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Study of Effect of Egg Shell Powder and Silica Fumes on Properties of Concrete

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ABSTRACT: Concrete is the most widely used man made materials in construction industry, but just like a coin it has two faces, no doubt it is the most useful thing in construction industry but it has a negative side also. Cement used in concrete produces carbon dioxide that is harming the environment, so now the researchers in the field of Civil Engineering are moving their interest towards the use of materials that can cause least harm to the environment. A step taken in this direction is the use of waste products along with or in replacement of cement. Many of these materials are already in use, like silica fume, fly ash etc.

In this study, egg shell powder was used as the replacement of cement in concrete. Along with egg shell powder, silica fume was also used to check the combined effect of both the materials. Egg shell is a waste product from food and poultry industry. India is the 2nd largest producer of egg shell waste. Egg shell waste is responsible for land degradation and cause serious health issues, but also it is a good source of lime CaO, which is an important constituent in cement concrete. It contains more than 50% of lime, also Silica fume is a silica rich material that provides a great strength to the concrete.

Objectives: objective of this study is to find an optimum replacement of ESP along with silica fume in concrete. **Method and Analysis:** Various experiments performed to test the workability, compressive strength, split tensile strength and flexure strength of the concrete containing ESP and Silica fume. Proportion of ESP in different mixes was selected on the basis of available literature. The Silica Fume Content was kept Constant at 15 % cement replacement. ESP content was used at various proportions such as 0, 2.5, 5, 7.5 and 10%. **Findings:** The optimum compressive and flexure strength were found at 2.5 % ESP along with 15% silica fume. Flexural strength increases initially as the replacement of cement with ESP at 2.5 % and then start decreasing.

KEYWORDS: Silica Fumes, Egg Shell Powder, Compressive Strength, Flexural strength.

I. INTRODUCTION

Concrete is the most widely used man made material used in construction industry and is the second after water as the most utilized thing on the Earth. It is nearly impossible to think of construction industry without concrete. In simple words it is defined as a mixture of four ingredients as coarse aggregates that form the largest proportion of the mix, fine aggregates such as sand that act as filler material in the voids, binding material such as lime or Portland cement that binds these material together and water that reacts with binding material. The mixing of these four materials gives us a paste that is called as matrix. Based on its compressive strength, the concrete can be graded as M10, M15 and M20 and so on, where M is denomination for mix and 10, 15, 20 is the characteristic compressive strength of concrete after 28 days. The emerging trends in engineering divert the interest of researchers towards the usage of waste material in concrete. Many of the waste materials are already in use such as fly ash, rice husk ash, silica fume and blast furnace slag. Eggshell Powder (ESP) has not being in common use as replacement of cement, it is a waste product from poultry and food industry, a rich source of lime can be used in concrete. It is a waste material from poultry and food industry. It is a calcium rich material and has the chemical composition nearly similar to that of lime stone. So use of egg shell waste instead of natural lime stone to replace cement in concrete can have benefits like minimizing use of cement, conserving natural lime and utilizing waste material. M25 grade of concrete has been taken for the study. The cement content in the concrete was replaced by 2.5%, 5%, 7.5% and 10 % by weight of cement. Also silica fume was added in replacement of cement at a fixed proportion of 15%. The tests were performed on concrete specimens to check their compressive, split tensile and flexure strengths.

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II. OBJECTIVE

The objective of this study is to find an optimum replacement of Cement by Eggshell Powder along with silica fume in concrete.

III. MATERIALS AND METHODOLOGY

M25 grade of concrete has been taken for the study Egg shell was collected from the local vendors and restaurants. It is a waste product so available at free of cost. It was firstly washed in water and then cleaned with hand to remove the internal organic layer. It was then oven dried at temperature of 100 -110 degree Celsius of temperature for 24 hours to remove the moisture. After removal of moisture, it was then grounded to fineness of cement. The grounded particles are then sieved through IS Sieve of 90µm.Silica fume which is the second additive is a by-product from the factories producing silicious materials such as glass industry. Silica fume was available from KGR Agro, Ludhaiana.

TABLE 1: Percentage reinforcement of cement by ESP and Silica fumes

S. No.	Concrete Name	Silica Fumes (%)	ESP (%)
1	M1	0	0
2	M2	15	0
3	M3	15	2.5
4	M4	15	5
5	M5	15	7.5
6	M6	15	10

TABLE 2: Physical properties of various additives

Physical Properties	Values
Specific Gravity of ESP	1.93
Colour of ESP	White
Particle Size (micron) of ESP	< 90
Percentage of ESP	0.25,5,7.5,10
Specific Gravity of Silica Fumes	2.48
Percentage of Silica Fumes	15

In this study, along with basic ingredients of concrete, Egg shell powder and silica fume has been used. The tests were performed on prepared concrete specimens to check their compressive, split tensile and flexure strengths.

IV. RESULTS AND DISCUSSION

The general properties of Different Component of Concrete are determined as stated.

TABLE 3: General properties of Ordinary Portland Cement

Properties	Value
Specific Gravity	3.16
Standard consistency, (%)	33.9
Initial setting time,(minutes)	36
Final setting time, (minutes)	490
Compressive Strength (N/mm^2) 7 days 28 days	 31.1 43.9
Fineness (%)	3.75

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TABLE 4: General properties of Fine Aggregates

Properties	Value
Type	Natual River Sand
Specific Gravity	2.61
Fineness Modulus	2.55
Grading Zone	III

TABLE 5: General Properties of Coarse Aggregates

Properties	Value
Maximum Size	20
Specific Gravity 10mm 20mm	 2.66 2.65
Total water absorption, (%)	1.76
Flakiness Index, (%)	8.8
Elongation Index,(%)	28.4
Aggregate Impact Value, (%)	17.2
Fineness Modulus 10mm 20mm	 6.11 6.99

A. Slump test result for different mix proportions

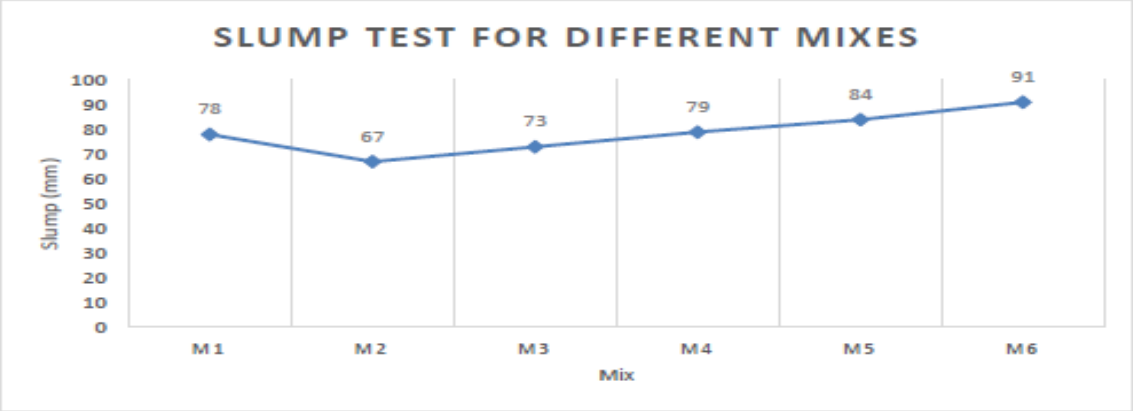

Fig 1: Variation in Slump Test values for different mixes

The results of slump test shows that there is firstly decrease in slump on addition of silica fume. Further on adding ESP, the slump value increase. This shows that there is increase in workability of concrete on addition of ESP. The graph shows the variation of slump for different mixes.

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B. Compressive Strength Test

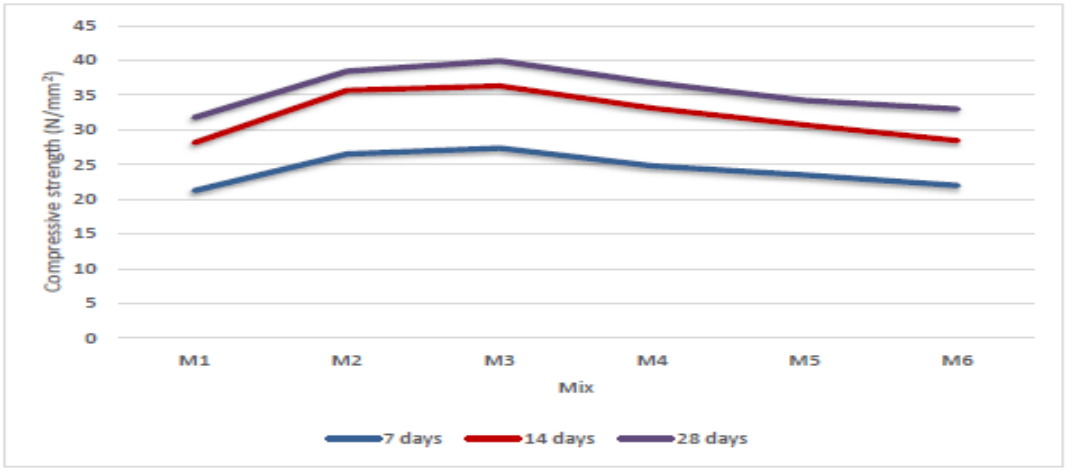

Fig 2: Comparison of Compressive strength of concrete at 7 days, 14 days and 28 days

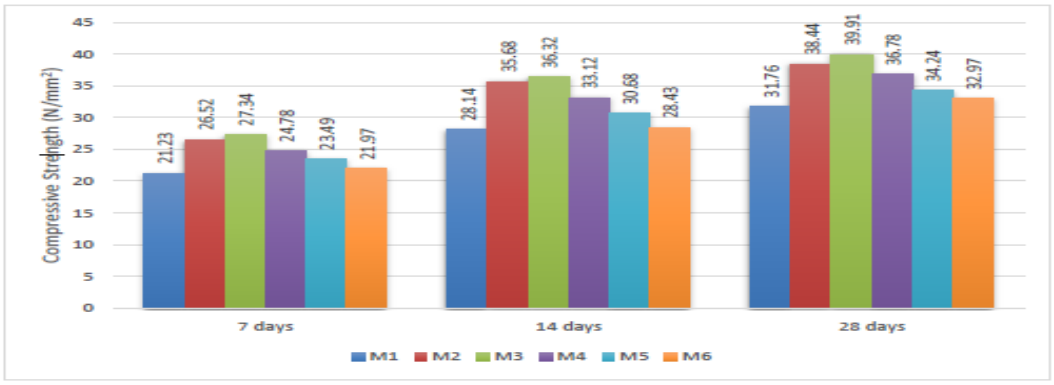

Fig 3: Bar chart showing variation of compressive strength of different mixes at 7 days, 14days and 28 days

From the graphs, it is clearly observed that the compressive strength firstly increased and then start decreasing. On addition of silica fume only there is a great increase in strength and it keep on increasing up to 2.5% replacement by ESP. The concrete attains strength more than 25N/mm2 after 7 days. The maximum strength attained by concrete was 39.91N/mm2 at 2.5% ESP and 15 % Silica fume after 28 days. There is nearly 25% increase in strength of M3 mix as compared with M1 mix. Further increase in ESP content above 2.5% shows decrease in strength. There is also a great increase in strength after adding silica fume only. So, ESP along with silica fume should be avoided for higher percentage of ESP. The optimum value of ESP in combination with Silica fume is found as 2.5%.

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C. Split Tensile Strength

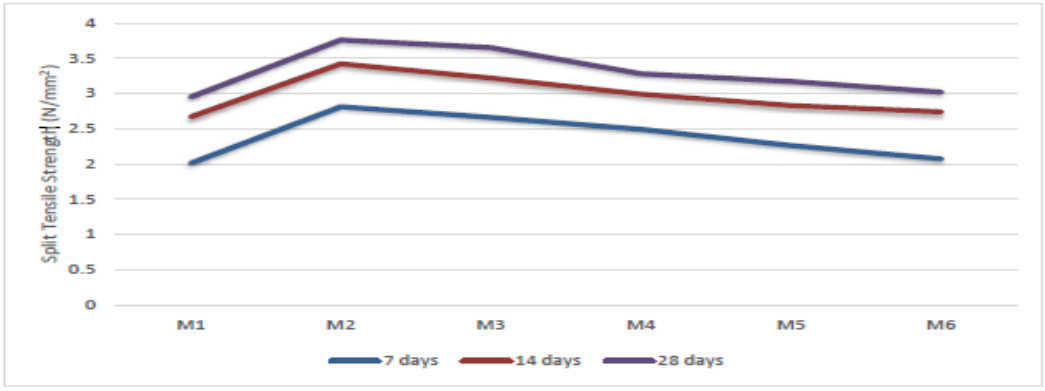

Fig 4: Comparison of Split Tensile strength of concrete at 7 days, 14 days and 28 days

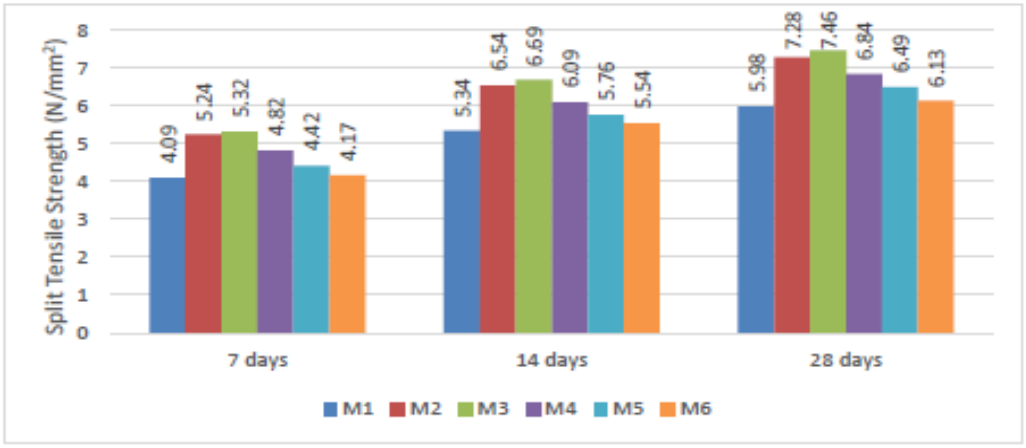

Fig 5: Bar chart showing variation of Split Tensile strength of different mixes at 7 days, 14days and 28 days

From the above graphs, it is clear that the split tensile strength also shows the same pattern of variation as that of compressive strength. The maximum split tensile strength comes for M2. The results shows that the split tensile strength lies between 8-10 % of the compressive strength which is recommended. The result shows that addition of ESP along with silica fume decreases the split tensile strength of concrete

D. Flexure Strength

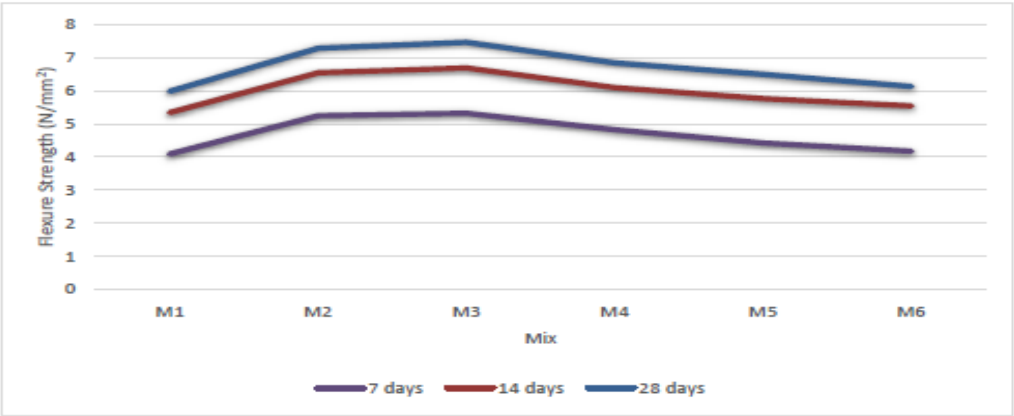

Fig 6: Comparison of Flexure strength of concrete at 7 days, 14 days and 28 days

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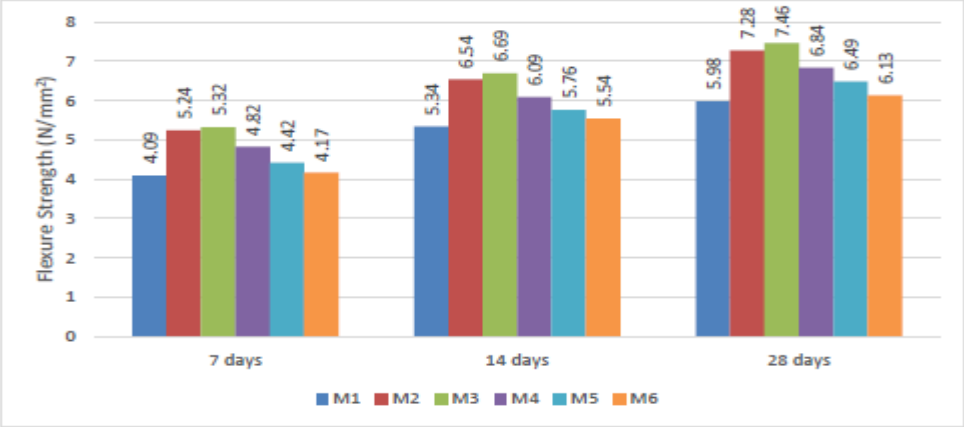

Fig 7: Bar chart showing variation of Flexure strength of different mixes at 7 days, 14days and 28 days

As the above graphs show that variation in Flexure strength for different mixes and at different ages of concrete. It is clear that flexure strength also follows the same pattern as other mechanical properties. The maximum flexure strength was attained for M3 mix.

V. CONCLUSION

i. The material used in the experiments is good and workable.
ii. The admixture used in the experiments gave the great impact on the strength of concrete.
iii. The specific gravity of ESP was lesser than that of cement.
iv. While testing the flexural strength of the beam, it is seen that beam failed in between the loading span between its two supports and hence formula that we used is 3PL/4bd2.
v. It is observed while experiment that the compressive strength of concrete increases at 2.5%ESP and 15% silica fume of replacement of cement but further addition of ESP shows reduction in strength.
vi. The optimum compressive strength is obtained at 2.5% ESP and 15% silica fume of replacement of cement.
vii. The compressive strength of the cubes comes more than 30 MPa after 28 days of curing.
viii. The tensile strength of cylinder after curing it for 28 days, came more than 3MPa.
ix. In case of flexural strength of beam, the replacement of cement with ESP and silica fume can be done same that 2.5% ESP and 15% silica fume
x. The flexural strength increases initially as the replacement of cement with ESP st 2.5 % and then start decreasing.

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