3.85

Table 11 flexural strength values for 28 days

Asbestosfibre%	Coconutshell%	Trail-1	Trail-2	Trail-3	Flexural strength for 28days(n/mm^{2})
0%	0%	3.85	3.92	3.95	3.89
0.2%	10%	4.82	4.81	4.82	4.82
0.4%	15%	5.34	5.33	5.35	5.35
0.6%	20%	6.35	6.35	6.34	6.35
0.8%	25%	5.88	5.89	5.89	5.89
1.0%	30%	5.31	5.30	5.30	5.30

4.CONCLUSIONS

An experimental study on cubes, cylinders, beams for Compressive Strength, Split tensile Strength and flexural Strength respectively by mixing of Asbestos and Coconut shell

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BASED ON THE INVESTIGATION THE FOLLOWING CONCLUSIONS ARE DRAWN THEY ARE:

From the results, the coconut shell has a future as, Lightweight aggregate in concrete it also reduces the total cost of concreting, Because of the low cost and ease of availability. Coconut shell concrete can be used in rural areas and places where coconut

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is profusion and the place where the regular aggregates are not economic. The use of 0.5% of fibers is the optimal combination to achieve the desired need. The use of Coconut shell improves durability by reducing maintenance cracks by reducing micro cracks and permeability. The use of Coconut shell has been shown to reduce segregation. Compressive strength shows an increase of 7.66% compared to ordinary concrete. The split tensile strength of fibers was increased at 0.5%. Split tensile strength shows an increase of 25.29% compared to conventional concrete. The flexural strength of fibers were increased at 0.5%. Flexural strength increased by 24.01% compared to conventional concrete. It has been found that cracking during spilt tensile testing is slower than conventional concrete. This shows that synthetic fibers are better in avoiding propagation of cracks. Coconut shells are more suitable as low strength giving lightweight aggregate when used to replace common coarse aggregate in production concrete. While testing the specimens, the plain cement concrete specimens have shown a typical crack propagation pattern which leaded into splitting of beam in two piece geometry. But due to addition of fibers to the concrete cracks eliminates the cracks that lead to ductile behavior of the fibrous concrete. Coconut shells are more power to resist crushing, and impact compared to Traditional granite aggregate. There is no need to treat the coconut shell before use as an aggregate except for water absorption.

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STUDY THE ANALYSIS OF OVERBURNED BRICK PIECES AS A COURSE AGGREGATE IN CONCRETE

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ABSTRACT

The purpose of this study was to demonstrate the possibility of using crushed over burnt building bricks as aggregate in place of natural stone aggregate. The study's main concern is the concrete's compressive strength, which will be improved by replacing natural aggregate with crushed over-burnt brick. In place of coarse aggregates, trial mixes were made utilizing crushed over burnt bricks. The compressive strength parameters of M20 concrete were investigated. The compressive strength of the outcome of 28 days. Natural stone aggregate concrete has 21.9 MPa and 20.2 MPa at 0.45 and 0.5 water-cement ratios, respectively. Similarly, the compressive strength of crushed over-burnt brick aggregate concrete after 28 days was 0.45 and the pressure is 24.9 MPa for a 0.5 water-to-cement ratio. When natural stone aggregate is partially replaced with crushed over-burnt brick aggregate, the compressive strength of concrete increases significantly. The result also said that there is a decrease in the water-cement ratio as a result of the decrease in the ratio of water to cement. The increase in concrete's compressive strength the use of crushed over is based on scientific findings. For structural concrete, burnt brick coarse aggregate is strongly suggested.

Key Words: - Concrete, Compressive Strength, Over burnt bricks

1. INTRODUCTION

Concrete is the most commonly utilized construction material for constructing various infrastructures. The use of concrete is expanding day by day due to the required strong qualities, long life, and sustainability. However, the needed qualities for optimal concrete consumption have changed along with technological advancements. Concrete is made by combining cement, fine aggregate, coarse aggregate, and water in a mixer. Proportions that are required Concrete is a composite building material made up of coarse granular material and water. Encased in a hard matrix of substance that binds the aggregate particles together by filling the space between them. The characteristics of aggregate have improved in recent years due to the judicious application of admixtures. Concrete is frequently utilized in the construction of architectural structures and civil structures including as foundations, retaining structures, pavements, highways, runways, parking structures, dams, and reservoirs. Pipes and poles are all part of the structure. The Romans introduced concrete technology, which was widely used under the Roman Empire. The Empire-Colosseum is mostly made of concrete, and the Pantheon's concrete dome is the world's largest. Concrete was insufficient after the

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Empire until the mid-eighteenth century. The well-known concrete. The Burj Khalifa (the world's tallest building), the Hoover Dam, and the Panama Canal were all built. Cement, fine aggregate, coarse aggregate, and water are the fundamental components of concrete. Concrete is a mixture of cement binder, aggregate, sand, and water in its most basic form. The fine and coarse aggregates are coated with a paste made of Portland cement and water. Using a chemical process known as The paste solidifies and acquires strength as it absorbs water, forming the rock-like mass known as concrete. The key to a noteworthy feature of concrete is its process: it is pliable and malleable when freshly mixed, strong and durable once set. When hardened, it is extremely durable. The aggregate is the most important and important material in the manufacturing of concrete, accounting for more than half of the entire volume. Aggregates in concrete have a higher volume stability and durability than hydrated cement paste, which leads to superior concrete economy. The aggregate mixture's kind and size are determined by the thickness.

2. REVIEW OF THE LITERATURE

Infrastructure construction is a critical component of development in a country like Nepal. Roads, bridges, hydropower, tunnels, buildings, and airports are all in the works. A list of requests Concrete is used in the following ways in infrastructure development.

2.1 Concrete's Applications

- When approaching from the street, the first thing we notice is that our driveway is built out of concrete.
- The next concrete structure we come across is our sidewalk.
- Our visitors are wowed by the appearance of the beautiful concrete when they enter the residence.
- Our entryway has new flooring. We enjoy how simple it is to clean and maintain.

Najmujddin Bin Nordinet al. (2014) (7): We have studied the use of partially substituted brick waste from concrete production to coarse aggregate. It was collected and analyzed to meet brick waste research as an alternative to replacing coarse aggregate parts in concrete production. The results were analyzed by replacing the blend ratios according to the percentage of brick waste with 0, 5.0, 7.5, 10.0 and 12.50% of coarse aggregate at a uniform strength of grade 25. The results show that the optimum strength was achieved relative to the 5.0% brick waste mixing ratio and the control sample, 0% brick waste mixing ratio. Their results indicate that the optimum strength of brick waste concrete has achieved 25 grades of concrete.

3.3.Apebo et al. (2014)(8) :We know that rough agglomerates to concrete are suitable for crushing on burnt bricks and can be crushed on burnt bricks to produce low-load concrete, so there is less dead load that can be used for low load capacity soils. When the bricks are burned properly, the weight is reduced and the bricks can be crushed to produce concrete with higher compressive strength. Decreasing moisture-cement ratio increases compressive strength

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3. RESEARCH METHODOLOGY

Research Design and Study Variables: The goal of this study is to determine the concrete's compressive strength at various proportions of locally accessible resources from Nepal, stone aggregate and over-burnt brick aggregate were used as coarse aggregate. The design mix is made according to M20 (1:1.57:2.93) concrete specifications. The cube test has become popular in recent years. Concrete's compressive strength test over burnt stone aggregate has partially or completely replaced the stone aggregate. As per the regulations, brick aggregate of various sizes and proportions. The goal of replacing stone aggregate was to0 percent, 10%, 25%, 50%, 75%, and 100% are all examples of percentages. A minimum of 9 concrete cubes should be prepared for this. Every percentage each one's physical and mechanical characteristics. There is no specific study area for the research, though the stone aggregate has been chosen for Kotre, Tanahun stone quarry site, and the over burnt brick aggregate has been picked for Janune, Tanahun. The study as a whole has done on university grounds with reliable testing laboratories.

3.1. Materials Used:

3.1.1 Cement: Cement, a common binding substance, is a critical component in civil engineering. The physical and chemical properties of cement, as well as the methods for testing them, are discussed in this article.

TABLE NO 1 Physical Properties of Cement

Properties in Physical	Value
Specific Gravity	3.13
Consistency %	31
Initial setting time	40
Final setting time	710
Fineness of cement	9.5

3.1.2 Fine Aggregate: Fine aggregates are natural sand particles mined from the ground. They might be natural sand or crushed stone particles that are smaller. Fine aggregates are those that are smaller than 4.75 mm in size. Fine aggregate should be devoid of lumps, organic matter, and other contaminants.

TABLE NO 2 Physical Properties of Fine Aggregate

Properties in Physical	Value
Absorption of water in %	1.75
Specific gravity	2.80

3.1.3 Coarse Aggregate: Coarse aggregates are irregular and granular materials used to make concrete, such as sand, gravel, or crushed stone. Coarse is usually found naturally and can be obtained by blasting quarries or crushing it by hand or with crushers. Their angularity and strength have a variety of effects on the concrete. Coarse aggregates are those that are greater than 4.75 mm in size.

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TABLE NO 3 Physical Properties of Coarse Aggregate

Properties in Physical	Value
Absorption of water in %	1.55
Specific gravity	2.70
Abrasion value	32.25
Impact value	22.12

3.1.4 Over Burnt Bricks: burned bricks are a waste product that, due to their uneven shape and dark colour, cannot be employed directly in building. The use of over-burned bricks contributes to the preservation of natural aggregate sources.

TABLE NO 4 Physical Properties Of Over Burnt Bricks

Properties in Physical	Value
Absorption of water in %	6.32
Specific gravity	2.15

3. RESULTS AND DICUSSIONS

TABLE NO 5 Workanality and Properties of Concrete

SI.No	Particular	W/C Ratio	
		0.45	0.5
1	100% aggregate stone		
	Slum value ,mm	34	31
	7 Day's Compressive Strength , Mpa	13.8	12.6
	28 Day's Compressive Strength ,Mpa	22	20.1
2	75 % Stome Aggregate +25 % Over Burnt Brick		
	Slump Value , mm	32	31
	7 Day's compressive Strengrh ,Mpa	14.23	12.5
	28 Day's compressive Strength ,Mpa	21.3	21.2
3	50% Stone Aggregate Strength ,Mpa+50% Over Burnt		
	Slum Value,mm	31	30
	7 Day's Compressive Strength ,Mpa	14.49	13.13
	28 Day's Compressive Strength ,Mpa	22	21.5
4	25 % Stone Aggregate+75% Over Burnt Brick Aggregate		
	Slump Value ,mm	30	28
	7 Day's Compressive Strenth ,Mpa	14.78	13.45
	28 Day's Compressive Strength , Mpa	22.25	21.42
5	100 % Over Burnt Brick Aggregate		
	Slump Value,,mm	29	27
	7 Day's Compressive Strength ,Mpa	15.75	13.67
	28 Day's Compressive Strength , Mpa	23.49	21.78

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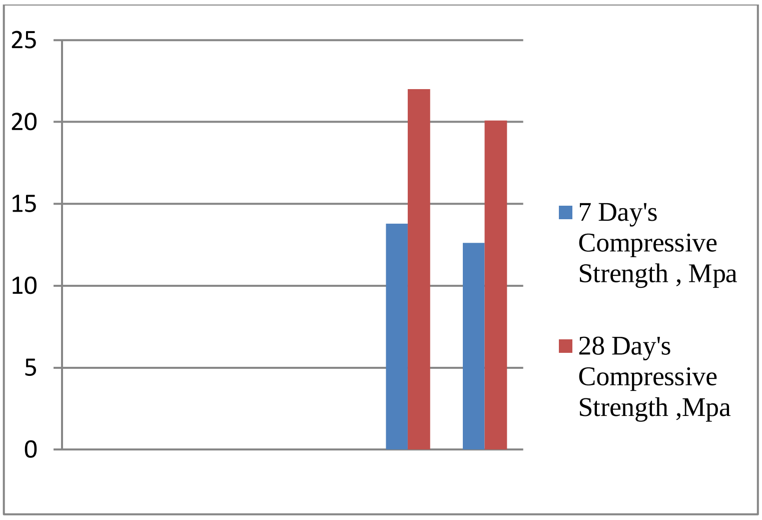
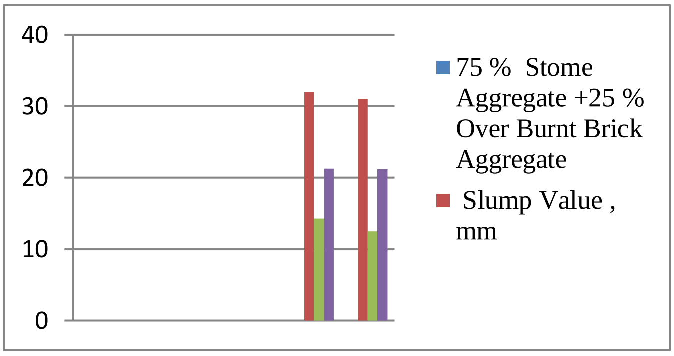
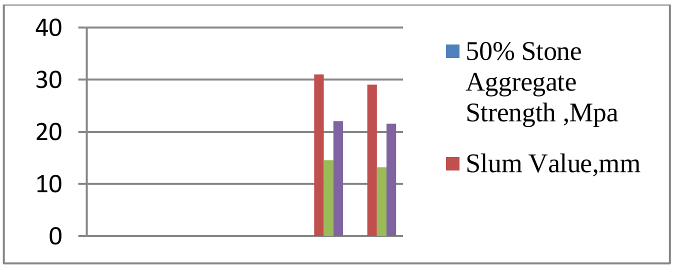


Graph1: *Compressive Strength after 7 and 28 days at w/c=0.45, 0.5 of 100 percent Stone Aggregate Concrete*



Graph2: *Compressive Strength after 7 and 28 days at w/c=0.45, 0.5 of 100% Stone Aggregate Concrete+25 % Over Burnt Brick Aggregates.*



Graph3: Compressive strength of concrete with 50% stone aggregate and 50% over-burnt brick aggregate

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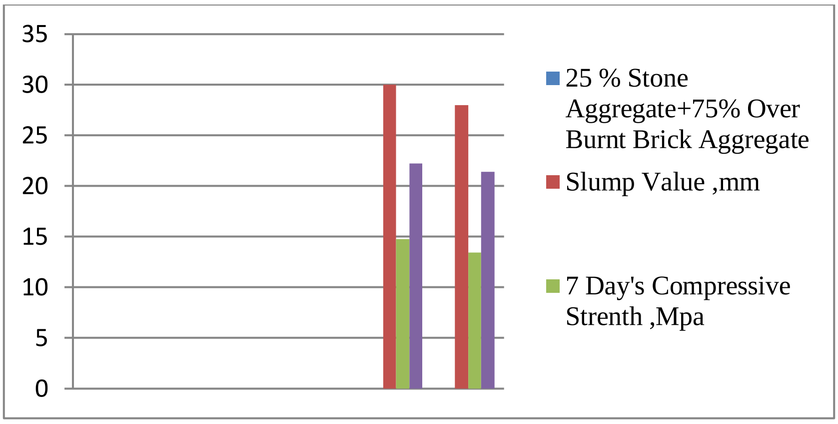
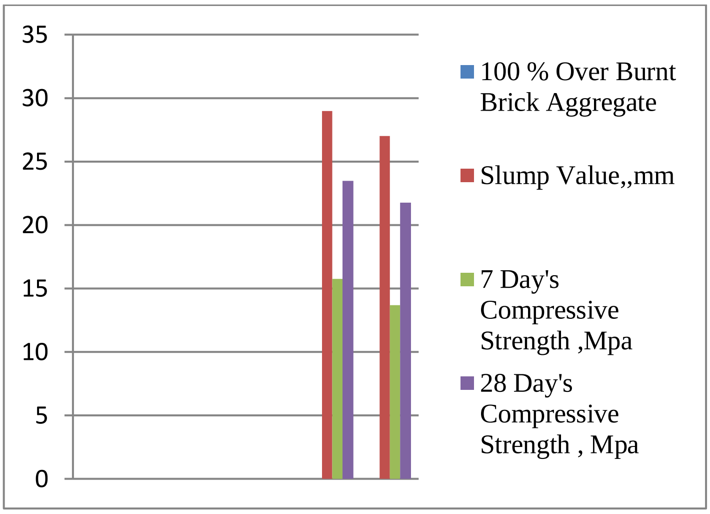


Graph4: *Compressive Strength after 7 and 28 days at w/c=0.45, 0.5 of 25% Stone Aggregate Concrete +75% Over Burnt Brick Aggregate.*



Graph5: *Compressive Strength after 7 and 28 days at w/c=0.45, 0.5 of 100% Over Burnt Brick Aggregate*

5. CONCLUSIONS

The goal of this research was to look at the compressive strength of crushed over burnt brick aggregate concrete and compare it to the compressive strength of natural stone aggregate against over burnt brick aggregate at various proportions. It has been determined that crushed over burnt bricks can be used as a substitute for river gravel in the production of concrete. The compressive strength of over burnt brick concrete is higher than stone aggregate, indicating that over burnt brick can be used to produce low and middle strength concrete. Crushed over-burnt brick aggregate concrete has a compressive strength that is comparable to regular stone aggregate concrete. Proper grading of crushed over-burnt brick aggregate provides the appropriate compressive strength of concrete with the prescribed water-cement ratio. Increases in over-burnt brick aggregate result in increases in compressive strength of design mix concrete, whereas decreases in water-cement ration result in increases in compressive strength of concrete up to a defined limit.

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STUDY ON STRENGTH OF PERVIOUS CONCRETE BY PARTIAL REPLACEMENT OF CEMENT WITH MINERAL ADMIXTURES

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ABSTRACT

The major problem encountered with impervious pavements is the drainage of surface runoff which deteriorate the wearing course and causes the urban heat island effect. Usage of pervious concrete can reduce this effect. Pervious concrete has applications in parking lots, footpaths, etc. The performance of pervious concrete depends on pore structure, cement matrix, aggregate gradation, cement content, admixtures, and water/cement ratio. This study partially replaces cement with alccofine and fly ash for M20-grade concrete. Compressive, Flexural, and split tensile strength tests were conducted in this investigation. The compressive strength, the flexural and tensile strength of concrete of OPC and concrete with alccofine and fly ash in comparison with mix contains 4, 6, 8, and 10% alccofine as cement replacement and 20% fly ash constant as a replacement for cement are compared. This study on pervious concrete deals with an optimal design for high strength. The results of investigations revealed that a higher percentage of alccofine and fly ash content has a significant effect, which improves the strength and microstructural features. Compressive, Flexural, and Split tensile strength is achieved with 10% alccofine without elevated heat curing.

***Keywords**: Fly ash, Alccofine, Pervious Concrete, Compressive Strength, Flexure strength, Split Tensile strength*

1. INTRODUCTION

With the rapid development and increasing population, there is a need to focus on sustainable practices in construction-related development. The most imminent issue due to urbanization is the increase in the number of impervious surfaces such as walkways, built-up areas, road networks, etc., which directly impact the environment. These impervious surfaces lead to various concerns such as stormwater runoff, which can lead to an efficient water management practice. Using an impervious surface reduces the soil-atmosphere interaction, increases heat absorption and radiation, affects the

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adjustment of temperature and humidity on the earth's surface, and is a leading cause of depleting groundwater table. One of the most feasible and economic solutions to these problems is the use of pervious concrete pavements. Pervious concrete is a class of concrete with no fines or very little fines and has a porosity ranging from 15% to 25%. It has a trending application in footpaths and parking lots to prevent waterlogging. Its interconnected pores help the water flow through it easily, making aggregate gradation a crucial factor. The use of pervious concrete is also a sustainable practice as it has varied environmental benefits. To make it greener, industrial by-products can be utilized for its production. The use of industrial by-products such as mineral admixtures and fillers is well known to be an economic as well as eco-friendly method to convert waste into a useful product. Here, fly ash and alccofine have been studied individually in varied proportions to arrive at a durable pervious concrete mix. The usage of these admixtures not only helps in enhancing the durability of concrete by densifying the cement matrix but also aids as an effective waste disposal method, thus making it a sustainable practice. Many studies have been conducted to determine the mix design of pervious concrete based on specific applications. However, not many studies have been done on the performance of pervious concrete based on its durability, especially against sulphate attacks. The effect of mineral admixtures on the durability of pervious concrete is different from that of conventional concrete because a higher surface area is exposed to the environment for the same volume. Also, in pervious concrete, the penetration of water/ions is studied only on the cement matrix, unlike conventional concrete where apart from cement matrix, denser concrete is required for lesser penetration to in-turn increase the durability. A study on compressive strength has been done. The strength of the resulting concrete is a major factor that decides the performance of pervious concrete. Hence, volumetric porosity is another important factor to quantify the efficiency of the pervious concrete being used. To establish a practical and application-based sampling, mix ratios were manually verified by trial-and-error method, thereby verifying the reproducibility and practicability of the same in plants or at the site. It is also verified that similar or better results are achievable in pan-mixed samples as well.

2. LITERATURE REVIEWS

Nikhil Saboo ***a,*** Pervious concrete has been studied widely considering its environmental benefits. Owing to its porous nature, it reduces the runoff quantity recharging the groundwater and as well reduces the effect of the urban heat island. Previous studies have been focused on characterizing and understanding the structural and functional properties of pervious concrete. However, very few studies have been made on incorporating supplementary cementitious materials (SCMs) in pervious concrete. SCMs, which are by-products of production processes from industries, pose several environmental concerns and hence it becomes imperative to utilize them as a partial replacement for OPC considering their pozzolanic action, which is beneficial in improving strength and durability properties. In this study, fly ash and metakaolin were used as partial replacements for OPC with curing conditions as another variable. Basic

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tests such as porosity, density, compressive strength, and permeability were conducted to determine the effect of test variables. The curing conditions were found to be insignificant in affecting the properties of pervious concrete, unlike fly ash and metakaolin. A 2% addition of metakaolin decreased porosity by 10%, while the optimum range of fly ash replacement in pervious concrete was found to be between 5 and 15%. Statistical tests indicated that fly ash content dominated the effect on influencing permeability and compressive strength. Aoki*Pervious concrete is one of the most effective pavement materials to address a number of important environmental issues, such as recharging groundwater and reducing storm water runoff. In this paper, the findings of an experimental investigation on the properties of pervious concrete are reported and discussed. The amount of general-purpose Portland cement has been reduced by introducing fly ash as a cementitious agent in pervious concrete samples. The properties of various pervious concrete samples including density, porosity, compressive strength, water permeability, and drying shrinkage have been carefully measured. In addition, the relationships among these properties are explored. According to the results, high porosity samples indicated higher permeability, whereas their compressive strength was reduced. There was no significant difference between the properties of pervious concrete samples containing fly ash and those samples comprising only cement as a cementitious agent. Hence, environmentally friendly pervious concrete with fly ash can be produced in lieu of conventional pervious concrete. B.L.N. Sai Srinath **a** The purpose of this review article is to effectively utilization of alccofine as a supplementary cementitious material (SCM) in concrete. Concrete is the most extensively used man-made construction material in the ecosphere. Cement is the binder material for producing concrete. During the clinkering process in the cement industry, a large amount of CO2 is produced as a byproduct and emitted into the atmosphere. This CO2 dominates the major share of total greenhouse gases (GHG) released into the atmosphere. Hence to reduce GHG emissions, research activities have been transforming from conventional materials to other supplementary materials. To support the recent research evidence researchers are using, fly ash, GGBS, Rice husk ash (RHA), silica fume, Phosphogypsum, Metakaolin, etc. are widely used as an SCM in concrete due to pozzolanic reactivity. One among the SCM, alccofine (1203), is a recent trend micro fine material that can be used in concrete as a partial replacement material for cement. This review paper presents a summary of the published literature by several researchers who have intended to highlight the importance of alccofine as an SCM in the various fields of the concrete industry. In this review, the article authors exhibit a detailed review on the utilization of alccofine as an SCM to improve the fresh, mechanical & durability properties of concrete. Each byproduct has varying mineral content. Alternatively, there is a huge problem with the disposal of the byproducts. They appraised the alccofine, when partly replaced with cement, showed a remarkable improvement in both mechanical as well as durability properties at all ages. But the microstructure and fire resistance properties were not yet approached by the current research, hence this gap is addressed as a future course of research.

ISBN: 978 – 81 – 959860 – 0 -2

3. MATERIALS

3.1. Cement

Ordinary Portland Cement 53 was chosen for experimentation, owing to the high initial strength and quicker setting time. The physical properties as provided by the manufacturer are tabulated in table1.

Table 1. Physical Properties of OPC 53 Cement

Physical Properties	Requirement	OPC 53
Fineness	225(min)	255
Initial setting time	300(min)	163
Final setting time	600(max)	315
Specific gravity	3.15	3.13

3.2 Coarse Aggregates: Locally available coarse aggregates having a maximum size of 20mm, and 12.5 mm size were used in this work. The aggregates were tested as per Indian Standard Specifications.

Table 2. Physical Properties of coarse aggregates

Physical Properties	Value
Specific gravity	2.17
Water absorption	0.163
Bulk density	1550
Fineness modulus	4.829

3.3 Mineral Admixtures

3.3.1 Fly ash

Fly ash is generally finely divided residue ash particles resulting from the combustion of coal in the furnaces which blows along with the flue gas of the furnace. These ashes are collected with the help of electric precipitators and are termed as fly ash. Fly ash is the most widely used pozzolanic material all over the world.

Table 3. Physical Properties of Fly ash

Physical properties	Value
Specific gravity	2.3
Fineness modulus	48%

3.3.2 Alccofine

Alccofine used in the experimentation was sourced from ultra tech cement (commercially available as Alccofine 1203); which is being widely used as a replacement for silica fumes in high-performance concrete. The physical properties of Ground Granulated Blast Furnace Slag as obtained from the manufacturer are tabulated.

Table 4. Physical Properties of Alccofine

Physical properties	Value
Fineness modulus	3.13
Specific gravity	2.87
Bulk density	675

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4. EXPERIMENTAL ANALYSIS

4.1. Specimen preparation and curing:

Cubical PC samples with dimensions 150×150×150 were prepared in the laboratory. The compaction was done in 3 layers, with 25 blows per layer, using a standard 2.5 kg proctor hammer. This method has been recommended over other methods such as vibration and rodding. The samples were prepared in three batches and left in the mould for 1 day. The three batches were kept underwater (wet curing-WC). The curing process was done for 28 days.

4.2. Determination of density and porosity:

The functional and structural properties of PC are strongly influenced by its density and porosity. In this study, the procedure outlined in ASTM C1754 was used for the determination of density and porosity for each of the wet cured samples. The process for the determination of density involves placing the cured samples in the oven at 60 °C for 7 days and noting down their hardened weight. For the determination of porosity, the samples are kept submerged in water for 35 min and the weight underwater is measured. The submerged weight and the oven-dried weight of PC samples are used in the relationship as given in ASTM C1754 for calculating the porosity.

4.3. Compressive strength:

Compression tests of the sample specimens were carried out as per ASTM C109. The tests were done after 28 days for the single gradation and mixed gradation cubes. For the mixes containing mineral admixtures, 7 days,14 days, and 28 days compressive strength were found accordingly.

5. RESULTS AND DISCUSSION:

5.1 Compression Strength:

The failure pattern observed from the compression test results leads to the following conclusions: The strength of pervious concrete with mineral admixtures Fly ash, Alccofine (PC-FA, ALLCOFINE)shows high compressive strength than pervious concrete with OPC(PC-REGULAR)…Pervious concrete with 20% fly ash and 10% alccofine gives high compressive strength than pervious concrete with only cement. Compression strength test is conducted for 7days,14 days, and 28 days.

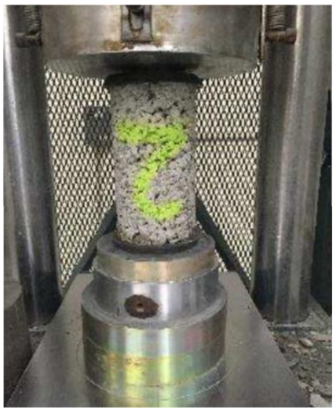

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Table 5: Compressive strength of pervious concrete

Compressive strength (MPa)	7 days	14 days	28 days
PC-REGULAR	14	25	52
PC-FA, ALCCOFINE	16	28	56

5.2 Flexural strength:

As compared to the pervious concrete with fly ash and alccofine (PC-FA, ALCCOFINE), pervious concrete with only cement (PC-REGULAR) the flexural strength is approximately the same. Flexural strength is conducted for 7 days and 28 days.

Table 6: Flexural strength of pervious concrete

Flexural strength	7 days	28 days
PC-REGULAR	2.14	2.51
PC-FA, ALCCOFINE	2.18	2.67

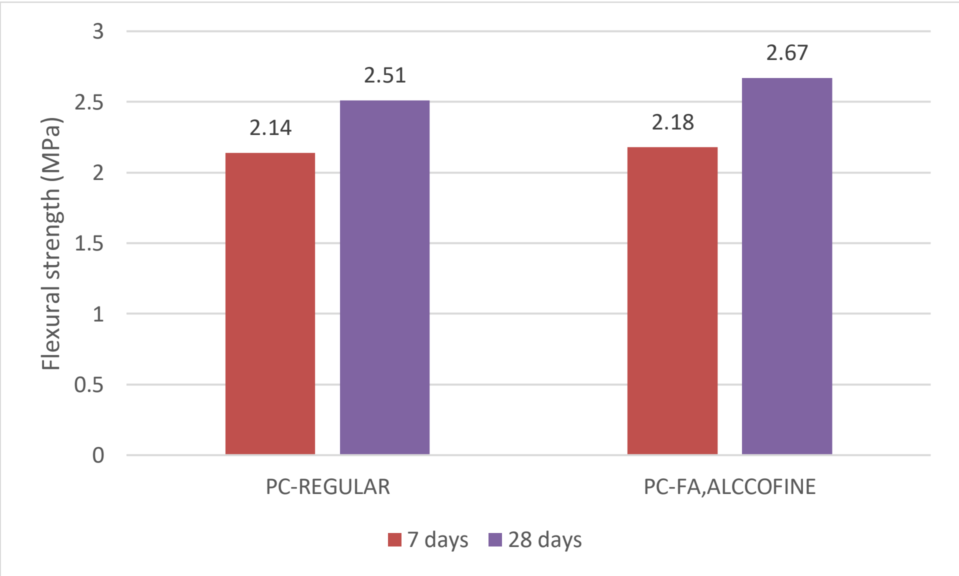

Fig 2: Flexural strength of pervious concrete

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5.3 Split Tensile Strength:

Based on the test results of split tensile strength it states that there is slight variation in the strength of pervious concrete with only cement and pervious concrete with mineral admixtures.

Table VII: split tensile strength for pervious concrete

Split tensile strength (MPa)	28 days
PC-REGULAR	2.56
PC-FA, ALCCOFINE	2.62

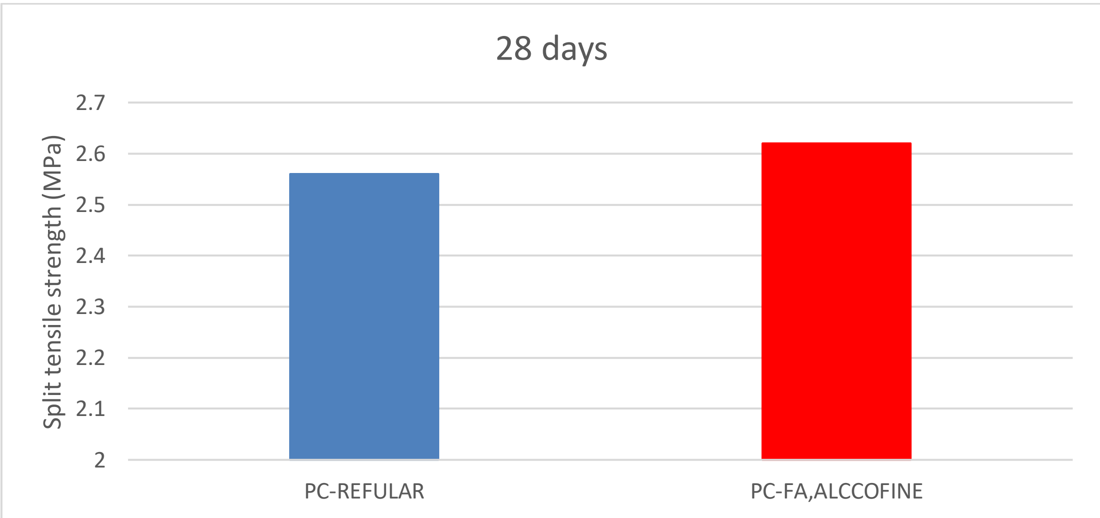

Fig 3: split tensile strength for pervious concrete

6. CONCLUSION

In this study, the effect of Alccofine and flyash as supplementary cementing materials and filling materials on the strength of concrete is investigated. The addition of Alccofine increases the self-compatibility characteristics like filling ability, passing ability, and resistance to segregation. The relative cost of Alccofine is cheaper than cement hence it is also economic with higher strength. The addition of fly ash helps in increasing the porosity. By using fly ash carbon emission can be reduced as well as waste fly ash can also be utilized effectively. The results of investigations revealed

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that a higher percentage of alccofine and fly ash content has a significant effect, which improves the strength and microstructural features.

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STUDY ON CONCRETE PAVEMENT BY PARTIAL USAGE OF FINE AGGREGATES

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ABSTRACT

In the rainy season, many cases of roads being submerged in water because of a lack of drainage capacity and low water absorption by the subgrade. This study utilizes porous pavement as an interlocking pavement to increase water absorption to the drainage layer and subgrade. For the development of construction technology, pervious concrete is vastly using in road infrastructure. Pervious concrete has a strong drainage ability that can recharge groundwater, made by the coarse aggregate, water, and cement with little fine aggregate or without fine aggregate. The use of recycled coarse aggregates from construction and demolition is a sustainable solution with many environmental benefits and also reduces the number of virgin aggregates to be created, hence reducing the extraction of natural resources. The compressive strength of pervious concrete is a smaller amount in comparison to the traditional concrete thanks to its porosity and voids. Hence, the development of strength should not affect the permeability property because it is the property which serves it purpose.

***Keywords**:* Pervious concrete, Compressive strength, Porous, Permeability.

1. INTRODUCTION

The rising growth of population and economy in India is leading to industrialization. The urbanization is leading to various kinds of researches in the engineering fields over recent years. Pervious concrete was first utilized in the 1800s in Europe as pavement surfacing and cargo bearing walls. Cost efficiency was the main motive because decreased amount of cement. Concrete is formed using large aggregates with little to no or some amount of fine aggregates. It is a crucial application for sustainable construction and is one among many low impact development techniques employed by builders to guard water quality. The strength of pervious concrete is low when compared to conventional concrete due to absence of fine aggregate Due to the lack of fine Aggregate, the pervious concrete suffers from the reduction in strength because of the weak bonding between the matrix (cement paste) and the filler the aggregates. Based on this concept, many researchers have made attempts to improve the strength of the cement paste by replacing the coarse aggregate with proportions of fine aggregate

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but there was a significant reduction in the permeability. Therefore, many studies focused on improving the porosity to achieve the required strength and permeability properties. One way to increase the pervious concrete compressive strength is to use fine aggregate composition in the previous concrete mixture. The use of fine aggregate compositions may increase the pervious concrete compressive strength, but decrease permeability because the interconnected voids can be covered by fine aggregates.

2. MATERIALS

2.1. Cement

Ordinary Portland Cement 53 was chosen for experimentation, owing to the high initial strength and quicker setting time. The physical properties as provided by the manufacturer are tabulated in table1.

Table 1. Physical Properties of OPC 53 Cement

Physical Properties	*Requirement*	*OPC 53*
Specific gravity	-	3.25
Normal consistency	-	33%
Initial setting time	Min of 30min	60Min
Final setting time	Max of 600min	345Min

1.2 *Coarse Aggregates:*

Locally available coarse aggregates and recycled coarse aggregates having a maximum size of 20mm, and 12.5 mm size were used in this work. The aggregates were tested as per Indian Standard Specifications.

Table 2. Physical Properties of coarse aggregates

Physical Properties	Value
Specific gravity	2.81
Water absorption	0.159
Bulk density	1660
Fineness modulus	4.534
Shape of grains	Angular

***2.3 Fine aggregates**:* The standard sand shall be of quartz, light grey or whitish variety and shall be free from silt. The sand grains shall be angular; the shape of the grains approximating to the spherical form elongated and flattened grains being present only in very small or negligible quantities.

Table 3 Physical Properties of Fine aggregates

Physical properties	Value
Specific gravity	2.62
Shape of grains	Rounded

ISBN: 978 – 81 – 959860 – 0 -2

3. EXPERIMENTAL ANALYSIS

3.1. Specimen preparation and curing:

Cubical PC samples with dimensions 150×150×150 were prepared in the laboratory. The compaction was done in 3 layers, with 25 blows per layer, using a standard 2.5 kg proctor hammer. This method has been recommended over other methods such as vibration and rodding. The samples were prepared in three batches and left in the mould for 1 day. The three batches were kept underwater . The curing process was done for 28 days.

3.2. Determination of density and porosity:

The functional and structural properties of PC are strongly influenced by its density and porosity. In this study, the procedure outlined in ASTM C1754 was used for the determination of density and porosity for each of the wet cured samples. The process for the determination of density involves placing the cured samples in the oven at 60 °C for 7 days and noting down their hardened weight. For the determination of porosity, the samples are kept submerged in water for 35 min and the weight underwater is measured. The submerged weight and the oven-dried weight of PC samples are used in the relationship as given in ASTM C1754 for calculating the porosity.

3.3. Compressive strength:

Compression tests of the sample specimens were carried out as per ASTM C109. The tests were done after 28 days for the single gradation and mixed gradation cubes. For the mixes containing less fine aggregate percentage, 7days,14 days, and 28 days compressive strength were found accordingly.

4. RESULTS AND DISCUSSION

4.1 Compression Strength:

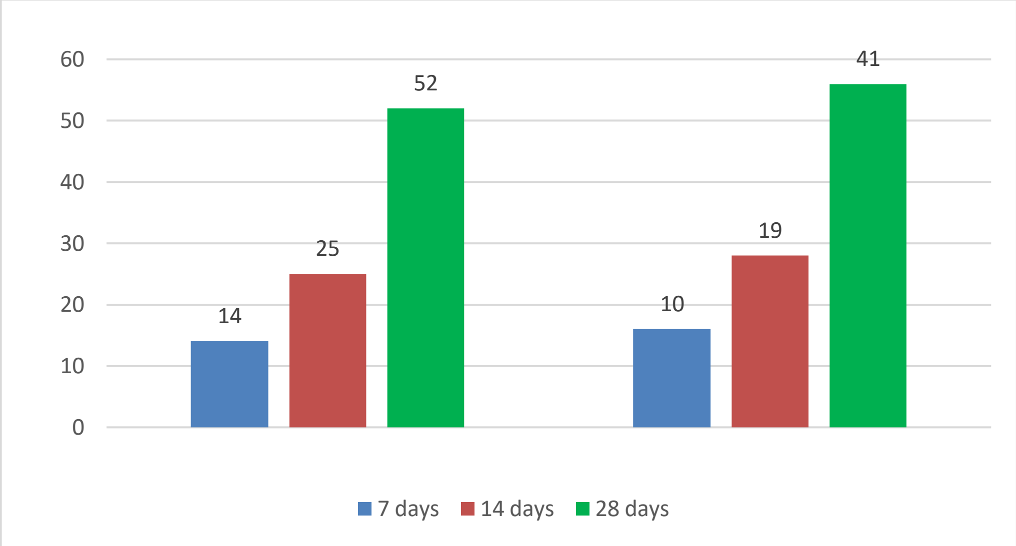
The failure pattern observed from the compression test results leads to the following conclusions: The strength of pervious concrete with standard grade proportions are shows high compressive strength than pervious concrete with less percentages of fine aggregates . Compression strength test is conducted for 7days, 14 days, and 28 days.

Fig 1: Compressive strength of pervious concrete

ISBN: 978 – 81 – 959860 – 0 -2

Table 4: Compressive strength of pervious concrete

Compressive strength (MPa)	7 days	14 days	28 days
PC-REGULAR	14	25	52
PC-LESS FINE	10	19	41



4.2 Permiability:

As compared to the pervious concrete with standard concrete, pervious concrete with only less percentage of sand shows greater permeability than the standard concrete. The permeability test is performed by using the falling head permeameter apparatus according to ACI 522R-2010 standard. Pervious concrete permeability test was conducted at 28 days. Based on the provisions of ACI 522R-2010, permeability is related to porosity and the void size in pervious concrete. The permeability coefficient (k) is obtained from the average values obtained from the five specimens tested. The value of k is calculated by using a formula of the Darcy equation with several parameters affecting the value of k. Among the sample area and tube, sample height, water level at the start and at the end, and the time required for the water to flow out. The equations used in the calculation of permeability can be seen in Equation.

$$K=A1/A2 \log(h1/h2)$$

The results of the permeability test are influenced by the amount of fine aggregate and the compacting method used.

Fig 2: Permeability test of pervious concrete

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As compared to the sample concrete with standard concrete, concrete with having less percentage of sand shows greater permeability than the standard concrete.

4.3 Split Tensile Strength:

Based on the test results of split tensile strength it states that there is slight variation in the strength of pervious concrete with only cement and pervious concrete with less amount of fine aggregates.

Fig 3: Split tensile strength of pervious concrete

Table 5: split tensile strength for pervious concrete

Split tensile strength (MPa)	28 days
PC-REGULAR	2.56
PC-LESS FINE AGGREGATES	2.35

5. CONCLUSION

In this study, y an effort has been made to experimentally understand the feasibility of the partial usage of fine aggregates in concrete and to analyses and compare the results obtained with the properties of conventional concrete. Based on the current experimental investigations the following conclusions were made The suitability of using coarse and fine aggregate in the concrete mixture was confirmed with their physical properties test. By the initial test results of pavement gives the best results in permeability and less in strength. The main reason for reducing the fine aggregates are to improve the absorption capacity of the pavement for increasing the ground water level and to control the flow of flood water. Following above discussions, it can be concluded that the partial usage of fine aggregates in concrete provides additional environmental as well as technical benefits for all construction related industries

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AN EXPERIMENTAL RESEARCH ON CBR BEHAVIOUR OF SOIL REINFORCED WITH WASTE BOTTLE STRIPS

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ABSTRACT

For any land-based structure, the inspiration is extremely important and has got to be strong to support the whole structure. In order for the inspiration to be strong, the soil round it plays a really critical role. So, to figure with soils, we'd like to possess proper knowledge about their properties and factors which affect their behavior. The process of soil stabilization helps to realize the specified properties during a soil needed for the development work. From the start of construction work, the need of enhancing soil properties has come to the sunshine . Soil stabilization was used but thanks to the utilization of obsolete methods and also thanks to the absence of proper technique, soil stabilization lost favor. In recent times, with the rise within the demand for infrastructure, raw materials and fuel, soil stabilization has began to take a replacement shape. With the supply of higher research, materials and equipment, it's emerging as a well-liked and cost-effective method for soil improvement. Here, during this project, soil stabilization has been through with the assistance of randomly distributed plastic strips from plastic bottles obtained from waste materials. The increase in the compressive strength values.

***Keywords*:** plastic strips, stabilizer, stabilization.

1. INTRODUCTION

Soil stabilization is the process of adding external material to improve the properties of the soil. Soils are generally stabilized to extend their strength and sturdiness or to stop erosion and mud formation in soils. The main aim is that the creation of a soil material or system which will hold under the planning use conditions and for the designed lifetime of the engineering project. The properties of soil vary an excellent deal at different places or in certain cases even at one place; the success of soil stabilization depends on soil testing. Various methods are employed to stabilize soil and therefore the method should be verified within the lab with the soil material before applying it on the sector .

This For any land-based structure, the inspiration is extremely important and has got to be strong to support the whole structure. In order for the inspiration to be strong, the soil around it plays a early critical role. So, to figure with soils, we'd like to possess proper knowledge about their properties and factors which affect their behavior. The process of soil stabilization helps to realize the Specified properties during a soil

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needed for the development work. From the start of construction work, the need of enhancing soil properties has come to the sunshine. Soil stabilization was used but thanks to the utilization of obsolete methods and also thanks to the absence of proper technique, soil stabilization lost favor. In recent times, with the rise within the demand for infrastructure, raw materials and fuel, soil stabilization has began to take a replacement shape. With the supply of higher research, materials and equipment, it's emerging as a well-liked and cost-effective method for soil improvement. Here, during this project, soil stabilization has been through with the assistance of randomly distributed polypropylene fibers obtained from waste materials.

2. SCOPE

Soil properties vary an excellent deal and construction of structures depends tons on the bearing capacity of the soil, hence, we'd like to stabilize the soil which makes it easier to forecast the load bearing capacity of the soil sub grade and able to improve the load bearing capacity. The gradation of the soil is additionally a really important property to stay in mind while working with soils. The soils could also be well-graded which is desirable because it has less number of voids or uniformly graded which though sounds stable but has more voids. Thus, it's better to combine differing types of soils together to enhance the soil strength properties. It is very expensive to exchange the inferior soil entirely soil and hence, soil stabilization is that the thing to seem for in these cases.

In future study test can be carried on black cotton soil or on different types of soil. The lime can be replaced by cement, marble polish waste Fly ash, sand and quarry dust. plastic can be replaced by waste plastic powder, polythene covers. From the above materials, different proportions and combinations can be made which can be used for construction of sub grade and pavements. Few future studies are summarized below

- Several efforts to be made for the effective use of waste plastic to reduce the cost of construction and operation.
- Field application of this method has to be done by various construction techniques.
- Effective use of waste bottle plastic strips on strengthening of other types of soils.

3. METHODOLOGY

•Mechanical method of Stabilization

In this procedure, soils of various gradations are mixed together to get the specified property within the soil. This may be done at the location or at another place from where it is often transported easily. The final mixture is then compacted by the standard methods to urge the specified density.
It suggested to add the external material to improve the standards of the soil.
Materials like cement, lime, bitumen, ash etc. are used as chemical additives.
Sometimes different fibers also are used as reinforcements within the soil. The addition of those fiber takes place by two methods;

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a) ***Oriented fiber reinforcement***
The fibers are arranged in some order and every one the fibers are placed within the same orientation. The fibers are laid layer by layer during this sort of orientation. Continuous fibers within the sort of sheets, strips or bars etc. are used systematically in this type of arrangement.
b) ***Random fiber reinforcement***
This arrangement has discrete fibers distributed randomly within the soil mass. The mixing is completed until the soil and therefore the reinforcement form a more or less homogeneous mixture.

• ***Additive method of stabilization***

4. TESTS AND RESULT ANALYSIS

Specific gravity of the soil
The specific gravity of soil is that the ratio between the load of the soil solids and weight of equal volume of water. It is measured by the help of a pycnometer and it is a very simple experiment where the volume of the soil is found out and its weight is divided by the weight ofequal volume of water.
(W2-W1)
specific gravity G=(W4-W1)-(W3-W2)

Where,
W1-Weightofbottleingrams
W2- Weight of bottle + Dry soil in grams
W3-Weightofbottle+Soil+Water
W4-Weightofbottle+Water

Table 1 Specific gravity is usually measured in temperature and reported to the closest 0.1.

Trail NO.	1	2	3
Weight of empty bottle (w1) in gms.	660	661	662
Weight of bottle+ dry soil (w2) in gms.	860	862	862
Weight of bottle + dry soil + water (w3) in gms.	1659	1660	1660
Weight of bottle + water (w4) in gms.	1542	1541	1543
specific gravity	2.409	2.451	2.409
Avg. specific gravity	**2.423**		

Liquid limit
The Casagrande tool cuts a groove of size 2 mm wide at rock bottom and 11 mm wide at the highest and eight mm high. The number of blows used for the 2 soil samples to return in touch is noted down. Graph is plotted taking number of blows on a scale on the abscissa and water content on the ordinate. Liquid limit gets at 25 blows. After plotting the graph.

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Sample No.	1	2	3	4
No. of blows	45	30	26	16
Container No.	76	52	33	66
weight of empty con in gms	31	29	31	31
weight of con + wet soil in gms.	41	42	48	47
weight of con + dry soil in gms.	38	38	43	42
weight of soil solids	7	9	12	11
weight of pore water	3	4	5	5
Water content (%)	42.85	44.44	41.66	45.45

Plasticlimit

This is found out by rolling out soil upto diameter reaches approximately 3 mm and measuring water content for the soil which crumbles on reaching this diameter. Plasticity index (Ip) was also calculated with the assistance of liquid limit and plasticlimit;

Sample No.	1	2	3
Container No.	31	7	39
weight of empty con	32	31	31
weight of (con+wet soil) in gms.	40	41	41
weight of (con + dry soil) in gms.	38	39	38
weight of soil solids	6	8	7
weight of pore water	2	2	3
Water content (%)	33.33	25	42.85
Average Plastic Index	**33.72**		

Particle size distribution

The results from sieve analysis of the soil when plotted on a semi-log graph with particle diameter or the sieve size because the abscissa with logarithmic axis and therefore the percentage passing because the ordinate gives a transparent idea about the particle size distribution. From the help of this curve, D10 and D60 are determined. This D10 is that the diameter of the soil below which 10% of the soil particles lie. The ratio of, D10 and D60 gives the uniformity coefficient (Cu) which successively may be a measure of the particle size range.

S Sieve No.	Aperture Size in mm	Weight of soil retained(g)	Retained (%)	Cumulative retained (%)	Passed (%)
4.75	4.75	146	14.6	14.6	85.4
2	2	267	26.7	41.3	58.7
1	1	270	27	68.3	41.7
600	0.6	112	11.2	79.5	20.5
425	0.425	80	8	87.5	12.5
300	0.3	50	5	92.5	7.5
150	0.15	48	4.8	97.3	2.7
75	0.075	18	1.8	99.1	0.9
Pan	<0.075	9	0.9	100	0

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California bearing ratio (CBR) test

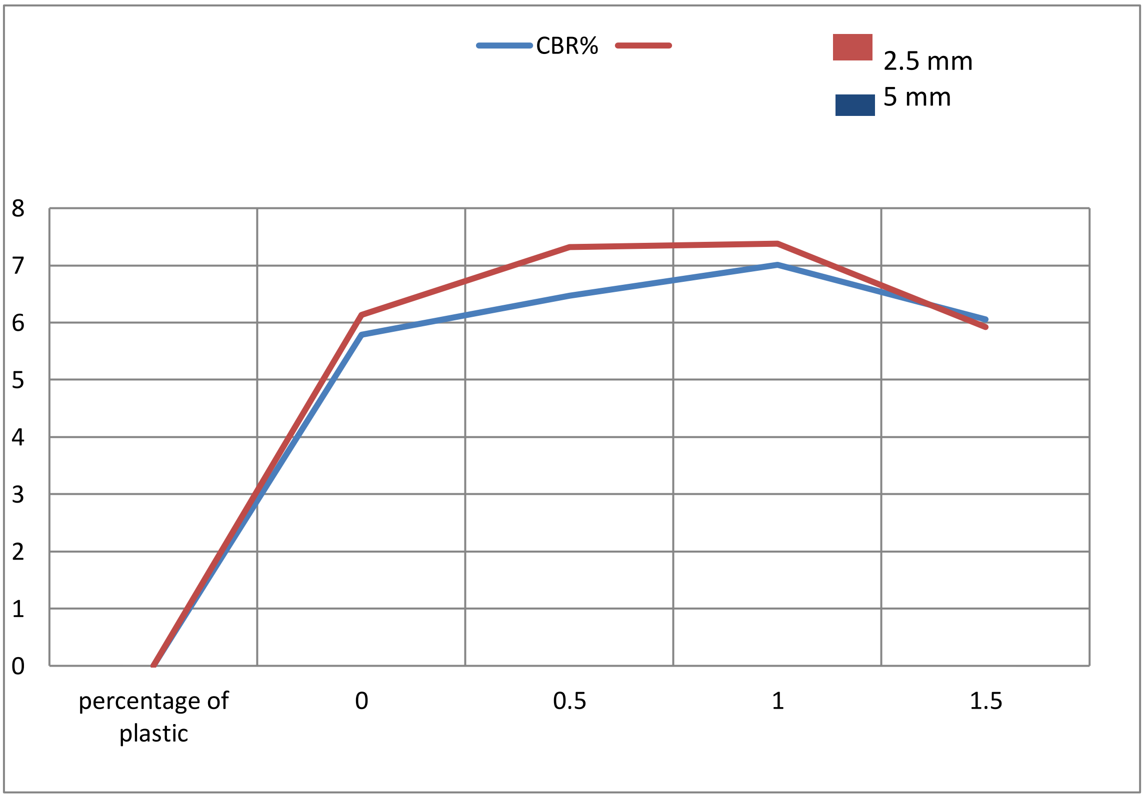
The California bearing ratio (CBR) is the test conducted to find the strength properties for the sub grade soils. It was developed by the California Department of Transportation. The results obtained by these tests are used with the empirical curves to work out the thickness of pavement and its component layers. This is the foremost widely used method for the planning of flexible pavement.

It is the ratio of force per unit area required to penetrate a soil mass with standard circular piston at the speed of 1.25 mm/min. to that required for the corresponding penetration of a typical material.

C.B.R. = (Test load/Standard load) X 100

The following table gives the quality loads adopted for various penetrations for the quality material with a C.B.R. value of 100%

Percentage of plastic	CBR(%)	
	2.5MM	5MM
0	5.79	6.13
0.5	6.47	7.32
1.0	7.01	7.38
1.5	6.06	5.92



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5. CONCLUSION

In the present study, the improved CBR value of the soil is thanks to the addition of plastic strips. Plastic are often utilized together of the fabric which will be used as a soil stabilizing agent but the right proportion of plastic must be there, which helps in increasing the CBR of the soil.

It can be concluded that CBR percentage goes on increasing up to 1% plastic content in the soil and thereon it decreases with increase in plastic content. Hence, we can say that 1% plastic content is the optimum content of plastic waste in the soil.

The usage of plastic material products are increased more and more. This has an adverse effect in nature and it's impossible to limit its uses. In this regard, the disposal of the plastic wastes without causing any ecological hazards has become a true challenge to this society. Thus, using plastic as a soil stabilizer is a cheap and gainful usage because there's lack of excellent quality soil for various constructions

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AN EXPERIMENTAL INVESTIGATION OF CORROSION EFFECT ON STEEL FE-415 AND FE-500 IN CO2 AND DO ENVIRONMENTAL

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ABSTRACT

The corrosion effect on HYSD Fe415 and TMT Fe500 steel bars in carbon dioxide(CO2) and dissolved oxygen (DO) environment in cyclic exposing conditions was evaluated. Based on the IS-456 and literature, 50, 100, 150, 200 mg/L concentrations of CO2 acidity and 8, 12, 16, 20 mg/L concentration of dissolved oxygen Do) were selected. Fe415 and Fe500 steel bars were immersed in CO2 acidic and D O waters. A set (3 bars) of each grade of steel bars from each concentration of CO2 and DO waters was taken out at the end of 1st and 3 month and they expose to free environment, remaining steel bars were continually kept in CO2 and DO waters. In this study, end of every month, corrosion and tensile strength of steel bars, were determined. P", ambient temperature, acidity, dissolved oxygen concentrations of CO2 and D O waters were determined for ever week. The total experimental study was carried out for three months. Corrosion was increased with increase in concentration of CO2 and D O as time progressed. Corrosion of steel due to CO2 was more than the D O. Tensile strength of Fe415 and Fe500 was decreased as corrosion increased

1. INTRODUCTION

It was recognized that the majority of highway bridge deterioration was caused by the corrosion of reinforcing steel, which is mainly initiated by the ingress of chloride ions from deicing salts. The corrosion of reinforced concrete bridge decks has historically been of significant cost to the states, as well as the nation's transportation infrastructure (Gannon and Cady 1993). The rust formation from corroding steel results in bond deterioration between the steel and concrete (Auyeung et al. 2002; Coronelli 2002), accelerates cracking and spelling of the concrete, and in turn, the damaged concrete with high permeability leads to a rapid penetration of aggressive chemicals into the concrete, shows a picture of a severely corroded top layer of steel bars in a

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bridge deck along I-70 in Denver. The corrosion of the steel bars deteriorated the surrounding concrete and caused significant damage to the deck. In addition to the corrosion problem in bridge decks, much of CDOT's corrosion problem is at pier caps and to a lesser extent, abutment seats . In the past, several the corrosion problems both for bridge decks and for leaking joints. solutions, both rehabilitative and preventative, were developed for reducing corrosion damages in bridge decks, and not much attention has been paid to leaking joints, which also seem to make a severe corrosion situation.

There are two main causes of the corrosion in the reinforcement bar: (1) localized breakdown of the passive film in the surface of rebar due to chloride ion attack, (2) general breakdown of the passivity by neutralization of concrete, predominantly by the reaction with atmospheric carbon dioxide. The use of high performance concrete would definitely reduce the risk of corrosion, but the increasing use of deicing salt and the increasing concentration of carbon dioxide in our modern environment has made the rebar corrosion one of the primary causes of premature failures in reinforced concrete structures. In order to understand the corrosion protection systems, one has to understand the mechanism behind the corrosion process in reinforced concrete structures. A simplified process of corrosion in reinforced concrete is as follows. A rebar is embedded in moist concrete. The concrete pores contain various dissolved ions which serve as electrolytes. Once the passive film or coating on the surface of the rebar is destroyed either by carbonation or the presence of chloride ions above the critical concentration, the rebar corrosion will most likely take place, provided that the oxygen is also present. Other conditions, such as the heterogeneity of surface of rebar, the differences of grain structures and composition, and the local differences in the electrolytes because of the heterogeneous nature of concrete, also contribute to the corrosion process. Under these conditions, one region of rebar will act as an anode and another region will act as a cathode. Since both anode and cathode may exist on the same rebar, there is an electrical connection between the two.

At the anode site, the iron atoms lose the electrons that move into the surrounding concrete as positively charged ferrous ions (Fe2+). The excess of free electrons (e-) flow through the rebar to the cathodic site where they react with dissolved oxygen and water to produce hydroxyl ions (OH-). To maintain the electrical neutrality, the hydroxyl ions diffuse through concrete pores toward the anode site where they react with the ferrous ions to form iron oxide or rust. The volume of the rust is larger than the original volume of the steel. The volumetric ratio of the rust to steel depends on the form of corrosion product. Generally, the ratio ranges from 2.2 for Fe3O4 to 6.4 for Fe(OH)33H2O.

"Corrosion is an irreversible interfacial reaction of a material (metal, ceramic, polymer) with its environment which results in its consumption or dissolution into the material of a component of the environment. Often, but not necessarily, corrosion results in effects detrimental to the usage of the material considered. Exclusively physical or mechanical processes such as melting and evaporation, abrasion or mechanical fracture are not included in the term corrosion" With the knowledge of the

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role of various microorganisms present in soil and water bodies, the definition for corrosion need be further widened to include microbial influenced factors.

***1.1Corrosion Of Steel Reinforcement**: Causes, Effects And Remedies*

Concrete, in itself, has poor tensile strength. To increase the tensile strength of concrete, steel reinforcement is used. Steel bars are embedded within the concrete mass. These steel bars carry most of the tensile load applied to the concrete.

The concrete renders the steel bars passive due to its highly alkaline nature, thus preventing them from corrosion. Still, due to various other reasons, the steel bars may get corroded over a long period of time. And due to the corrosion of the steel bars, various weaknesses arise in the concrete structure, which may eventually collapse if not taken proper care of within suitable time.

Corrosion of steel reinforcement bars is basically an electrochemical reaction. Small anodes and cathodes are created and a flow of ions between these two electrodes lead to the corrosion of the steel bars.

There are two types of corrosion observed in the steel reinforcement bars:

1) Crevice corrosion – In small crevices within the concrete structure, solutions may get stagnated. Anodes and cathodes may be created within the solutions due to uneven reaction of solute ions over the volume of the solution. Flow of ions is triggered by these electrodes, thus slowly causing corrosion.

2) Pitting corrosion – It is related to de-passivation of small areas on the steel reinforcement bars. This type of corrosion is extremely localized and small holes or pits are created in the steel.

1. 2Causes Of Corrosion In Reinforcement Steel

Corrosion of the steel reinforcement bars may occur due to localized failure of the passive film on the steel by chloride ions or a general failure of the passivity by neutralization of the concrete due to reaction with carbon dioxide from the atmosphere.

The main factors responsible for corrosion of reinforcement bars are:

1) Loss of alkalinity due to carbonation – When the steel surface is left unprotected in the atmosphere, rust begins to form on the steel surface and gradually flakes off.

2) Loss of alkalinity due to chlorides **–** Chloride ions tend to de-passivity the steel surface by destroying the alkalinity of the concrete.

3) Cracks in concrete – Cracks may expose the steel bars to the atmosphere and hence increase carbonation.

4) Moisture pathways – Regular wetting of the concrete may lead to water reaching the steel reinforcement bars by diffusion through the pore structure of the concrete or cracks present in the concrete. Rusting of the steel bars follow thereafter.

5) Insufficient Cover **-** Insufficient dimension of concrete cover.

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Fig.1.0 Corroded steel reinforcement possibly due to insufficient concrete cover

Effects Of Corrosion On Steel Reinforcement

Once the steel bars start corroding, the reinforced concrete member gradually begins deteriorating going through the following stages:

***1) Formation of white** patches* – Atmospheric carbon dioxide reacts with calcium hydroxide present in the cement paste forming calcium carbonate. This calcium carbonate is carried by moisture and deposited onto the concrete surface forming white patches.

2) Brown patches along reinforcement – When the steel bars start corroding, a layer of iron oxide is formed on it. This iron oxide also gets carried to the surface of the concrete by moisture.

3) Formation of cracks – The products of corrosion occupy a greater volume than the original material. Hence they exert pressure on the concrete and crack it. With more corrosion occurring, more and wider cracks are formed.

4) Spelling of concrete cover – Due to loss of the bond between concrete and steel, the concrete starts forming multiple layers of scales and peels off. The steel bars also get reduced in size.

5) Snapping of bars – Due to reduction in the size of the steel bars, they finally snap. Also, there is a considerable reduction in the size of the main bars.

6) Buckling of bars – Spelling of the concrete cover and snapping of bars lead to buckling of the main bars. This bulges the concrete in that region and eventually the whole structure collapses.

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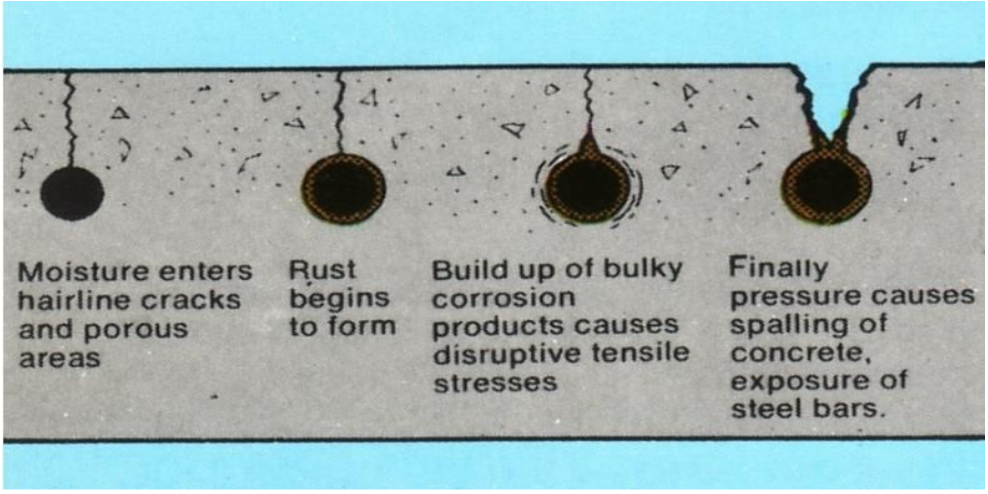

Fig 1.1 Process of Corrosion

1.3 How To Avoid Corrosion Of Steel Reinforcement

Corrosion of steel reinforcement bars may be prevented or at least delayed by practising good measures. Also, damaged steel bars can be repaired and the concrete structure can be restored properly.

Some steps are given below:

1) Providing Sufficient Concrete Cover - A good amount of concrete cover should be provided over the steel reinforcement bars. This ensures proper maintenance of the alkaline nature within the concrete and the passivity of the steel bars. The steel bars should be precisely placed in position.

2) Use of Good Quality Concrete - High quality concrete must be used. It helps to maintain proper alkaline nature. For the concrete, a water/cement ratio of 0.4 or less is to be maintained. Excessive water may damage the steel bars.

3) Proper Compaction of Concrete - Concrete must be completely compacted such that there are no air voids or pockets present inside.

4) Use of FBE coated Bars - Fusion Bonded Epoxy Coating (FBEC) may be applied on the steel bars to prevent them from corrosion. Epoxy powder is spread electro statically on to the steel bars. The powder melts and flows over the bars upon heating, forming a protective coating. They are thermo set polymer coatings because application of heat will not melt the coating. Apart from rebar it also has wide application in pipeline construction.

5) Use of Cement Based Polymers - Cement based polymers can be used in the concrete to enhance its protection against corrosion capabilities. The cement based polymers act as a binder in the concrete. They also increase the durability, tensile strength and vibration damping of the concrete.

6) RCPT test to assess degree of Corrosion - The Rapid Chloride Permeability Test (RCPT) may be performed to assess the degree of corrosion. The quantity of electrical current that passes through a sample 50 mm thick and 100 mm in diameter in 6 hours is measured. Based on this a qualitative rating is made of the permeability of the concrete.

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7) Use of Migratory Corrosion Inhibitors - Migratory corrosion inhibitors may be used in the concrete mix or may be applied on the hardened surface of the concrete. These inhibitors diffuse through the concrete cover and reach the steel bars to protect them against corrosion. Calcium nitrite based inhibitors are quite common.

2. MATERIALS

Fe-415:

The standard Fe 415 TMT bar has a maximum per cent of 0.060 Sulphur, the TMT bars of Fe 415 S and Fe 415 D has a maximum Sulphur content of 0.045. It is a similar story when it comes to Phosphorus as well, while the standard Fe 415 has a maximum Phosphorus content of 0.060%, the specialist Fe 415D has a maximum Phosphorus content of 0.045% and Fe 415S also a maximum Phosphorus content of 0.045%. When taking the combined Phosphorus and Sulphur content, the standard TMT bars have a maximum of 0.110% and the specialists Fe 415S and Fe 415D have Sulphur and Phosphorus content of 0.085%.

Fe-500:

The standard 500 D is a high strength ribbed TMT reinforcement bar. For reference, the strength of the rebar is 500 MPa and 'D' represents the ductility of the rebar. By keeping the level of impurities like Sulphur and Phosphorous to below 0.075%, the consistency in strength across the rebar is maintained.

Portable water:

Drinking water, also known as potable water, is water that is safe to drink or to use for food preparation. The amount of drinking water required varies. It depends on physical activity, age, health issues, and environmental conditions. Americans, on average, drink one litre of water a day and 95% drink less than three litres per day. For those who work in a hot climate, up to 16 litres a day may be required. Water is essential for life.

DO Tablets :

Dissolved Oxygen is the amount of gaseous oxygen (O2) dissolved in the water. Oxygen enters the water by direct absorption from the atmosphere, by rapid movement, or as a waste product of plant photosynthesis. Water temperature and the volume of moving water can affect dissolved oxygen levels. Oxygen dissolves easier in cooler water than warmer water. Adequate dissolved oxygen is important for good water quality and necessary to all forms of life. Dissolved oxygen levels that drop below 5.0 mg/L cause stress to aquatic life. Lower concentrations cause greater stress. Oxygen levels that go below 1-2 mg/L for a few hours may result in large fish kills.

CO_2 Tablets:

Atmospheric carbon dioxide derives from multiple natural sources including volcanic out gassing, the combustion of organic matter, and the respiration processes of living aerobic organisms; man-made sources of carbon dioxide come mainly from the burning of various fossil fuels for power generation and transport use.

2.1Structural Effects Of Corrosion

2.1.1. Loss of Strength:

ISBN: 978 – 81 – 959860 – 0 -2

Corrosion reduces the effective cross section of structural components. This will reduce the axial, and flexural strength of elements, and makes them structurally weak. Even if corroded elements look stable, it does not mean they are safe; in fact, the corroded structures become vulnerable for design loads (ultimate loads), i.e. a strong ground motion can increase the stress actions beyond the capacity of the sections. Loss of strength can happen in steel and reinforced concrete structures. Corrosion under insulation -CUI- is a frequent observation in refineries, and oil and gas industry. Steel sections covered under fireproofing insulation experience corrosion over their service life. Another famous example is the reduced flexural, and shear capacity of the RC element. Du- etal developed a mathematical model for the residual area and strength parameters (such as yield strength). This formula described the residual area based on the corrosion rate.

2.1.2. Fatigue:

Another structural effect of corrosion is on the fatigue strength of steel elements, connections, and RC elements. Corrosion may accelerate fatigue crack propagation in structural steels. Development of pitting corrosion introduces additional points of stress concentration at which cracking may develop, which will reduce the fatigue strength. Apostolopoulos (2006) studied the effect of corrosion on high and low cycle fatigue of reinforcing steel.

2.13. Reduced Bond Strength:

The capacity of composite elements such as RC elements depends on the characteristics of concrete-rebar interface. When steel corrodes, the products of corrosion expand. This will leave a poor quality steel layer over the surface of the reinforcement. This layer has a poor bond with surrounding concrete; therefore, it will reduce the capacity of the section. In case of lap splices or anchorage, this may reduce the effective length of anchorage, and resulting in premature failure of sections. Stanish(1997) studied the effect of corrosion on the bond strength in RC elements.

2.1.4. Limited Ductility:

Corrosion can significantly reduce the ductility of RC sections. This is critical in seismic design and evaluation. Corroded sections have lower ductility, which means their plastic deformation is limited. This will affect the seismic response of the elements. Corrosion of reinforcement in the lap splices will affect the load transfer in the laps, preventing the to develop yield stress. Asri and Ou (2011) studied the seismic response of corroded bridge columns by nonlinear pushover analysis.

2.1.5. Reduced Shear Capacity:

Corrosion can reduce the effective cross sectional area of transverse reinforcement in beams and columns, and reducing the shear capacity of the section. In concrete slabs, this can reduce the shear strength of the slab close of the columns, and increasing the chance of punching shear failure. In footings, the corrosion can result in shear failure of the footing, anchorage failure, or flexural yielding of steel reinforcement.

ISBN: 978 – 81 – 959860 – 0 -2

2.2 Dissolved Oxygen And Corrosion

Dissolved oxygen can destroy the protective hydrogen film that can form of many metals and oxidize dissolved ions into insoluble forms. Deposits of rust in a plumbing system are such an example of differential aeration cells and accelerate corrosion.

Dissolved oxygen (DO) refers to the volume of oxygen that is contained in water. Oxygen enters the water by photosynthesis of aquatic biota and by the transfer of oxygen across the air-water interface. The amount of oxygen that can be held by the water depends on the water temperature, salinity, and pressure. Gas solubility increases with decreasing temperature (colder water holds more oxygen). Gas solubility increases with decreasing salinity (freshwater holds more oxygen than does saltwater). Both the partial pressure and the degree of saturation of oxygen will change with altitude . Finally, gas solubility decreases as pressure decreases. Thus, the amount of oxygen absorbed in water decreases as altitude increases because of the decrease in relative pressure.

In modern boiler systems, dissolved oxygen is handled by first mechanically removing most of the dissolved oxygen and then chemically scavenging the remainder. The mechanical degasification is typically carried out with vacuum degasifiers that reduce oxygen levels to less than 0.5-1.0 mg/L or with deaerating heaters that reduce oxygen concentration to the range of 0.005-0.010 mg/L. Even this small amount of oxygen is corrosive at boiler system temperatures and pressures.

Removal of the last traces of oxygen is accomplished by treating the water with a reducing agent that serves as an oxygen scavenger. Hydrazine and sulfite have been widely used for this purpose, but they have some shortcomings. Sodium sulfite, although an effective scavenger, is not recommended for use in systems operating above 1,000 psi because breakdown occurs to form corrosive hydrogen sulfide and sulfur dioxide. Also, sodium sulfite increases the amount of dissolved solids, as well as the conductivity, in the boiler water.

Hydrazine efficiently eliminates the residual oxygen by reacting with the oxygen to give water and gaseous nitrogen. Unfortunately, however, it has become widely recognized that hydrazine is an extremely toxic chemical. It is therefore desirable to provide alternate boiler water treatment chemicals which are generally free of the dangers inherent in the use of hydrazine, but which effectively scavenge oxygen and passivate steel surfaces under typical boiler conditions.

Erythorbic acid and its sodium salt are replacing sulfite and hydrazine as oxygen scavengers in boiler water treatment. Based upon the stoichiometric relationship, it should take about 13 parts of sodium erythorbate to react with one part of dissolved oxygen. Actual lab and field test data show that much less erythorbate is actually needed than theoretical to scavenge the oxygen. This result occurs because the erythorbate breakdown products accomplish further oxygen scavenging. Field trials in large utility boilers show the intermediate breakdown products to be lactic and glycolic acids. The ultimate breakdown product is CO_2.

2.3 The Effect Of Dissolved Oxygen On Corrosion Behavior Of Mild Steel

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Corrosion of mild steel is a function of Dissolve Oxygen (DO) and microbial life activities. The present work indicates the corrosion behavior of mild steel which were dipped in different water sample of different amount of Dissolved oxygen. It was found, initially corrosion of mild steel is directly proportional to Dissolved Oxygen concentration then this rate diminished over a period of days because of formation of oxide film on the samples. It was generally observed that corrosion rate decreases with exposure times in all periods of environments. In our work observed results were due to the formation of an impermeable protective oxide film on the surface of the steel, after this, the steel is said to be passive and does not corrode easily.Oxygen (DO) refers to volume of oxygen that is contained in water. The amount of Oxygen that can be held by water depends on the water temperature, salinity and pressure. Dissolved Oxygen may change depending upon depth, distance, temperature and period of sampling. DO may also change drastically due to waste produced by many process industries.

A water body produces oxygen by gaining it from the atmosphere and from plants as a result of photosynthesis. Running water dissolves more oxygen than still water, because of its churning. DO consume by aquatic animals during respiration, by bacteria during decomposition and various chemical reactions. Wastewater from sewage treatment plants often contains organic materials that are decomposed by microorganisms, which use oxygen in the process. (The amount of oxygen consumed by these organisms in breaking down the waste is known as the biochemical oxygen demand or BOD). Other sources of oxygen consuming waste include storm water runoff from farmland or urban streets, feedlots, and failing septic systems.

Mild steel also known as plain-carbon steel, is now the most common form of steel because its price is relatively low while it provides material properties that are acceptable for many applications like automobile components, structural shapes and sheets that are used in pipelines, buildings, plants and bridges. Low-carbon steel contains approximately 0.05–0.25% carbon1 making it malleable and ductile. Mild steel has a relatively low tensile strength but high ductility, weld ability and mach inability. It is cheap and easy to form; surface hardness can be increased through carburizing.

Mild steel was not produced for corrosion resistive purposes but often use of this alloy in corrosive atmosphere has raised many issues. Mild steel is used in railways where this alloy is in contact of water. The bottom pillars of railway bridges and road bridges constructed over rivers, lakes and sea always remain in water.2 In 1967, Silver Bridge build over Ohio river crumpled because of the failure of material due to immersion corrosion and the material was mild steel. The immersion corrosion is a function of Dissolved Oxygen and Microbial Life Activities. If the water contains high oxygen concentration, initially corrosion rate may reach a high value.

ISBN: 978 – 81 – 959860 – 0 -2

3. EXPERIMENTAL PROCEDURE

Mild steel samples were in the forms of cuboids, all of which have same exposed area. Water samples which have different dissolved oxygen values (ranged from 1.4 mg/L to 5.7 mg/L) were collected.

Experimental procedure can be divided into two steps:

3.1 Determination of dissolved oxygen; The dissolved oxygen test procedure was in accordance to IS: 3025 (Part 38) - Reaffirmed 2003. Dissolved Oxygen Reading Water Sample Dissolved Oxygen (in mg/L) usually concentrations are 8,12,16,20. The procedure and DO values for different water sample are t6aken out periodically. Determination of corrosion loss: To determine the corrosion loss four steps were involved. The mild steel samples were dipped in water samples which have different dissolved oxygen values. Mild steel was dipped under normal room temperature conditions. After this, mild steel samples were periodically removed from the water, after drying and removing rust were weighted.

Relationship between Dissolved Oxygen and Corrosion Characterization of X80 Steel in Acidic Soil Simulated Solution

The relationship between dissolved oxygen (DO) and corrosion behavior of X80 steel in acidic soil simulated solution was studied by potentiodynamic polarization curves, electrochemical impedance spectroscopy (EIS), scanning Kelvin probe technique (SKP) and X-ray diffraction (XRD). Results showed that the presence of DO accelerated the cathodic process of corrosion for X80 steel in the acidic soil simulated solution. With the decrease of DO, 1/Rct and corrosion decreased gradually, the corrosion rate of X80 steel reduced. The corrosion of X80 steel was controlled by the ionization reaction when the content of DO in solution was bigger than 1.90 ppm. However, the diffusion of oxygen dominated the corrosion process of X80 steel in simulated solution with 0.85 ppm DO, as demonstrated by the presence of cathodic limiting diffusive current and Warburg impedance. Besides, DO could affect the formation and composition of the corrosion product formed on X80 steel. In O2-saturated solution, a homogeneous and compact corrosion product layer, FeOOH and Fe3O4, formed on the surface of X80 steel. But the phase composition of corrosion product was FeOOH, Fe2O3 and a few FeCO3 when DO in solution was 0.85 ppm.

Pipelines are the most preferred method for transporting large volumes of crude oil and natural gas over long distances. X80 steel is a low carbon and micro-alloyed steel, and has been used widely for building the gas transmission pipelines because of its high-intensity and high-toughness. As buried pipelines, X80 steel will pass through different soils, such as alkaline soil, neutral soil and acidic soil. In this area, the annual precipitation is 1600 ~ 1700 mm, the temperature is above 15^0C in all year, the pH of soil is 3.90~4.50, which are easy to result in the corrosion of pipeline steel. As we all know, corrosion of steel in soils is an electrochemical process. Oxygen and proton ion (H+) have been recognized as the most common cathodic depolarizers in corrosion process of steel in soils. It has been found that the compaction of soil will affect the air permeability.

ISBN: 978 – 81 – 959860 – 0 -2

The diffusion of oxygen through water-saturated red soil is slow; the contribution of oxygen reduction to corrosion of the steel in water-saturated red soil can be negligible. However, loose red soil has good permeability, and red clay soil is acidic, both the depolarization of oxygen and the contribution of H+ to corrosion may need to be considered Therefore, it is necessary to clarify the role of dissolved oxygen (DO) in the corrosion process of X80 steel in acidic red soil. Recently, the role of DO on the corrosion of carbon steel and stainless steel has been studied extensively. Beak WC considered that DO plays a significant role on the composition of the corrosion film formed on carbon steel. Caceres found that the oxygen reduction reaction on iron is a mixed mass transfer and charge transfer controlled process, the cathodic current is predominantly mass-transfer controlled and steadily decreases with corrosion time at high NaCl concentrations, whereas at low NaCl concentrations, the current is predominantly charge-transfer controlled and increases with corrosion time. Demonstrated that the cathodic process on carbon steel in saturated 3.5% NaCl solution contains dissolved oxygen reduction, iron oxides reduction and hydrogen evolution, the oxygen molecule adsorption is inhibited by the adsorption of chloride ion on steel, the rate of oxygen reduction reaction will decrease with the increase of the concentration of chloride ion. However, so far, investigations are still inadequate to fully understand the relationship between oxygen and the corrosion mechanism of steel. Especially, there is little work about the role of DO on the corrosion of X80 steel in acid soil environment.

In this work, the relationship between DO and the electrochemical corrosion behavior of X80 steel in acidic soil simulated solution was investigated by polarization curves, EIS and SKP. The effects of DO on the corrosion products were analyzed by three dimensional video microscope and XRD. The results from this study have the potential to be useful in understanding the corrosion mechanism and improving the general criteria of soil corrosion.

3.2 Carbon Dioxide And Corrosion

In the oil and gas industry, carbon dioxide corrosion is known as sweet corrosion, while hydrogen sulfide corrosion is known as sour corrosion. When carbon dioxide is dissolved into water, carbonic acid is formed. Electrochemical corrosion may be generated when metal is in water. Dry carbon dioxide itself may not corrode metal under the condition of no electrolyte (water). However, with the development of oil and gas fields, the water cut is gradually increased. The carbon dioxide, after being dissolved into water and changed into carbonic acid, may have a stronger corrosiveness.

Iron carbide (Fe3C). Carbon steel corrosion mechanism in aqueous solution containing carbon dioxide is complex and necessity a fundamental corrosive material conditions lead to corrosion cracking. The effect of pH corrosion aqueous solution has been investigated and evaluates carbon steel corrosion attack under carbon dioxide Carbon dioxide is dissolved into the water phase, thus generating carbonic acid, which may chemically react with the pipe wall. Thus carbon dioxide corrosion is generated. The carbon dioxide content in the water phase is closely related to the partial pressure of carbon dioxide under the condition of gas-liquid equilibrium. If there is no free gas, the carbon dioxide content in water will depend on the gas phase carbon dioxide

ISBN: 978 – 81 – 959860 – 0 -2

pressure. Therefore, the carbon dioxide corrosion rate should be predicted as follows on the basis of the partial pressure of the carbon dioxide in gas phase.

The major problems of corrosion in oil and gas production is particularly found in oil production materials as tubing and casing are more exposed to carbon dioxide (CO_2) pressure environments in deep water environment. Usually, oil field materials used for oil and gas production are manufactured in carbon steels as pipelines, casing and production tubular. Carbon dioxide injection method and deep water oil reservoir environment have considerably changed and multiplied corrosion prediction study and techniques. The current reading is aimed at evaluating the carbon steel corrosion behavior exposed to supercritical carbon dioxide (CO_2) at different carbon dioxide pressure, temperatures in a de-ionized water aqueous solution . Carbon steel corrosion rate was evaluated by using weight loss measurements; corrode aqueous solution pH, surface analytical methods by Scanning Electron Microscopy (SEM) examination and Energy Dispersive Spectroscopy (EDS) examination. Carbon steel corrosion rates increased when the carbon dioxide pressure increased. At a lower exposed period, the presence of iron carbonate ($FeCO_3$) was identified and the long period of exposed time has been identified as partial pressure.

3.3 Effects Of Corrosion

Unfortunately, one of the biggest corrosion offenders is public infrastructure which means we all pay (taxes) for the lack of adequate planning. The long-held attitude in public construction of cheapest bid wins has been proven flawed. Building with the cheapest method initially often means greater costs in the future – costs public budgets rarely account for nor have the means to consume.

However, the cost of corrosion is not just financial. Beyond the huge direct outlay of funds to repair and/or replace corroded and/or decaying structures are the indirect costs (natural resources, potential hazards, and lost opportunity). When a project is constructed with a building material not able to survive its environment for the length of the design life, natural resources are needlessly consumed to continually repair and maintain the structure. Wasting natural resources is a direct contradiction to the growing focus and desire for sustainable development to benefit future generations.

In addition to the waste of natural resources, building structures that cannot sustain their environment can lead to hazardous situations. Accidents caused by corroded structures can lead to huge safety concerns, loss of life, resources, and more. One failed pipeline, bridge collapse, or other catastrophe is one too many and leads to huge indirect costs (more traffic delays, loss of business, etc.) and public outcry. Depending on which market sector (industrial, infrastructure, commercial, etc.) is being considered, these indirect costs may be as high as five to ten times the direct cost.

4. TESTS

4.1 Preparation of DO Solution

To Perform the investigation firstly we should collect a portable drinking water which is used for testing. Then the water sample is taken into required buckets and filled in it . Then the DO tablets of required amount is taken into consideration and it is gently make into powder and thoroughly mixed with the portable

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water into proportions. After the dilution process is over then the water is kept aside and should not be disturb it. Then the required proportions namely 8 mg/L, 12 mg/L, 16 mg/L, 20 mg/L is maintained. These sample should be thoroughly dissolved with powder sample of DO tablets.

4.2 Preparation ofCO_2 Solution

To Perform the investigation firstly we should collect a portable drinking water which is used for testing. Then the water sample is taken into required buckets and filled in it . Then CO_2 tablets of required amount is taken into consideration and it is gently make into powder and thoroughly mixed with the portable water into proportions. After the dilution process is over then the water is kept aside and should not be disturb it. Then the required proportions namely 50 mg/L, 100 mg/L, 150 mg/L, 200 mg/L is maintained. These sample should be thoroughly dissolved with powder sample of CO_2 tablets.

4.3 Determination of P^h

To prepare a buffer solution and to determine pH of that buffer solution and other samples.

Chemicals Required

1. Solutions of glacial acetic acid.
2. Sodium acetate
3. Hydrochloric acid.

The experiment comprises of 2 parts, such as

(i) Preparation of Buffer Solution.

(ii) (ii) Determination of their P^H.

(I) Preparation Of Buffer Solution:

The resistance to change hydrogen ion concentration of a solution on addition of acid or alkali is known as Buffer action. The buffer solution is variably consists of a mixture of a weak acid or weak base and its salt. The combination of weak acid, weak base and its salt suppress the dissociation of acid or base due to common ion effect so that the hydrogen ion or hydroxyl ion availability is lower than in the pure solution at a comparable concentration.

(Ii) Determination Of Ph Of Buffer Solution:

The ionic product of water and hydrogen ion concentration are related from the dissociation of water molecule as follows.

H2O = [H +] + [OH -]

Ka = [H +] [OH -] = 10 -14

At neutral point, [H +] = [OH -] = 10 -7

The no. of gram ions of hydrogen present in 1 lit of solution is known as hydrogen ion concentration. If hydrogen ion concentration is more than 10 -7 then the solution is acidic, if it is less than 10-7 then it is basic. Sorenson (1909) introduced the

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term pH and suggested its use to express the acidity or alkalinity of solution which is defined as the negative logarithm of the hydrogen ion concentration.

PH = - log [H+]

For pure water, pH = - log [H+] = - log 10[10-7] = 7

For acidic solution, pH < 7

For basic solution pH > 7

4.4 Determination Of Acidity

Acidity of water is its quantitative capacity to neutralize a strong base to designated PH. Strong minerals acids, weak acids such as carbonic and acetic and hydrolyzing salts such as ferric and aluminum sulphates may contribute to the measured acidity. According to the method of determination, acidity is important because acid contributes to corrosiveness and influences certain chemical and biological processes. It is the measure of the amount of base required to neutralize a given sample to the specific P^H.

Hydrogen ions present in a sample as a result of dissociation or hydrolysis of solutes are neutralized by titration with standard alkali. The acidity thus depends upon the end point pH or indicator used. Dissolved CO2 is usually the major acidity component of unpolluted surface water. In the sample, containing only carbon dioxide-bicarbonate carbonate, titration to pH 8.3 at 25°C corresponds to stoichiometric neutralization of carbonic acid to carbonate. Since the color change of phenolphthalein indicator is close to pH 8.3, this value is accepted as a standard end point for the titration of total acidity. For more complex mixture or buffered solution fixed end point of pH 3.7 and pH 8.3 are used. Thus, for standard determination of acidity of wastewater and natural water, methyl orange acidity (pH 3.7) and phenolphthalein acidity (pH 8.3) are used.

Thus, in determining the acidity of the sample the volumes of standard alkali required to bring about color change at P^H 8.3 and at P^H 3.7 are determined.

25 ml of sample is pipette into flask. If free residual chlorine is present, 0.05 ml (1 drop) of 0.1 N thiosulphate solution is added. A drop of methyl orange indicator is added. These contents are titrated against 0.02 N hydroxide solution. The end point is noted when color change from orange red to yellow. Then two drops of phenolphthalein indicator is added and titration continued till a pink color just develops. The volumes of the titrate used are noted down.

4.5 Determination of Tension Test

Tensile tests are used to determine how materials will behave under tension load. In a simple tensile test, a sample is typically pulled to its breaking point to determine the ultimate tensile strength of the material. The amount of force (F) applied to the sample and the elongation (ΔL) of the sample is measured throughout the test. Material properties are often expressed in terms of stress (force per unit area, σ) and strain (percent change in length, ε). To obtain stress, the force measurements are divided by the sample's cross sectional area (σ = F/A). Strain measurements are

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obtained by dividing the change in length by the initial length of the sample ($\varepsilon = \Delta L/L$). These values are then presented on an XY plot called a stress-strain curve. Testing and measuring procedures vary based on the material being tested and its intended application.

ADMET material testing systems perform accurate and reliable tension tests / tensile tests. Our systems are ideal for measuring the tensile properties of metals, plastics, textiles, adhesives, medical devices and many other products and components. As they pull materials apart, ADMET testing machines accurately calculate mechanical properties such as tensile strength, peak load, elongation, tensile modulus, and yield.

4.6 Corrosion Testing By Using Poroscope

First place the Cu/CuSo4 agent (or) apparatus on to the concrete surface in an area protected from dust. Make sure the sponge is wet and sufficient electrical contact solution is in the container. This should keep the concrete damp for the term of the test. Connect the reference cell to the voltmeter and connect the voltmeter to the reel of the test wire. Connect the test wire to the exposed reinforcing steel, making sure there is a good electrical connection. Measure and record the potential difference values between the reference cell and the reinforcing steel as seen on the display.

- Metal potential measurements with ± 0.001v {Electrical continuity probable}.
- Metal potential measurements greater than ± 0.001v but less than ± 0.003v {Electrical continuity uncertain}.
- Metal potential measurements greater than ± 0.003v {Electrical discontinuity probable}.

4.7 Measurement Of Temperature

Temperature is a physical quantity expressing hot and cold. It is measured with a thermometer calibrated in one or more temperature scales. The most commonly used scales are the Celsius scale (formerly called centigrade) (denoted °C), Fahrenheit scale (denoted °F), and Kelvin scale (denoted K). The Kelvin (the word is spelled with a lower-case k) is the unit of temperature in the International System of Units (SI), in which temperature is one of the seven fundamental base quantities. The Kelvin scale is widely used in science and technology.

Theoretically, the coldest a system can be is when its temperature is absolute zero, at which point the thermal motion in matter would be zero. However, an actual physical system or object can never attain a temperature of absolute zero. Absolute zero is denoted as 0 K on the Kelvin scale, −273.15 °C on the Celsius scale, and −459.67 °F on the Fahrenheit scale. For an ideal gas, temperature is proportional to the average kinetic energy of the random microscopic motions of the constituent microscopic particles. Temperature is important in all fields of natural science, including physics, chemistry, Earth science, medicine, and biology, as well as most aspects of daily life.

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5. CONCLUSIONS

The effect of co2 on the atmospheric corrosion of line hot dip ZnMg Alcoatings was investigated under carefully conditions at ambient temperatures as a function o f chloride concentration.

1. The following conclusions may be drawn from the experimental results
2. Corrosion is more in CO_2 water than DO water
3. Corrosion is more on bars which were being kept in CO_2 and DO waters than bars kept alternative months in same waters.
4. Tensile strength loss is more in Fe415 than Fe500 bars
5. Tensile strength loss is proportional to the corrosion

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WATER ABSORPTION BY CRAVING CONCRETE USING RECYCLED AGGREGATES AND WASTE PLASTIC

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ABSTRACT

In Worldwide a great research is currently being conducted on the storm water management in concrete. Concrete is an artificial stone-like material used for various structural purposes. The binding material cement and various aggregates are made by through mixing of stone chips, recycled aggregate, etc. with water and allowing the mixture to harden by hydration. Number of research has been done to find an alternate material in concrete. The Craving concrete is also called as pervious concrete, Permeable concrete, No fines concrete and Porous pavement. This concrete is mainly used in the places where the water is stagnant. The Main use of the Craving concrete is to transfer the stagnant water from the top surface to the ground surface (Soil). During rainy seasons the water is stagnant at one place. Sometimes, there is no proper management practice available. To overcome these defects the Craving concrete is used. This concrete is used as a paving material due to its efficient to the water is allowed to pass through itself to maintain groundwater level and storm water runoff is minimized. It will help to increase the low ground water level and agricultural problems. In this Craving concrete we are planned to use the recycled aggregates instead of the normal aggregates and we are going to do the probe on the Craving concrete with normal aggregate and the Craving concrete with recycled aggregates. A concrete mix ratio of 1:3 was obtained as per BIS method for our experimental work. Water cement ratio 0.35 has been adopted and performance of concrete with treated normal and recycled aggregate is investigated.

***Keywords**:* Recycled Aggregate, Waste Plastic, Compressive Strength, Split Tensile Strength

1. INTRODUCTION

Worldwide the ground water level is been minimizing. To maintain the water level number of research has been carried out based on sending the water to ground surface. So, there are been various research carried on pavement areas in that Craving concrete plays an important role in sending water to ground. During rainy seasons the water is

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stagnant at one place. Sometimes, there are no proper management practices available. To overcome these defects the Craving concrete is used. This concrete is used as a paving material due to its efficient to the water is allowed to pass through itself to maintain groundwater level and storm water runoff is minimized. It will help to increase the low ground water level and agricultural problems. In this project, we compare of ordinary aggregate & recycled aggregate in craving concrete. The Craving concrete is used for pavements. So, don't require a separate draining chamber along the roads. The various applications of previous concrete are listed as follows residential road, alleys and driveways, Low volume pavements, Sidewalks and pathways, Parking areas, Tennis courts, Sub base for conventional concrete pavements, Well lining, Swimming pool decks.

2. PROJECT SCOPE

The scope of this Craving concrete is to reduce the water logging in road surface this concrete can be used for the purpose of constructing the sports court, animal shelter, Pavement. By use of recycled aggregate in this concrete, In future we can reduce the usage of raw material. This concrete having the characteristics of high porosity, so it is thermally insulating and it can be used as a sound barrier walls.

3. MATERIALS

Cement :

Cement, is an adhesive substances used as a binding materials in civil engineering construction. Cements in the form of finely ground powders, when it's get mix with water, it goes to harden state form like solid mass substance. The cement is most widely used of all construction materials in the world today, the manufacture of cement is widespread. Each year almost one ton of concrete is poured per capita in the developed countries. The result of material test ofcement is been listed in table below

Table1 Properties of cement

S. No	PROPERTY	VALUE
1	Initial setting	28min
2	Final setting time	540min
3	Specific gravity	3.15

- ***Coarse Aggregate:***

  Aggregates are crystalline or granular rocks used for construction industry. Aggregate are termed which are sized more than 4.75mm. The crushed stone of Gravels are used majorly in concrete works. The angular aggregates are used for proper bonding. Here the primary aggregates (withdrawn from quarries) are used to find the strength of craving concrete. Aggregates plays important in strength factor of the structures it is an essentially needed material in construction of all major works. The result of material test of Normal coarse aggregate is been listed in table below

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Table2 Properties of coarse aggregates

S. No	PROPERTY	VALUE
1	Impact test	11.18%
2	Water absorption	0.5
3	Specific gravity	2.72

- ***Fine Aggregate:***

Fine aggregates or sand is an accumulation of grains of mineral matter derived from the disintegration of rocks. It is distinguished from gravel only by size of the grains or particles, but is distinct from clays which contain organic materials. Sands that have been stored out and separated from the organic material by the action of currents of water or by winds across arid lands are generally quite uniform in size of grains. Usually commercial sand dunes originally formed by the action of winds.

Table2 Properties of coarse aggregates

S. No	PROPERTY	VALUE
1	Fineness Modulus	2.55
2	Water absorption	0.74%
3	Specific gravity	2.31

D. Recycled Coarse Aggregate:

The secondary aggregates are termed normally as recycled coarse aggregate. The recycled coarse aggregate which are broken pieces of waste comes from construction works. The density of recycled aggregate varies slightly from normal aggregate. In this project the pre used concrete cylinders and cubes are reused in the form of recycled coarse aggregate. It Conserves landfill space, reduces the need for new landfills and hence saving more costs. The result of material test of recycled coarse aggregate is been listed in table below

Table4 Properties of recycled aggregates

S. No	PROPERTY	VALUE
1	Impact test	10.55%
2	Water absorption	0.56
3	Specific gravity	2.31

- ***Waste Plastic:***

- Plastic waste management is the process of recycling plastic waste and reprocessing it to make useful products. Plastic, as we know, is a non-biodegradable item and therefore it needs to be recycled to reduce environmental damage.
- Majorly, there are two methods to recycle plastic – mechanical and chemical recycling. Plastics can also be recycled to form a fresh item. Recycling plastic

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is considered to be the most effective way to deal with waste and therefore, public awareness must be created regarding the recycling of plastic.

- For better recycling, it is necessary to empty the plastic bottles and containers before it is sent out for recycling. Giving them a quick rinse can help in better recycling.

Table5 Properties of waste plastic

S. No	PROPERTY	VALUE
1	Specific Gravity	1.04
2	Density	0.945 -0.962
3	Melting Point (°C)	75 - 100
4	Softening Point (°C)	110
5	Elongation at Break	>500%
6	Fineness	<2.36mm

4. EXPERIMENTAL TESTS

i. *Slump Cone:*

The slump cone value is determined for various water cement ratio's and the result are listed in table below

Table 6 slump values

SPECIMEN	0.35 W/C	0.4 W/C	0.5 W/C
Normal	300	290	270
Recycled	300	300	290

II .*Compaction Factor:*

The compaction factor value is determined for various water cement ratio's and the result are listed in table below

Table7 Compaction values

SPECIMEN NAME	0.35 W/C	0.4 W/C	0.5 W/C
Normal Aggregate	0.76	0.70	0.64
Recycled Aggregate	0.85	0.74	0.68

iii. *Compressive Strength:*

The test is carried out on cube specimens of size (150x150x150mm). For normal and recycled aggregate each three specimens are been tested for 7, 14 and 28 days respectively. The compressive strength of Craving concrete (Normal Aggregate and Recycled Aggregate) are tabled below

Table7 Compressive strength values

SPECIMEN NAME	7	14 DAYS	28 DAYS
Normal Aggregate	17.06	25.60	27.77
Recycled Aggregate	15.73	23.60	25.07

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Iv. Split Tensile Strength:

The test is carried out on cylinder specimens of size (150x300 mm). For normal and recycled aggregate each three specimens are been tested for 7, 14 and 28 days respectively. The split tensile strength of thirst concrete (Normal Aggregate and Recycled Aggregate) are tabled below

SPECIMEN NAME	7	14 DAYS	28 DAYS
Normal Aggregate	4.29	5.92	6.57
Recycled Aggregate	3.66	5.57	6.1

5. CONCLUSION

From this experimental probe the followings are been concluded Using the Recycled aggregates instead of normal aggregates in Thirsty concrete we can reduce the construction demolition waste. The Normal aggregates are fully replaced by theRecycled aggregates which results in more or less equal compressive strength. Water absorption of the Recycled aggregates are9-10% higher than the Normal aggregates. The Compressive and Split Tensile strength of the thirsty concrete using Recycled aggregates is slightly lesser than the Normal aggregate thirsty concrete. From this investigation it is clear the thirsty concrete is very useful to our environment toreduce the stagnant water.

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