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Experimental Study on Combined Effect of Steel and Glass Fibers on Compressive Strength, Flexural Strength and Durability of Concrete and Comparision with Conventional Concrete

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Abstract: **conventional concrete show low tensile strength, limited ductility and little resistance to cracking which not suitable where the impact load is more like airport, highways, tunnels etc. to overcome these problem fiber reinforced is more suitable. Concrete traditionally consists of cement, fine aggregate, coarse aggregate and water. An attempt has been made to improve the tensile strength of concrete, steel fiber and glass fibers are used in concrete. Results of compressive strength and tensile strength and durability properties of concrete are been presented in this paper. It is found that using of steel fibers in concrete increase the strength and using of glass fibers reduced bleeding and workability compared to conventional concrete.**

Keywords: **steel and glass fibers; concrete; compressive strength; durability of concrete.**

1. INTRODUCTION

Concrete is the most versatile and robust construction material available. Concrete is the mixture of cement, fine aggregate, coarse aggregate and water. Concrete have good compressive strength, but conventional concrete is weak in tensile strength. For centuries, civil and structural engineering have been based on brittle materials like ceramic elements or lime mortar. These materials proved to be flexible in use and allowed to erect versatile type of buildings throughout the centuries, brittleness have always been limiting shape and size of structure at the same time influencing their durability. Concrete is weak in resisting tensile forces so it will crack easily under low level tensile stress.

The main objective of the present work is to improve tensile property of concrete using steel and glass fibers at varying percentage. During the present study, 0.5% &0.25%, 0.525% & 0.3% and 0.55%& 0.35% steel and glass fibers are used by volume of concrete. Compression, split and flexural strengths and its durability were found after 7and 28 days of curing.

2. MATERIALS

The materials used in the experiment are:

a. Cement
b. Fine aggregate
c. Coarse aggregate
d. Water
e. Steel fiber without hook end
f. AR- glass fiber

3. METHODOLOGY

A. Material collection of steel fiber, glass fiber, sand, coarse aggregate and cement.

B. Physical tests to be conducted on materials.

C. Preparation of mix design for M25 GRADE.

D. Adding of steel and glass fibers of 0.5%&0.25%, 0.525%&0.3% and 0.55%70.35%.

E. Making number of samples of concrete cubes, cylinders and beams

F. Testing of specimens was done for 7 and 28days

The following tests are to be conducted on specimens

- Compressive strength
- Flexural strength
- Split tensile strength
- Durability test

4. MIX PROPORTIONS FOR M25 GRADE

Cement= 394 kg/m^3

Fine aggregate= 730.80 kg/m^3

Coarse aggregate = 1013.64 kg/m^3

Water= 197 kg/m^3

5. CASTING AND CURING

The cubes, cylinders and beams are assembled on the concrete leveled flooring with a paper between the mould and the floor. The inner side of the mould is lubricated properly. Cover blocks of sufficient thickness are placed below the bottom of the case so that the required effective depth is maintained. The materials are mixed in the electronically operated mixer thoroughly to get the uniformity. The concrete is placed in the moulds in two layers and compacted with tamping rod. The moulds are de moulded after 24 hours of casting. After the required period of curing, the specimens are taken out of the curing tank, wiped off the moisture and the surface is made dry.

The physical properties of concrete depend to a large extent on the degree of hydration of the cement and the resultant microstructure of hydrated cement. It is necessary to create conditions of temperature and humidity during a relatively short period immediately after placing and compaction of concrete, favorable to the setting and hardening of concrete. The process of creation of a favorable environment is termed as curing. The cube cylinder and beam specimens were kept in water for 7days and 28 days curing before conducting the test.

Experimental work:

The specimens required for compressive strength test are cast with established concrete mix proportion, as per the relevant codal requirement, the details of which are as below. To study the compressive strength behavior of M25 grade concrete in which steel and glass fibers are used. The cubes specimens of size 150mmx150mm150mm and beam specimen of 500mmx100mmx100mm and cylinder of 300mmx150mm dia are prepared. The cubes, beams and cylinder each tested for 7 days and 28 days. Compressive, split tensile and flexural strength of normal concrete compares with fiber reinforced concrete

6. TEST PROCEDURE AND RESULTS

Compression test:

After 28 days of curing, the cubes were taken out of the curing tank, dried and tested using a compression machine. These cubes were loaded on their sides during compression testing such that the load was exerted perpendicularly to the

direction of casting. The cubes were placed in the compression testing machine and the loads are applied gradually. The average value of the compression strength of three cubes was taken as the compression strength. Three conventional concrete cubes and cubes with different percentage of steel and glass fiber were casted. The compressive strength of conventional was found to be 29.35 N/mm^2. The compressive strength of fiber reinforced concrete are given in fig. 1

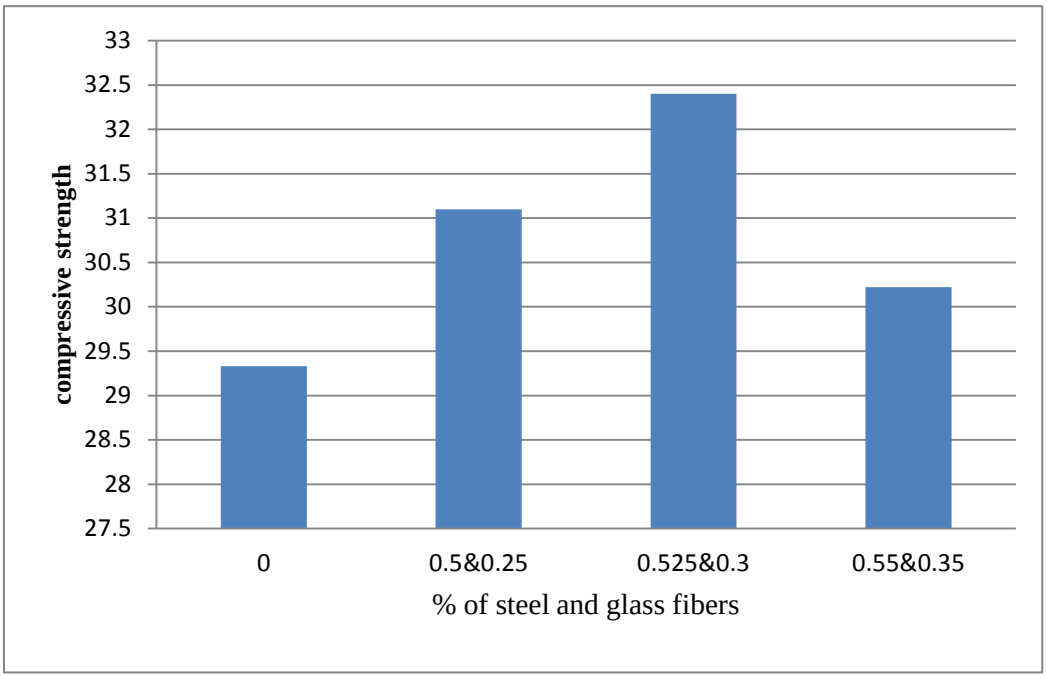

Fig. 1 compressive strength of PC and HFRC

The compressive strength is more for the hybrid fiber reinforced concrete compared to the plain concrete. The percentage increase in strength is 31.6% more for the HFRC compared to PC.

Split Tensile Strength:

The cylindrical specimens of diameter 150mm and height300mm were used to determine the split tensile strength. The specimens were tested in computerized universal testing machine of capacity 1000kN. The cylindrical specimens tested for each percentage of steel and glass fibers. The cylinders were placed in the machine horizontally. Load was applied gradually at a uniform rate until the specimens failed. Split tensile strength was taken as the average strength of three specimens. The split tensile strength of conventional concrete was found to be 8.53 N/mm^2. From the study it can be seen that the curing period increases, the split tensile strength also increases. The split tensile strength is more for the concrete specimen made with 0.525% & 0.3% steel and glass fibers compared to other percentages. The percentage increase in strength is 24.56%.

Flexural Strength:

The beam specimens of size 500x100x100mm were used for the determination of the flexural strength. The bearing surface of the supporting and loading rollers were wiped clean and any other loose fine aggregate or other materials removed from the surface of the specimen where they are to make contact with rollers. The specimen was then placed in the machine and two point load was applied. Load was increased until the specimen failed and the load at failure was recorded and flexural strength was determined. Flexural strength was taken as the average strength of three specimens. Three conventional concrete with varying percentage of steel and glass fibers specimens were casted. The flexural strength for conventional concrete was found 8 N/mm^2. The flexural strength of the specimens with varying steel and glass fibers are given in fig.2

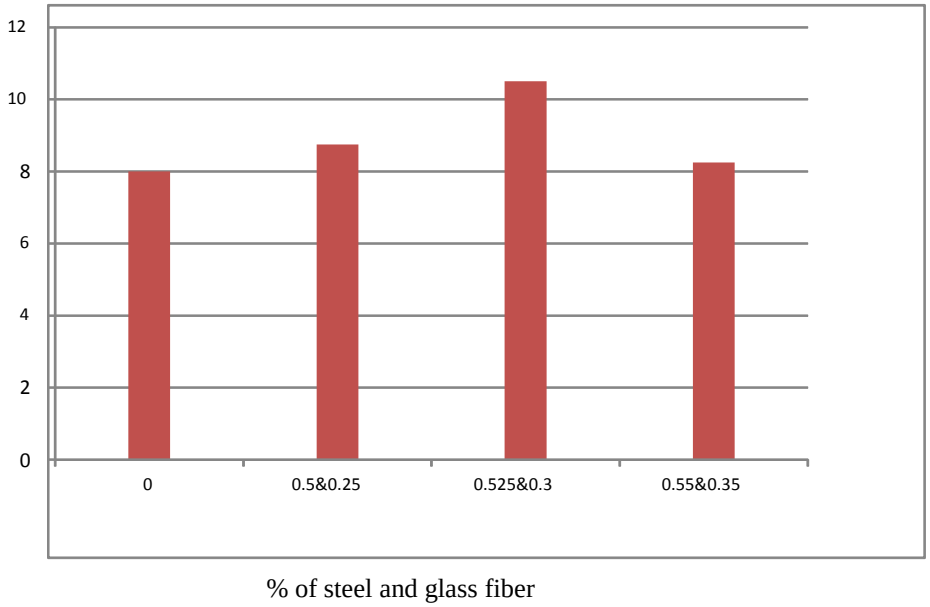

Fig.2: flexural strength of PC and HFRC

From the figure, it can be seen that the HFRC concrete has more flexural strength compared to normal concrete. The percentage increase in strength is 9.7%.

Durability Test:

The cube specimens of 150x150x150mm were cured for 28 days in the water. Then weighed and kept in the acid (HCL) and base ($N_2SO_{\square}$) solution of the quantity of solution added for immersing of cubes is of 5%. Then the specimens are kept for 28 days reaction to happen. Then the specimens took from the acid and base solutions for testing in compression machine. Three normal concrete and hybrid fiber reinforced concrete specimens were tested.

From figure it was observed that there is reduction of compressive strength, the specimens which was exposed to acid to unexposed to acid.

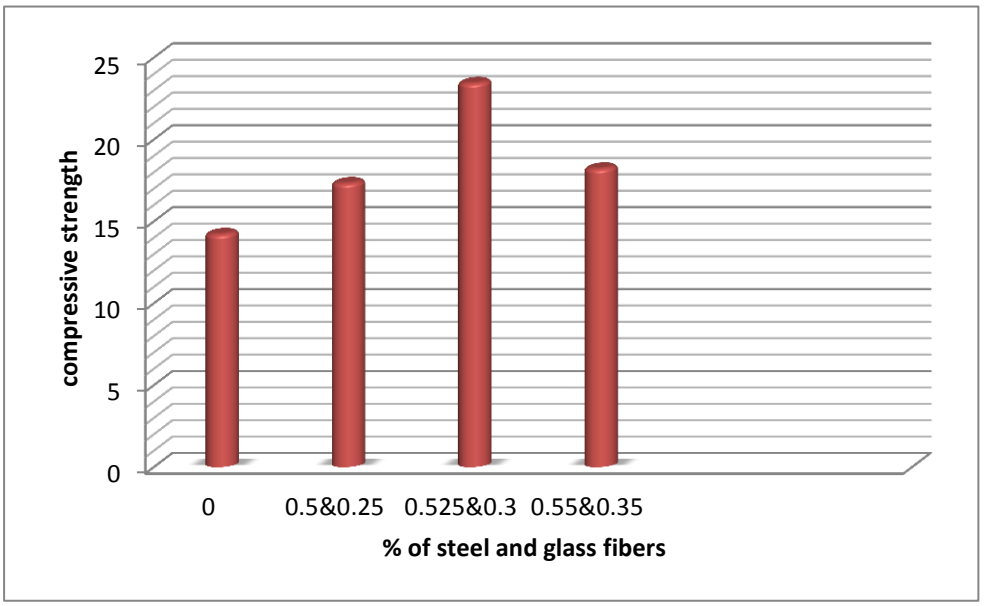

Fig.3: shows the compressive strength of specimens after 28 days in acid

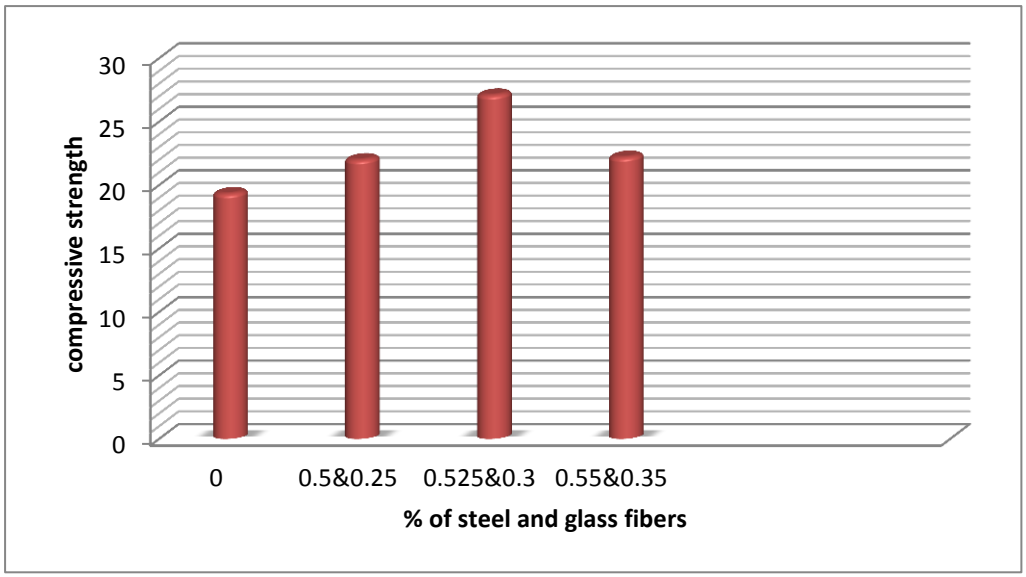

Fig.4: shows the compressive strength of specimens after 28 days in base

From figure it was observed that there is increase of compressive strength, the specimens which was exposed to acid to unexposed to base.

7. CONCLUSIONS

From the present study it was observed that the specimens made with 0.525% and 0.3% steel and glass fibers gives the more strength compare to other mix proportion and from normal concrete. Increase in % of glass reduces the compressive strength. Workability of normal concrete is more compare to fiber reinforced concrete; it was observed that % of steel increase means there is reduced in workability. From acid test it was observed that the specimens exposed to acid shows lesser compressive strength compare to unexposed to acid. The specimens made with 0.525% and 0.3% steel and glass fiber shows the better compressive strength compare to other specimens. And loss of weight was more in increased percentages of glass fiber. And loss of weight due to increased steel fiber after acid test. From base test it was observed that the specimens exposed to base shows more weight gain compare to the specimens subjected to unexposed to base.

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