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EXPERIMENTAL STUDIES ON CONCRETE BY PARTIAL REPLACING CEMENT WITH SILICA FLOUR AND STRENGTHENING WITH GLASS FIBERS

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ABSTRACT

This paper presents the Mix designs of M25 grade concrete prepared by mixing two different types of materials i.e., cement is partially replaced by silica flour and glass fibers are used to strengthen the concrete by adding them with certain percentages to the weight of cement.

Silica Flour is replaced by 0%, 10% & 20% with cement and Glass Fibers are replaced by 0%,0. 4%, 0.8%&1.2% to the weight of cement.

In this experimental study the strength properties of cement are tested. By this project it can be proved that the cement production can be reduced.

Keywords*: Silica Flour, Environmental effects due to cement, Pozzolanas, Glass fibers.*

I. INTRODUCTION

The production of Portland cement is not only costly and energy intensive, but it also produces large amounts of carbon emissions. The production of one ton of Portland cement produces approximately one ton of CO2 in the atmosphere. Silica flour is simply made by grinding pure silica sand to a very fine powder. It is used as a cheap filler in plaster and some plastics to add strength, or just to reduce the amount of (expensive) resin needed to fill a mold. Limestone (CaCO3) is a raw material available in nature. It is primary need for production of cement material. Silica flour is commonly used in concrete in replacement, ranging from 0% to 20% by weight of the total cementations material. This material reduces green house gas emission proportionately and result in a more "green concrete", through reduction of energy consumptions (energy required to produce cement) and prevent the depletion of natural resources. Additional benefits include minimization of waste disposal (land filling these industrial byproduct). The use of silica flour in concrete has recently gained popularity as a resource-efficient, durable, cost–effective, sustainable option for ordinary Portland cement (OPC) concrete application.

II. METHODOLOGY

- The study work is to analyze strength properties of partially replaced Silica flour concrete.
- The tests on concrete are carried out as per IS code for this proposed investigation work. For successful investigation, tests have to be performed on normal concrete and on Silica flour concrete with proportion 0%, 10%, 20% cement replacement.
- A comparative report is prepared before arriving at the final conclusion of plain concrete and Silica flour concrete with crush and natural sand.
- It is well known that Silica flour can increase the ability of preventing water penetration and chloride penetration, and it can improve the durability of concrete structures (Ramezanianpour, 1995).
- Also, the use of Silica Flour for concrete material contributes to the saving the natural resources and energy

in cement manufacturing process and to reducing CO_2 emissions and environment impact.

- While some applications to pre-tensioned concrete have been reported (Ishida, 2000) (Fukunaga, 2009), the application to post-tensioned concrete has been very few.
- The more positive use of Silica Flour has been required. In this study, the specimens which include normal-strength concrete and high-strength concrete were examined by changing water to binder ratio (W/B).

Glass Fibers

- Glass fibers are most commonly used. They come in two forms:
  - Continuous fibers
  - Discontinuous or "staple" fibers

- Chemically, glass is called silicon dioxide (SiO_2). Glass fibers used for structural applications come in two flavours: E-Glass, and S-Glass.
  - Principal advantages:
  - Low cost
  - High strength

- Limitations:
  - Poor abrasion resistance causing reduced usable strength.
  - Poor adhesion to specific polymer matrix materials.
  - Poor adhesion in humid environment.

- Glass fibers are coated with chemicals to enhance their adhesion properties. These chemicals are known as "coupling agents".
  - Many of coupling agents are "silane" compounds

Glass Fiber Types

Glass fibers fall into two categories, low-cost general-purpose fibers and premium special-purpose fibers. Over 90% of all glass fibers are general-purpose products. These fibers are known by the designation E-glass, and are subject to ASTM specifications. The remaining glass fibers are premium special-purpose products. Many, like E-glass, have letter designations implying special properties. Some have trade names, but not all are subject to ASTM specifications.

Table 2.1

Letter designation	**Property or characteristic**
E, electrical	Low electrical conductivity
S, strength	High strength
C, chemical	High chemical durability
M, modulus	High stiffness
A, alkali	High alkali or soda lime glass
D, dielectric	Low dielectric constant

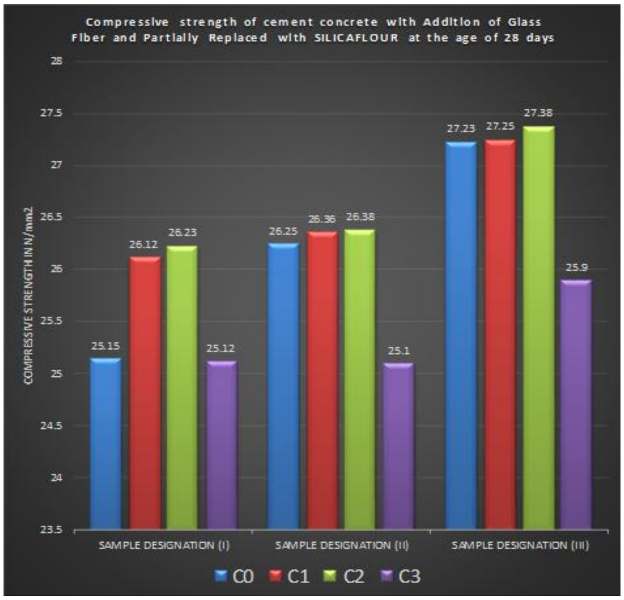
III. RESULT & DISCUSSION

Compression Test

Concrete cubes of size 150×150×150mm were casted and tested for compressive strength in normal water at ages of 7, 28,56 and 90 days for 0%, 10%, 20% and 0%, 0.4%, 0.8%, 1.2% combined replacement of Silica Flour and glass fiber respectively for M25 grade of concrete.

Fig: 3.1 compression test specimen

Fig: 3.2 Tested specimen



Graph 3.1:-Compressive strength of cement concrete with Addition of Glass Fiber and Partially Replaced with SILICAFLOUR at the age of 28 days

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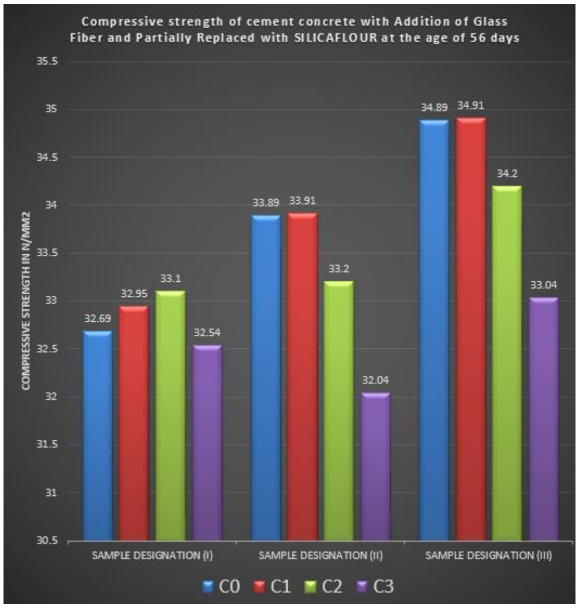
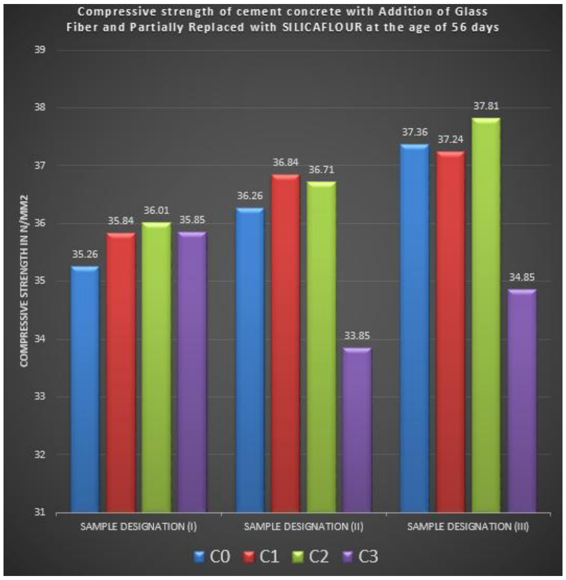


Graph: 3.2 Compressive strength of cement concrete with Addition of Glass Fiber and Partially Replaced with SILICAFLOUR at the age of 56 days

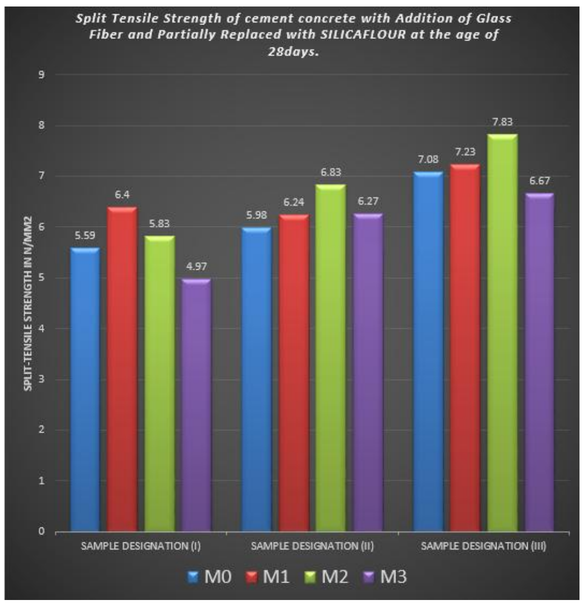


Graph: 3.3 Compressive strength of cement concrete with Addition of Glass Fiber and Partially Replaced with SILICAFLOUR at the age of 90 days

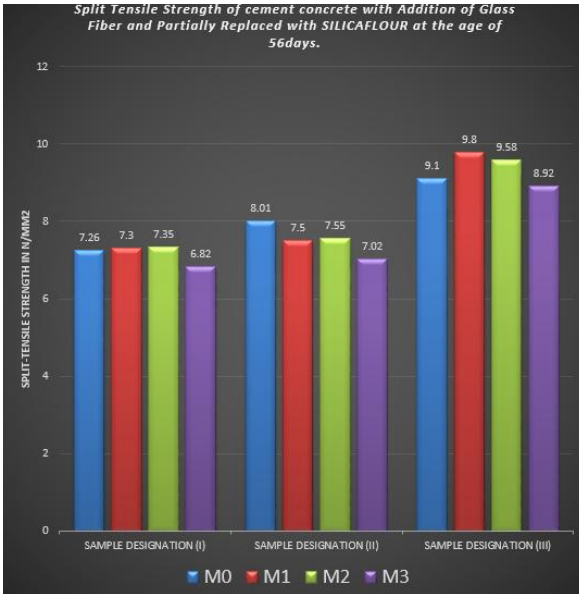
Split Tensile Test

Test has been conducted after 7, 28, 56 and 90 days of curing. Split tensile is conducted on 150mm diameter and 300mm length cylinders.

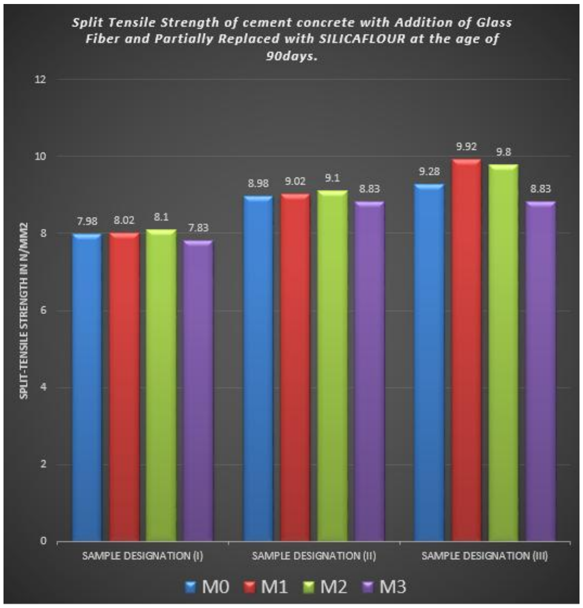
Fig: 3.3 Split tensile test on cylinders



Graph 3.4: Split Tensile Strength of cement concrete with Addition of Glass Fiber and Partially Replaced with SILICAFLOUR at the age of 28days.



Graph 3.5: Split Tensile Strength of cement concrete with Addition of Glass Fiber and Partially Replaced with SILICAFLOUR at the age of 56days.

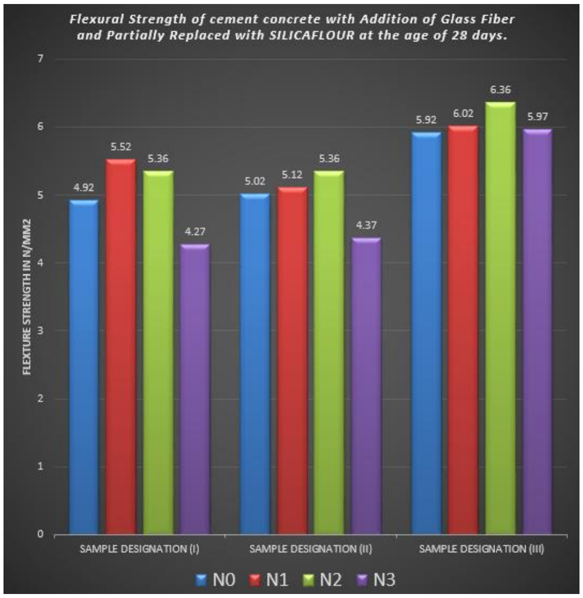


Graph 3.6 Split Tensile Strength of cement concrete with Addition of Glass Fiber and Partially Replaced with SILICAFLOUR at the age of 90days.

Flexural Strength Results

Flexural strength, also known as modulus of rupture, bending strength, or fracture strength, is a material property, defined as the stress in a material just before it yields in a flexure test.

Fig 3.5 Flexural test on Beams



Graph 3.7: Flexural Strength of cement concrete with Addition of Glass Fiber and Partially Replaced with SILICAFLOUR at the age of 28 days.

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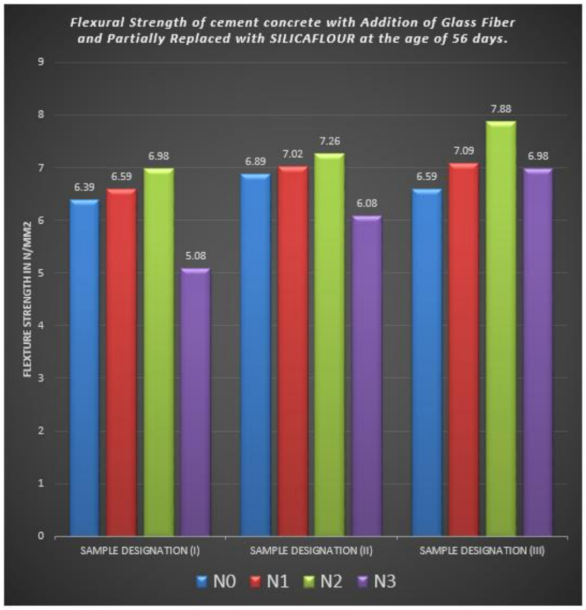
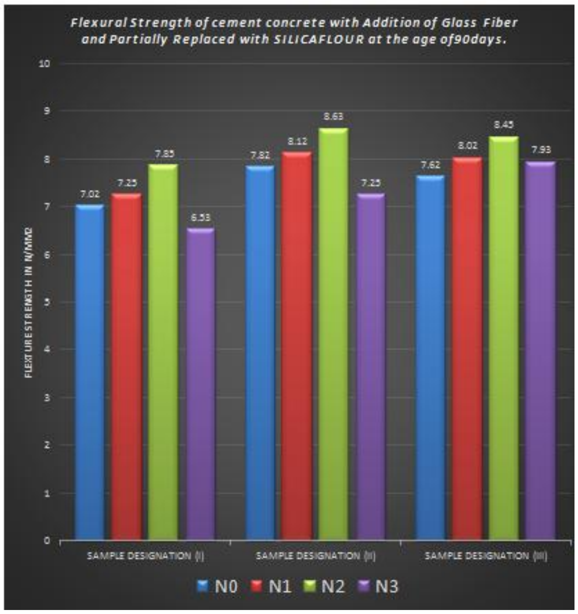


Graph 3.8: Flexural Strength of cement concrete with Addition of Glass Fiber and Partially Replaced with SILICAFLOUR at the age of 56 days.



Graph 3.9 Flexural Strength of cement concrete with Addition of Glass Fiber and Partially Replaced with SILICAFLOUR at the age of 90 days.

IV. CONCLUSION

Based on the limited experimental investigations concerning Compressive strength, Flexure strength and Split tensile strength of concrete with Silica Flour as a partial replacement of cement, the following conclusion can be drawn.

- The compressive strength of concrete cubes with addition of glass fibers to concrete with 100% cement, tends to increase but after addition of 12% glass fibers the compressive strength decreases, it happens with all the samples at 28,56 and 90 days.
- The Compressive strengths of sample (I) , sample (II) ,sample (III) at 28,56 and 90 days the strength of concrete cubes started to increase till 10% of silica flour but when 20% silica flour is added the strength dramatically decreases , so from this we can conclude the percentage of silica flour shouldn't be increased more than 10%
- The Split tensile test conducted on the specimens at 28, 56 and 90 days shows that adding the silica flour and glass fibers at certain limit gives good results than conventional concrete.
- The Flexure strength test also shows the same as above tests that glass fibers and silica flour added at certain range gives better results than conventional concrete but as the amount of glass fibers and silica flour increases the strength of the concrete specimens' decreases.
- The percentage increase or decrease of compressive strength at 28, 56 and 28 days are as follows:

For sample I
C1: 3.85%, 0.07%, 1.6% increase compared to conventional concrete cube respectively
C2: 4.29%, 1.25%, 2.12% increase compared to conventional concrete cube respectively
C3: 0.11%, 0.45, 1.6% decreased compare to conventional concrete cube respectively

For sample II
C1: 0.40%, 0.79%, 1.6% increase compared to conventional concrete cube
C2: 0.49%, 1.25%, 2.12% increase compared to conventional concrete cube
C3: 4.3%, 0.45%, 0.31% decreased compare to conventional concrete cube

For sample III
C1: 0.073%, 0.05%, 0.48% increase compared to conventional concrete cube
C2: 0.55%, 0.02%, 1.02% increase compared to conventional concrete cube
C3: 4.88%, 5.03%, 6.77% decreased compare to conventional concrete cube

- Therefore from this we can conclude that the percentage increase may be less but the amount of cement usage in construction can be reduced at least to 10% because at 20% replacement the results are not up to the mark.
- The initial cost of the project is high but with regular usage and demand the cost can be reduced.

V. FUTURE SCOPE

- The usage of this kind of materials can reduce the pollution caused by manufacturing cement.
- Utilization of the waste materials in construction can be increased which will reduce unwanted landfills.

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