PROPERTIES OF CONCRETE WITH EGG SHELL POWDER AND SILICA FUME AS CONCRETE REPLACEMENT

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Abstract: **Concrete is a material that is being put to extensive use all over the world in the construction of the vast majority of buildings, bridges, and other kinds of construction. At the moment, the whole building and construction sector is actively engaged in the hunt for an acceptable and practical product that has not yet been used. If it were to be commercially successful, this product would reduce the amount of cement that is employed, which would, in turn, result in a reduction in the cost of building structures overall. This kind of alternative material includes things like egg shell powder and silica fume, for example. Because egg shells have historically been considered worthless and have finally been shown to have detrimental impacts on the environment, the great majority of egg shells that have been thrown away are able to be disposed of in landfills without first needing to undergo any form of pretreatment. Because of this, a suitable alternative is required in order to deal with the waste in an ecologically friendly way. The goal of this investigation research is to determine whether or noteggshell powder and silica fume might be successfully included in cement in a limited capacity as additional components. In addition to the substitution of eggshell powder for 2.5 percent, 5 percent, and 7.5 percent of the total weight of cement, silica fume is being replaced by egg shell powder in the amounts of 5 percent, 10 percent, and 15 percent of the overall weight. The strength of concrete made from eggshells was evaluated in a number of different ways, including split tensile strength, compressive strength, and flexural strength. The outcomes of these examinations are shown in the table that is located below. It was found that adding eggshell powder and silica fume to the concrete caused the strength of the concrete to rise, and in the end, a comparison was made between the increased strengths of eggshell and silica fume in concrete.**

***Keywords*:Eggshell,Silicafume,Cement,Compressivestrength,Splittensiletest,Flexuralstrengthtest.**

I INTRODUCTION

As reported by the statistics section of the Food and Agriculture Organization (FAO), India is presently the third greatest producer of eggs and the fourth largest producer of broilers in the world. As a result, India is fast becoming the world's second-most significant market for poultry as a result of its yearly growth rate of more than 14 percent. This country's egg production is estimated to be 61 million tonnes per year, accounting for 3.6 percent of global egg output. Egg production typically increases by 5 to 8 percent per year on average. According to the estimates provided by the Ministry of Agriculture, India is the sixth largest producer of broilers in the world, with an annual output of approximately 2.39 million tonnes of broiler meat. This information comes from the country's position as the sixth largest producer of broilers in the world. It is believed that the worth of the poultry industry as a whole is somewhere in the neighbourhood of 350 billion rupees. The manufacturing sector of the food processing industry is responsible for the production of all of the approximately 250,000 metric tonnes of egg shell scrap that are generated annually. It was predicted that egg mainframes and manufacturers in India must be willing to generate between 10,000 and 11,000 tonnes of egg shell each year, as stated in the release. The great majority of used egg shells are thrown away in landfills without going through any form of processing since it is customarily believed that this waste is useless and eventually causes significant environmental problems. As a direct consequence of this, an acceptable replacement is required in order to complete the process. 2-4. The operation of waste includes both the biodegradation of waste into useable energy as well as the process of wastes themselves being decomposed. In today's society, a significant amount of focus has been put on the actual treatment and management of biowaste from the perspectives of both the environment and the economy. 5. The removal of waste from eggshells often does not result in an increase in income but rather in an increase in expenses (6, 7). Because of this, having the least amount of money necessary to throw away is the outcome that is sought after the most. Some of the choices that may still be made need to be evaluated with a very critical eye, and the method of reprocessing that requires the greatest amount of money and the longest amount of time must be taken into consideration. The results of the research and the report indicate that eggshells contain 2.2 milligrammes of calcium in the form of calcium carbonate (CaCO3), which accounts for 94 percent of the total. Phosphorous and magnesium are represented by the remaining masses in the diagram, together with negligible amounts of sodium, potassium, zinc, manganese, iron, and copper. Phosphorous and magnesium account for a large portion of the total mass.

II PROPERTIES AND METHODOLOGY

This experimental program involves all the preliminary tests which are carried out in the material and theconcrete.Thesetestshelpustoknowthepropertiesofthematerialbeingusedfortheprocessofconcretingandinthederivation ofthemix ratio.

CEMENT When it comes to the production of concrete, cement is an essential ingredient that simply must be accounted for in the process. Cement is a well-known building material that has consistently been an essential factor over the course of the construction industry's history. Cement comes in a wide range of forms, and each of those forms has a particular use due to the one-of-a-kind characteristics it has, such as the colour and the structure of the cement. Cement may be acquired from a number of different vendors on the market.

Despite accounting for only about 10% of the total volume of the various concrete mixes, cement is the only component of concrete that is methodically controlled. This is due to the fact that cement is the only component of concrete that is a binding agent. The cement constituting the necessary medium is what's known as the active component. The physical features of cement, as well as its chemical components, are broken down into detail in the tables that are labelled "Table 1" and "Table 2," respectively.

Table-1:Physicalpropertiesofcement

Material Property	Test Value
Specific Gravity of Cement	3.14
Fineness of Cement	3%
Consistency of Cement	34%
Initial Setting Time of Cement	35 minutes

Table-2:ChemicalcompositionofOPC

Oxide contents	Percentage (%)
CaO	60-67
SiO_2	17-25
Al_2O_3	3-8
Fe_2O_3	0.5-6.0
MgO	0.1-4.0
K_2O, Na_2O	0.4-1.3
SO_3	1.3-3.0

EggshellDue to the fact that there is a potential for recovery, the eggshell wastelands that are produced by the poultry processing industry have garnered a lot of interest in recent times. Egg shells are wasted in large quantities as a byproduct of several businesses, including the food processing industry, the egg cracking industry, and the shading industry. It is possible to recycle these shells. The food and beverage industry has a responsibility to do research in order to come up with an alternate method for processing and making use of used egg shells in a way that is less damaging to the natural environment. It is essential to look for a solution that will only cost a small amount of money. In the majority of circumstances, the elimination of discarded egg shells does not contribute to the creation of income but rather results in expenses. For this reason, selecting a technique of removal that would result in the fewest financial expenses is of the utmost significance. Some of the options that may still be chosen need to be considered very carefully, and consideration should be given to selecting the recycling approach that provides the most potential benefit. The components that make up egg shells are broken down into their individual parts in the following table, which you may find below.

Table-3:Chemicalcompositionoftheeggshellpower

Oxide contents	Percentage (%)
Cao	50.7
SiO_2	0.09
Al_2O_3	0.03
MgO	0.01
Fe_2O_3	0.02
Na_2O	0.19
P_2O_5	0.24
SrO	0.13
NiO	0.001
SO_3	0.57
Cl	0.219

Fig 1. Egg shell

SilicaFumeAccording to the findings of the calculation involving silica fume, the toughness of concrete, in addition to its compressive strength, has the potential to be increased. In addition, it has been shown that the presence of this additive is crucial in snowballing the electrical resistivity and the durability of concrete when subjected to demanding situations such as environments that include chloride. Pozzolanic materials may generally establish an association with hydrated calcium hydroxide, which is the first step in the creation of hydrated calcium silicate. This process is initiated by the pozzolanic material. The fundamental ingredient responsible for the benefits given by hydrated cement pastes is hydrated calcium silicate. Hydrated cement paste has several applications. Additionally, as a consequence of the very minute components of the admixture filling the gaps that were left in the mixture, the bulk density of the concrete will rise, which will lead to an improved use of the material. The decrease in porosity that takes place in the evolution zone between the matrix and the aggregate in regenerated concrete as a result of the addition of silica fume to concrete is one of the side effects of this process. In addition to this, this results in the construction of the microstructure that is required for the formation of a robust transition zone. As a consequence of this, egg shell powder and silica fume are combined and added to the cement in order to recreate the same level of strength and durability that is normally associated with mortar cubes. In the mixture, the quantity of silica fume is reduced by five percent, ten percent, and fifteen percent, respectively, according to the weight of the cement. The numerous physical and chemical features of silica fume are outlined in Tables 4 and 5, respectively.

Table-4:Chemicalcompositionofsilicafume

Oxide content	Percentage (%)
SiO_2	90.21
Cao	0.30
Fe_2O_3	0.15
Al_2O_3	0.12
MgO	0.73
SO_3	0.01
Na_2O	0.46
K_2O	1.51

Table-5:PhysicalpropertiesofSilica FumeandEggshell

S.No.	Materials	SpecificGravity
1	Silicafume	2.24
2	EggShell	1.01

MixCombinations

The following mix combinations as per IS code 10262 - 2009 by trial and error combinations are to becasted and tested by replacing egg shell powder up to 10, 20, 30 %and silica fume up to 5,10,15 % byweight ofcement.Thefollowings Tables-6 and 7showthemix combinationsofmortarcubes.

Table-6:Mixproportions

Water	Cement	Fine aggregate	Coarse aggregate
191.58	383.16	663.765	1129.702
0.5	1	1.73	2.94

III RESULTSANDDISCUSSION

The objectives of all the tests are to find the mechanical properties the concrete (Grade M30) with EggShell Powder and Silica fume as the replacement of cement. The strength properties such as compressivestrength and split tensile strength test results are presented in the tabular form and also in graphical formfor better understanding.Theresultsareanalyzed,comparedbet weenthevariousmixproportions.

CompressiveStrength

The compressive strength of the concrete is the characteristic that is examined the most, and it is much more important in high performance concrete. This is because the compressive strength of concrete is directly related to how well it can hold its shape under pressure. A uniaxial compression test is done on the specimen (cubes measuring 150 mm on each side) on a number of different days in order to measure the increase in compressive strength that occurs as a consequence of curing. This allows the increase in compressive strength to be evaluated. When compared with controlled concrete cubes, it is clear that increasing the percentage of cement that is substituted with

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egg shell powder to a maximum of 15 percent results in an increase in compressive strength. This increase can be seen even when the percentage of cement that is substituted is kept at the same level. Combining egg shell powder with silica fume in a proportion of up to 7.5 percent of the cement's total weight may also result in an increase in the material's compressive strength. This can be accomplished by adding the powder to the fume. The typical egg shell mixture is all that is required for the flexural and split tensile tests to be carried out. This is due to the fact that the incorporation of silica fumes does not result in any noticeable changes to the concrete's strength. Figure 2 depicts the results of a comparison of the compressive strength of standard mix to every other eggshell and silica fume concrete mix with varying percent.

Although some strikes occur at an angle to the load that is being applied, the vast majority of blows that originate as a consequence of uniaxial compression are generally perpendicular to the force that is being applied. Similar cracks are formed when there is a localised tensile stress in comparison to the compressive load, and motivated cracks take place as a result of the collapse that is brought on by the formation of shear planes. Similar cracks can also be formed when there is a difference in the compressive load and the tensile stress. It is essential to emphasise the fact that the fractures have grown in two planes that are analogous to the load, and as a direct consequence of this, the specimen has broken up into column-type trashes as a result of these fractures.

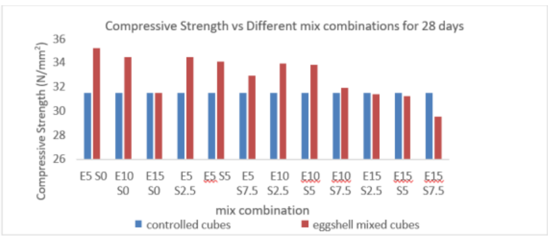

Fig 2. Compressive strength of concrete

SplitTensileStrength

In order to conduct the split tensile strength test, cylindrical specimens of 150 millimetres in diameter and 300 millimetres in length were used. The load was progressively increased until the specimen failed, which was indicated by a fracture in a plane that encompassed the vertical diameter of the specimen. This was done after arranging the cylindrical specimen such that its axis was horizontal with regard to the platens of the testing machine. The results of split tensile strength tests were obtained for all various types of specimens by administering split tensile tests, and the results were reported after the tests were completed. Figure 3 illustrates the findings of a study that compared the strengths of conventional mix to those of all other eggshell powder and silica fume concrete mixes with varying percentages.

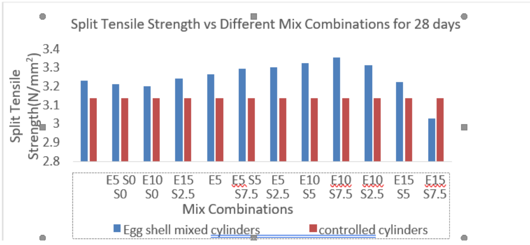

Fig 3. Tensile strength of concrete

FlexuralStrengthTest

A concrete beam of a suitable size that is loaded in a manner that involves two points is supported by steel rollers in a manner that is positioned in such a way that either end of the beam. The Indian standards are consulted as a source of information for the specifics of the exam. To enable two-point loading, a constant bending moment is created in the gap between the top roller bearings. This moment is applied to the bearing assembly's top. As a consequence of this, there is a consistent circulation of stress throughout the vertical parts of the triangle. This stress flows from compression above the neutral axis at the intermediate height to tension below the neutral axis. The load, together with any associated rebounds, was recorded all the way up until the point of failure. Each group had three beams checked, and the value that is being reported is the average of those beams. The computation that was used in order to determine the flexural strength is as follows. The following is the formula that should be used to calculate flexural strength: PL is calculated by dividing the distance between the bottom supporting rollers by the beam's width and depth. This distance is denoted by L, and b and d represent the width and depth of the beam, respectively.

Figure 4 illustrates the findings of a study that compared the strengths of conventional mix with those of all other eggshell and silica fume concrete mixes with varied percentages.

When measured against controlled concrete beams, the flexural strength of concrete that incorporates egg shell powder as a replacement for up to 15 percent of the cement shows a considerable increase. This improvement may be attributed to the concrete's increased porosity. One may reach the conclusion that it is appropriate for use in practical applications on account of the fact that it generates less deflection in the beam.

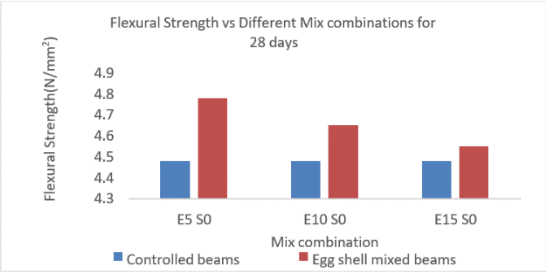

Fig 4 flexural strength of concrete

IV CONCLUSION

- Constructing concrete cubes and prisms served as the basis for the extensive testing that was carried out to evaluate the practicability of using egg shell powder as an alternative to cement. These examinations were carried out for the purpose of accumulating data. Additionally, to evaluate the influence that the incorporation of silica fume into the cement will have on the product. Egg shell powder is produced in a range of various combinations without the use of any silica fumes in the manufacturing process. On the basis of the data gathered from the experimental study, one may draw the following deductions and conclusions:
- It is possible that the compressive strength of concrete produced by employing eggshell powder as a cement replacement material will increase by up to 15 percent if silica fume is not added to the mix.
- The replacement of the egg shell powder is the only alternative that is substantial enough to produce the necessary degree of improved strength. The addition of silica fume makes the material stronger as well, but from a cost standpoint, changing the egg shell powder is the only option that works.
- The split tensile strength of concrete decreases when egg shell powder is added to it as a component of the concrete mix. The culprit in this case is egg shell powder. The quality of this may potentially be improved if reinforcement was used in combination with the concrete.
- The flexural strength of eggshell concrete may be improved by adding eggshell powder in concentrations of up to 15 percent. This results in an improvement in the overall strength of the egg shell concrete.

The powder made from egg shells that is spread on the surface of the mixture has the potential to hasten the carbonation process while at the same time lowering the mixture's permeability over the course of time. Because of this, it is essential to carry out an extensive study on the process of carbonation that takes place in the combination.

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