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Experimental Research on M30 Grade of Concrete for the Partial Substitution of Cement with Egg Shell Powder and Fly Ash

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ABSTRACT: The effects of partial cement replacement with eggshell powder and fly ash on the characteristics of M30 grade concrete are investigated in this experimental investigation. The goal is to determine the viability of using these waste products as prospective cementitious alternatives. Casting of concrete cubes 15x15x15 cm and beams 15x15x70 cm for curing periods of 7 and 28 days was performed in this investigation. Cement replacements with varied quantities of eggshell powder and fly ash at levels of 4%, 5%, and 6% were investigated. Flexural and compressive strength tests were performed on the concrete specimens to assess mechanical performance and durability. The findings of the trials show that using eggshell powder and fly ash as partial substitutes for cement has a significant impact on the qualities of M30 grade concrete. With the addition of these waste components, the compressive and flexural strengths of the concrete sample alter. Curing intervals of 7 and 28 days also lead to variances in strength growth, offering light on the potential for long-term performance.

KEYWORDS: Egg shell powder, fly ash, concrete, cement, aggregate

I. INTRODUCTION

During the world, concrete is presence broadly used for the structure of greatest of the buildings, bridges etc. Presently, the complete construction industry is in exploration of an appropriate and operative the unused product that would greatly minimize the use of cement and eventually decrease the creation cost. Such a substitute material are egg shell powder and silica fume. Greatest of egg shell waste is willing in landfills short of any pre-treatment since it is conventionally unusable and eventually makes thoughtful eco glitches. Therefore, proper alternate is required to manage the wastes in eco-friendly way. The goal of this investigation work is to use the egg shell powder, silica fume as a limited additional of cement. Egg shell powder is replaced by 5%, 10% and 15% in addition with the silica fume by 2.5%, 5%, and 7.5% of weight of cement. An experimental research demonstrates the strength features such as split tensile strength, compressive strength, and flexural strength test of egg shell based concrete were investigated. It is found the strength of the concrete rises with the adding of egg shell powder and silica fume and finally the comparison is made for the egg shell and silica fume added strength of concrete

Energy plays a crucial role in growth of developing countries like India. In the context of low availability of non-renewable energy resources coupled with the requirements of large quantities of energy for Building materials like cement, the importance of using industrial waste cannot be under estimated. During manufacturing of one tonnes of Ordinary Portland Cement we need about 1.1 tonnes of earth resources like limestone, etc. Further during manufacturing of 1 tonnes of Ordinary Portland Cement an equal amount of carbon-di-oxide are released into the atmosphere. The carbon-di-oxide emissions act as a silent killer in the environment as various forms. In this Backdrop, the search for cheaper substitute to OPC is a needful one.

Earlier works on the combination concrete conducted by scholars have led us to the point that the eggshell ash can be used as an additive in concrete production. Eggshells are agricultural waste materials generated from chick hatcheries, bakeries, and fast-food restaurant among others, which can litter the environment and consequently constituting environmental problems or pollution which would require proper handling.

1.1 General

Energy plays a crucial role in growth of developing countries like India. In the context of low availability of non-renewable energy resources coupled with the requirements of large quantities of energy for Building materials like cement, the importance of using industrial waste cannot be under estimated. During manufacturing of one tones of Ordinary Portland Cement, we need about 1.1 tons of earth resources like limestone, etc. Further during manufacturing of 1tones of Ordinary Portland Cement an equal amount of carbon-di-oxide are released into the atmosphere. The carbon-di-oxide emissions act as a silent killer in the environment as various forms. In this Backdrop, the search for cheaper substitute to throughout the world, waste products are seriously polluting the environment. There are many types of waste disposal system such as land filling, open burning, drains clogged up with rubbish and river fill definitely indicate solid waste is a major environmental problem in India.

1.2 Materials used

1.2.1 Cement

Cement is the important required material for the construction of concrete. Cement is a well-known construction material and has engaged a vital place in construction work. There is a change of cement obtainable in market and each type is used under convinced illness due to its singular properties such as Color and arrangement of cement. Although cement creates only about ten percentage of the volume of the various concrete mix, it is the active portion of the compulsory medium and the only systematically controlled component of concrete. The physical properties of cement, chemical composition of cement are shown in Table-1 and Table-2 respectively cement .

1.2.2 COARSE AGGREGATE

Without aggregate, large castings of neat cement, paste would essentially self-destruct upon drying. Coarse aggregates are particles greater than 4.75 mm, but generally range between 9.5 mm to 37.5 mm in diameter. They can either be from primary, secondary or recycled.



Fig. 1 Coarse Aggregate

1.2.3 FINE AGGREGATE

The finer aggregate has a better positive effect on the properties of fresh concrete and hardened in high performance concrete. Thus, fine aggregate are playing an important role in the concrete mixture.

1.3 Egg Shell Powder

Eggshell consists of several mutually growing layers of CaCO_3 , the innermost layer-maxillary 3 layer grows on the outermost egg membrane and creates the base on which palisade layer constitutes the thickest part of the eggshell. The top layer is a vertical layer covered by the organic cuticle. The eggshell primarily contains calcium, magnesium carbonate (lime) and protein. In many other countries, it is the accepted practice for eggshell to be dried and use as a source of calcium in animal feeds. The quality of lime in eggshell waste is influenced greatly by the extent of exposure to sunlight, raw water and harsh weather conditions. It is the fine grained powder with suitable proportion which is sieved to the required size before use with concrete/mortar.

Eggshell known as a smooth surface that is desirable compared rough eggshells fracture more easily. Most good quality eggshells from commercial layers contain approximately 2.2 grams of calcium in the form of calcium carbonate. About 95% of the dry eggshell is calcium.



Fig 2. Egg shell powder

1.3.1 History of egg shell powder

Every day, the world's egg companies process an estimated one million eggs. In the process to produce liquid and powdered egg products, these companies also generate huge volumes of wastes. In this environment-conscious world, disposal of eggshells and paper egg trays represents a significant cost and in many countries, legislation requires eggshells to be heat-treated so that they do not become a source of disease to humans or animals. A 'green' solution Danish engineering company, Sunoco Environmental Solutions, has developed a new way to deal with these wastes in an environmentally friendly and safe way. Eggshells and trays are processed together, the trays forming the fuel to burn the shells. Rather than worthless ash from heating at low temperatures, the resulting residue from incineration is burnt limestone (also known as quicklime), a chemical with many industrial uses, including the building industry. Ordinary Portland Cement of 53 grade conforming to IS 12269- 1987 was used in this study. River sand conforming to grading zone III of IS 383-1970 was used as a fine aggregate. Well graded coarse aggregate passing through 20mm sieve according to IS 383-1970 was used. Well graded coarse aggregate passing through 20mm sieve according to IS 383-1970 was used. Egg shell procured from local industry. It grained and sieved to the required size before used in concrete mix. Saw dust was obtained from sawmill and saw dust ash was obtained by incineration process and sieved before used. Fly ash was collected from Salem steel Plant, Salem, Tamilnadu and sieved before used conforming to IS 3812 (part I). Micro silica was a byproduct of the silicon and Ferro-silicon production. Portable water was used in the investigations for both mixing and curing purposes.

1.4 History of Fly ash

Fly ash is a byproduct of burning coal in power plants, and its history dates back to the 1930s when power plants began producing it in large quantities. In the early days, fly ash was considered a nuisance and was often disposed of in landfills or ponds, leading to environmental problems. During World War II, there was a shortage of cement, which led to the use of fly ash as a substitute for cement in concrete production. This marked the beginning of the use of fly ash as a construction material.

In the 1950s, research was conducted on the use of fly ash in concrete, and it was found to have several benefits, including increased durability, improved workability, and reduced permeability. This led to the widespread adoption of fly ash as a concrete additive in the 1960s.

In the 1970s, the Environmental Protection Agency (EPA) began regulating the disposal of fly ash due to its environmental impact. The EPA classified fly ash as a hazardous waste, which led to the implementation of strict regulations on its disposal. This prompted the power industry to find ways to reuse fly ash instead of disposing of it.

In the 1980s, the use of fly ash as a soil stabilizer and filler in road construction became popular. It was found to improve the strength and stability of soil, reducing the need for costly and environmentally damaging excavation and disposal of soil.

In the 1990s, the use of fly ash as a construction material continued to expand. It was used in the production of lightweight concrete blocks and as a raw material in the production of glass and ceramics.

In the 21st century, the use of fly ash has continued to evolve. It is now commonly used in the production of high-performance concrete, geopolymer concrete, and other advanced building materials. Research is also being conducted on the use of fly ash in the production of biodegradable plastics and other sustainable materials.

1.4.1 Fly ash

Fly ash is a fine powder that is produced as a byproduct of burning pulverized coal in electric power plants. It is one of the most commonly generated industrial wastes in the world, with millions of tons being produced every year. Fly ash is composed of a mixture of inorganic and organic materials, including silicon dioxide, aluminum oxide, iron oxide, calcium oxide, and magnesium oxide. The chemical composition of fly ash varies depending on the type of coal being burned, the combustion conditions, and the type of emission control equipment used. The disposal of fly ash is a significant environmental concern, as it can contaminate air and water resources if not handled properly. Fly ash can also be a valuable resource when used as a cement replacement in the construction industry, due to its pozzolanic properties. It has been used in a variety of applications, such as making concrete, bricks, and road construction.

Fly ash is a fine powder that is a byproduct of burning pulverized coal in electric power generating plants. It is typically composed of oxides of silicon (SiO_2), aluminum (Al_2O_3), iron (Fe_2O_3), calcium (CaO), and magnesium (MgO), along with smaller amounts of other compounds. Fly ash is usually collected from the flue gases by electrostatic precipitators or bag filters.



Fig 3 Fly ash

Fly ash has a wide range of applications, including use as a cement replacement in concrete, as a soil stabilizer, in road construction, and in the manufacture of building materials such as bricks and blocks. It is also used in agriculture to improve soil fertility and as a component in animal feed. However, fly ash can contain trace amounts of heavy metals, so its disposal is regulated by environmental agencies to prevent contamination of soil and water resources.

II. LITERATURE REVIEW

Amarnath Yerramala studied the Properties of concrete with eggshell powder as cement replacement. This paper describes research into use of poultry waste in concrete through the development of concrete incorporating eggshell powder (ESP). Different ESP concretes were developed by replacing 5-15% of ESP for cement. The results indicated that ESP can successfully be used as partial replacement of cement in concrete production. The data presented cover strength development and transport properties. With respect to the results, at 5% ESP replacement the strengths were higher than control concrete and indicate that 5% ESP is an optimum content for maximum strength. In order to investigate properties of ESP concretes, five mixes were employed in this study. Several laboratory trial mixes were carried out with 300kg/m³ cement. Water to cementitious ratio, coarse and fine aggregate quantities was arrived for concretes to be tested from the trial mixes. In this study, Compressive loading tests on concretes were conducted on a compression testing machine of capacity 2000 KN. For the compressive strength test, a loading rate of 2.5 kN/s was applied as per IS: 516-1959 [10]. The test was conducted on 150mm cube specimens at 1, 7 and 28 days. Compressive

strength was higher than control concrete for 5 % ESP replacement at 7 and 28 days of curing ages. ESP replacements greater than 10 % had lower strength than control concrete. Addition of fly ash improved compressive strength of ESP concrete.

D.Gowsika et al experimentally investigated the Egg Shell Powder as Partial Replacement with Cement in Concrete. This paper reports the results of experiments evaluating the use of egg shell powder from egg production industry as partial replacement for ordinary Portland cement in cement mortar. The chemical composition of the egg shell powder and compressive strength of the cement mortar was determined. The cement mortar of mix proportion 1:3 in which cement is partially replaced with egg shell powder as 5%, 10%, 15%, 20%, 25%, 30% by weight of cement. The compressive strength was determined at curing ages 28 days. There was a sharp decrease in compressive strength beyond 5% egg shell powder substitution. The admixtures used are Saw Dust ash, Fly Ash and Micro silica to enhance the strength of the concrete mix with 5% egg shell powder as partial replacement for cement. In this direction, an experimental investigation of compressive strength, split tensile strength, and Flexural strength was undertaken to use egg shell powder and admixtures as partial replacement for cement in concrete.

Praveen Kumar R et al experimentally investigated the Partial Replacement of Cement with Egg Shell Powder. The aim of this study is to study the chemical composition of the egg shell to find its suitability of replacement in the concrete. To examine the feasibility of utilizing the egg shell and silica fume as cement replacement material. To study the strength parameters of the egg shell powder mixed specimens and to compare it with conventional specimens. The scope of the study is to cast the concrete specimens and conduct the compressive strength test, split tensile strength test and flexural strength test at 7th & 28th day, with the specified combinations of egg shell powder and compare it with the controlled concrete specimens. In this project M30 Concrete is designed for various combinations. A combination of Egg shell with silica fumes are used in different combinations to find the feasibility of using the Egg shells as an alternate to cement Egg shell powder replaces 10%, 20% and 30% in addition with the silica fume by 5%, 10%, 15% of weight of cement. Concrete is cast and Compressive test, Tensile and Flexural tests were carried out to find the best combination which results in optimum percentage of strength

T.KARUN KUMAR et.al conducted to study the properties of concrete containing copper slag as a partial replacement of fine aggregates in the concrete mix design. Various durability tests will be conducted on such concrete of M30 grade and M40 grade to know the compressive strength, split tensile strength, flexural strength by varying proportions of copper slag (CS) with fine aggregates by 0%, 5%, 10%, 15%, 20%, 25%, 30% and Egg shell powder (ESP) as cement by 0%, 5%, 10%, 15%, 20%, 25%, 30% by weight. The obtained results will be compared with the conventional concrete, there by knowing the changes in the properties of concrete containing copper slag as a partial replacement of fine aggregates.

G. Anisha studied Egg shell which is made of calcium is thrown away as a waste. When the calcium carbonate is heated a binding material called Calcium Oxide (Lime) is obtained. As lime is the major compound of Portland cement, eggshell powder can be used as partial replacement of fine aggregate. Fly Ash is one of the residues generated in the combustion of coal. Fly ash includes substantial amounts of Silicon dioxide (SiO₂) and Calcium Oxide (CaO). 75 million tons of fly ash which are rich in Silica is disposed to landfill as a waste annually in India. This project aims at examining the feasibility of eggshell powder as a partial replacement of fine aggregate and also to observe the effect of fly ash on the proposed concrete. In the present study, concrete cubes of grade M30 and M40 were prepared in the laboratory by replacing the fine aggregate with fly ash and egg shell powder at combined proportions of 0%, 7%, 14%, 21%, 28%, 35% & 42% by weight. Tests are conducted at 7 days and 28 days on concrete cubes, cylinders and flexural beams to study compressive strength, split tensile strength and flexural strength/ finally the results are compared with the normal conventional concrete and the effect of fly ash on it is studied.

Dhanalakshmi M et.al examine the carbon dioxide produced by cement industries causes environmental pollution and global warming. In 1000Kg of cement manufacturing processes approximately 900Kg of CO₂ is emitted. In order to reduce the impact of cement production on atmosphere, wastes by products are used as admixture in this study, so that environmental pollution and natural resources consumption is reduced. 75million tones of fly ash which are rich in silica are disposed to landfill as a waste annually in India. Egg shell powder which is rich in calcium is thrown away as a waste. In the present study, these two wastes are used as a partial replacement of cement and various properties like workability, compressive strength, and density were determined. Egg shell powder are varied upto 12.5% (0%, 2.5%, 5%, 7.5%, 10% and 12.5%) and fly ash is added to optimum egg shell powder content cement concrete from 0% to 30% (0%, 5%, 10%, 15%, 20%, 25% and 30%).

2.1 PROBLEM STATEMENTS

In India, waste disposal is one of the factors contributing the environmental problem and increasing dramatically year by year. According to Antara News (2011), In India, the egg consumption of the Indian people which is still low. In Indian the per capita egg consumption of the people was recorded at one egg per week while in Indian the per capita egg consumption was noted at three per day.

The study aims to explore the optimal mixture ratio for incorporating fly ash into eggshell concrete, focusing on achieving the highest strength-to-weight ratio in the sample specimens. Additionally, the research seeks to assess the viability of partially replacing concrete materials by evaluating both compressive and split tensile strengths. By analyzing the test outcomes, the study aims to propose the most suitable fly ash addition level that aligns with the desired concrete performance. Furthermore, the investigation aims to delve into the strength characteristics of the specimens containing fly ash, facilitating a comprehensive comparison with conventional concrete specimens.

2.2 SCOPE OF STUDY

An investigation the effect on the performance of the eggshell powder as in additive in concrete mixed. In eggshell concrete production, Portland composite cement, coarse aggregate, fine aggregate, water, and eggshell. Fly ash can be used as a partial replacement for Portland cement in concrete production, which reduces the amount of cement needed and thus lowers the cost and carbon footprint of concrete. Additionally, concrete made with fly ash is stronger, more durable, and less permeable than concrete made without it. Fly ash can be used to stabilize soil, which makes it more resistant to erosion and better suited for construction. Fly ash can also neutralize acidic soils, which can improve crop yields. The experiments will use to investigate are compressive strength, tensile test and flexural test. Thus, the amount of eggshell waste can be used as additive in concrete production. Besides that, it also will decrease the construction cost and landfill. Some test and experiments are proposed to be performing to determine the performance concrete strength and eggshell ash. These eggshells must be grinded into fine powder. This test will be tested at 7 days, 14 day and 28 days to get the strength.

III. METHODOLOGY

3.1 MATERIALS USED

3.1.1 CEMENT

a) **Portland Pozzolana Cement:**
We Used UltraTech PPC Cement (The Engineer's Choice)

3.1.2 SAND (Fine Aggregate)

The sand most of which pass through 4.75mm IS sieve are termed as fine sand or fine We used locally available Manjra River Sand which pass through 4.75mm IS sieve

3.1.3 COARSE AGGREGATE:

The aggregate, which retains above 4.75 mm IS sieve are termed as coarse Aggregate.
The crushed stone or metal, called khadi or gitti comes under coarse aggregate. We used 12.5 mm to 15mm size Angular Shape Coarse Aggregate.

3.2 MIX DESIGN PROCEDURE

To explore the use of business squanders as a swap for bond in cement and impact of this on the Strength of cements made with completely totally unique concrete supplanting levels with admixtures. Common concrete of 53grade affirming to IS 12269- 1987 was utilized amid this investigation. Stream sand affirming to reviewing zone III of Is 383-1970 was utilized as a fine blend. Well hierarchic coarse blend going through 20mm sifter for every IS 383-1970 was utilized. Well hierarchic coarse blend going through 20mm strainer for each IS 383-1970 was utilized. Egg shell acquired from local exchange. It grained and sieved to the required size before utilized as a part of solid blend. Saw earth was acquired from sawmill and saw soil slag was gotten by burning strategy and sieved before utilized. Fiery debris was gathered from Salem process, Salem, Tamilnadu and sieved before utilized affirming to IS 3812 (section I). Little oxide was a side-effect of the part and Ferro-silicon creation. Transferrable water was utilized inside the examinations for each blend and cementing capacities.

3. 3 MIX DESIGN

Mix Calculation

- i. Cement =442.85 Kg/m3
- ii. FA =796.96 Kg/m3
- iii. CA =992.59 Kg/m3
- iv. Water = 186 Kg/m3
- v. W/C ratio=0.42

Table No: 1 Mix proportion for 1 m3:

water (Kg/m3)	Cement (Kg/m3)	Sand (FA) (Kg/m3)	Coarse aggregate(Kg/m3)
185.99	442.85	796.96	992.59
0.42	1	1.79	2.24

IV. RESULT AND DISCUSSION

The experimental investigation of M30 grade concrete centered on the partial substitution of cement with eggshell powder and fly ash. The investigation included exhaustive testing, including assessments of compressive and flexural strength. These experiments were essential for evaluating the mechanical properties and performance of concrete mixtures containing variable amounts of eggshell powder and fly ash. The outcomes of these tests cast light on the potential improvements in concrete's strength, durability, and overall quality that could result from the addition of these supplementary materials. In the subsequent discussion, the implications of the findings are analysed in terms of the practical applicability and sustainability of using eggshell powder and fly ash in the production of concrete, thereby contributing to the ongoing discourse on innovative and environmentally friendly construction materials.



Fig. 4 casting Mould

4.1 QUANTITIES AND ESTIMATION

- **CUBE**

Table No. 2 Total cost of materials

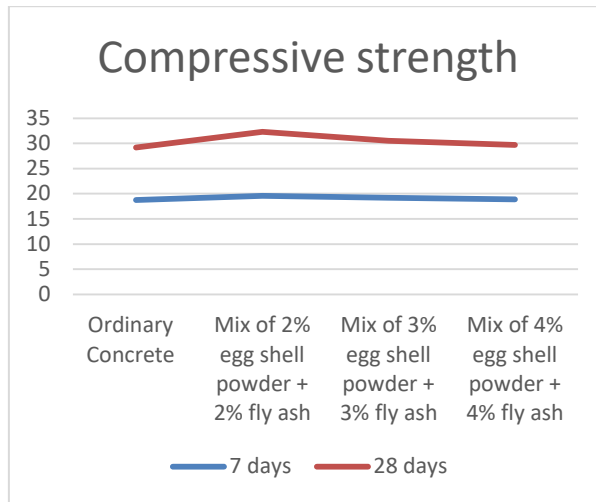
Total material	Cost per unit	Total cost per material
Cement: kg	112.542876	821.563
Sand: kg	209.70432	479.3242
Coarse aggregate: kg	261.484056	435.8068
Water: kg	48.956076	0.489561
Fly ash: kg	3.45692772	6.913855
Eggshell powder: kg	3.45692772	172.8464
	Total cost in rupees	1916.944

4.2 COMPRESSIVE STRENGTH TEST

Compressive strength is a critical property of materials that measures their ability to withstand axial loads without undergoing deformation or failure. In the context of concrete or construction materials, compressive strength is a key factor in determining the structural integrity and load-bearing capacity of the material. The compressive strength test involves applying a gradually increasing load to a specimen until it fractures or fails. The maximum load that the specimen can bear before failure is recorded as the compressive strength. In addition to the materials mentioned earlier, fly ash can be included as a supplementary cementitious material. Fly ash is a fine powder that is a byproduct of burning pulverized coal in power plants. It can be used to partially replace cement in concrete mixes, offering benefits such as improved workability, durability, and reduced heat of hydration.



Fig 5 Testing Cube on CTM



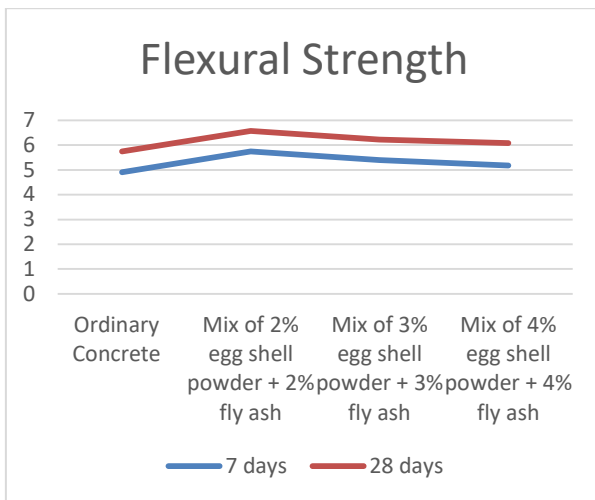
Graph 1 Compressive Strength

4.3 FLEXURAL TEST

The flexural test, also known as the three-point bend test, is a mechanical testing method used to determine the flexural strength and modulus of elasticity of a material. In this modified procedure, we will incorporate eggshell powder and fly ash as reinforcing additives to study their effects on the mechanical properties of a composite material.



Fig 6 Flexural Testing Machine



Graph 2 Flexural Strength

4.4 TENSILE STRENGTH TEST

The Tensile Strength Test is a fundamental mechanical test used to determine the mechanical behaviour of materials under tensile loading conditions. It serves as a vital parameter in assessing the ability of a material to withstand axial forces without undergoing permanent deformation or fracture. Tensile strength, often referred to as ultimate tensile strength (UTS), signifies the maximum load a material can endure before breaking. This test aids engineers, scientists, and manufacturers in selecting appropriate materials for various applications, ensuring structural integrity, and refining production processes. By subjecting a specimen to gradually increasing tensile forces while measuring its corresponding deformation, the tensile strength test provides crucial insights into a material's durability and performance characteristics.

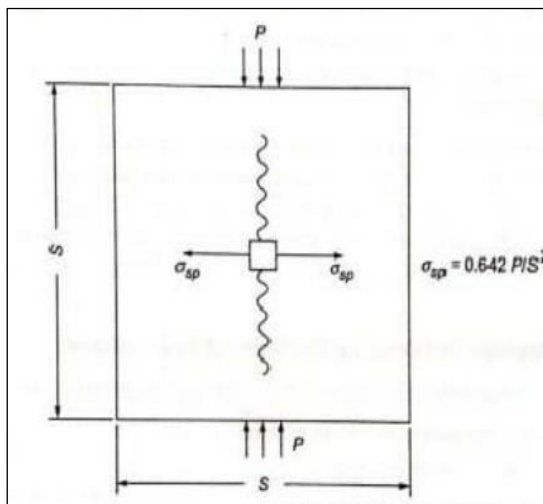
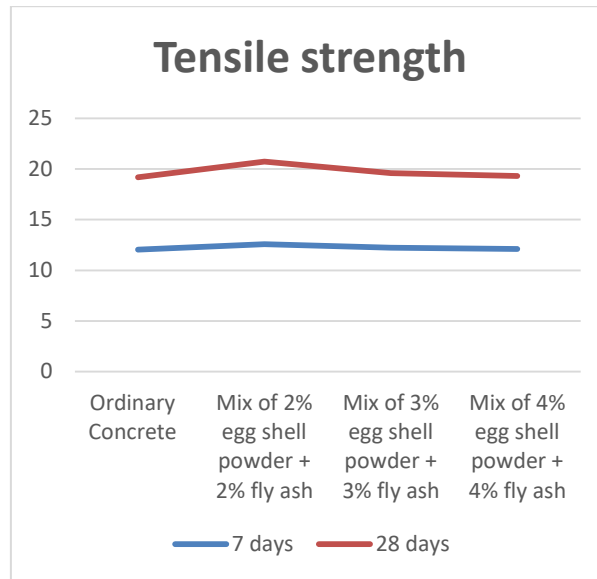


Fig 7 Tensile strength



Graph 3 Tensile strength

V. CONCLUSION

1. The compressive strength at the age of 7 days

- Compressive strength of ordinary concrete is found to be 18.79 N/mm² by using concrete mix having w/c ratio 0.42 and aggregate cement ratio 4.04.
- The compressive strength of mix of 2% egg shell powder + 2% fly ash found to be 19.61 N/mm². The compressive strength of mix concrete is increased by 4.36% as compare to ordinary concrete by using concrete mix having w/c ratio 0.42 and aggregate cement ratio 4.04.
- The compressive strength of mix of 3% egg shell powder + 3% fly ash found to be 19.2 N/mm². The compressive strength of mix concrete is increased by 2.18% as compare to ordinary concrete by using concrete mix having w/c ratio 0.42 and aggregate cement ratio 4.04.
- The compressive strength of mix of 4% egg shell powder + 4% fly ash found to be 18.89 N/mm². The compressive strength of mix concrete is increased by 0.532% as compare to ordinary concrete by using concrete mix having w/c ratio 0.42 and aggregate cement ratio 4.04.

2. The compressive strength at the age of 28 days

- Compressive strength of ordinary concrete is found to be 29.22 N/mm² by using concrete mix having w/c ratio 0.42 and aggregate cement ratio 4.04.
- The compressive strength of mix of 2% egg shell powder + 2% fly ash found to be 32.3 N/mm². The compressive strength of mix concrete is increased by 10.54% as compare to ordinary concrete by using concrete mix having w/c ratio 0.42 and aggregate cement ratio 4.04.
- The compressive strength of mix of 3% egg shell powder + 3% fly ash found to be 30.51 N/mm². The compressive strength of mix concrete is increased by 4.41% as compare to ordinary concrete by using concrete mix having w/c ratio 0.42 and aggregate cement ratio 4.04.
- The compressive strength of mix of 4% egg shell powder + 4% fly ash found to be 29.72 N/mm². The compressive strength of mix concrete is increased by 1.711% as compare to ordinary concrete by using concrete mix having w/c ratio 0.42 and aggregate cement ratio 4.04.

3. The flexural strength at the age of 7 days

- a. flexural strength of ordinary concrete is found to be 4.9086 N/mm^2 by using concrete mix having w/c ratio 0.42 and aggregate cement ratio 4.04.
- b. The flexural strength of mix of 2% egg shell powder + 2% fly ash found to be 5.7383 N/mm^2 . The flexural strength of mix concrete is increased by 16.9 % as compare to ordinary concrete by using concrete mix having w/c ratio 0.42 and aggregate cement ratio 4.04.
- c. The flexural strength of mix of 3% egg shell powder + 3% fly ash found to be 5.3926 N/mm^2 . The flexural strength of mix concrete is increased by 9.86 % as compare to ordinary concrete by using concrete mix having w/c ratio 0.42 and aggregate cement ratio 4.04.
- d. The flexural strength of mix of 4% egg shell powder + 4% fly ash found to be 5.18 N/mm^2 . The flexural strength of mix concrete is increased by 5.52 % as compare to ordinary concrete by using concrete mix having w/c ratio 0.42 and aggregate cement ratio 4.04.

4. The flexural strength at the age of 28 days

- a. flexural strength of ordinary concrete is found to be 5.7383 N/mm^2 by using concrete mix having w/c ratio 0.42 and aggregate cement ratio 4.04.
- b. The flexural strength of mix of 2% egg shell powder + 2% fly ash found to be 6.5679 N/mm^2 . The flexural strength of mix concrete is increased by 14.45% as compare to ordinary concrete by using concrete mix having w/c ratio 0.42 and aggregate cement ratio 4.04.
- c. The flexural strength of mix of 3% egg shell powder + 3% fly ash found to be 6.222 N/mm^2 . The flexural strength of mix concrete is increased by 8.42% as compare to ordinary concrete by using concrete mix having w/c ratio 0.42 and aggregate cement ratio 4.04.
- d. The flexural strength of mix of 4% egg shell powder + 4% fly ash found to be 6.08 N/mm^2 . The flexural strength of mix concrete is increased by 5.95% as compare to ordinary concrete by using concrete mix having w/c ratio 0.42 and aggregate cement ratio 4.04.

5. The Tensile Strength at the age of 7 days

- a. Tensile strength of ordinary concrete is found to be 12.06 N/mm^2 by using concrete mix having w/c ratio 0.42 and aggregate cement ratio 4.04.
- b. The tensile strength of mix of 2% egg shell powder + 2% fly ash found to be 12.59 N/mm^2 . The tensile strength of mix concrete is increased by 4.39 % as compare to ordinary concrete by using concrete mix having w/c ratio 0.42 and aggregate cement ratio 4.04.
- c. The tensile strength of mix of 3% egg shell powder + 3% fly ash found to be 12.24 N/mm^2 . The tensile strength of mix concrete is increased by 1.49 % as compare to ordinary concrete by using concrete mix having w/c ratio 0.42 and aggregate cement ratio 4.04.
- d. The tensile strength of mix of 4% egg shell powder + 4% fly ash found to be 12.12 N/mm^2 . The tensile strength of mix concrete is increased by 0.49 % as compare to ordinary concrete by using concrete mix having w/c ratio 0.42 and aggregate cement ratio 4.04.

6. The tensile strength at the age of 28 days

- a. tensile strength of ordinary concrete is found to be 19.19 N/mm^2 by using concrete mix having w/c ratio 0.42 and aggregate cement ratio 4.04.
- b. The tensile strength of mix of 2% egg shell powder + 2% fly ash found to be 20.73 N/mm^2 . The tensile strength of mix concrete is increased by 7.42% as compare to ordinary concrete by using concrete mix having w/c ratio 0.42 and aggregate cement ratio 4.04.
- c. The tensile strength of mix of 3% egg shell powder + 3% fly ash found to be 19.58 N/mm^2 . The tensile strength of mix concrete is increased by 2.03% as compare to ordinary concrete by using concrete mix having w/c ratio 0.42 and aggregate cement ratio 4.04.
- d. The tensile strength of mix of 4% egg shell powder + 4% fly ash found to be 19.31 N/mm^2 . The tensile strength of mix concrete is increased by 0.625% as compare to ordinary concrete by using concrete mix having w/c ratio 0.42 and aggregate cement ratio 4.04.

As we can see that when the percentage of mix of egg shell powder and fly ash increases then strength decreases.

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