Experimental Investigation on the Behaviour of Strength and Durability of Concrete Using the Combination of Steel Fiber, Glass Fiber and Fly ash

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Abstract - Concrete is the most widely utilized "manmade" material globally for construction. There has been lot of research took place over using fly ash and steel and glass fibers as additive in cement, admixture in concrete and cement replacement material in concrete. Many of investigations were attempted by the researchers to improve the quality, strength and durability against adverse exposures, since decades. When fibers are added to the concrete mix, it too can add to the tensile loading capacity of the composite system. Results shows that the workability goes on increasing continuously when there is increase in the amount of fly ash. This is due to the fact that fly ash being spherical, small, fine particles that required very low content of water to mix with free lime. But by adding glass steel fiber, the workability goes on decreasing In fact, research has shown that the ultimate compressive, strength of concrete can be increased by adding fly ash steel and glass fiber reinforcing. In this research paper, an attempt is made to use combination of fly ash, steel and glass fibers in concrete with varying percentages of fibers and fly ash from 0%, 05%,10%,20%,30% percentages of total fiber content for M 20 grade structural concrete with locally available aggregates (i.e. fine & coarse aggregates) and Ordinary Portland cement (OPC). The details of investigation along with the analysis and discussion of the test results are reported here in.

1. INTRODUCTION

Concrete durability and economy have made it in this world widely used construction material. The term concrete refer to a mixture of fine aggregate, course aggregate and binding material (Portland cement) and water may also contain supplementary cementing material such as fly ash, chemical admixture. The Concrete as a material literally forms the basic our modern life: infrastructure and of its physical development. Hence concrete is well suited for a wide range of application. Concrete has some deficiencies as low tensile strength, low posting cracking capacity, brittleness and low ductile. Limiting fatigue life not capable of accommodating last deformation low impact strength. It is added to steel fiber that has higher tensile strength as compared to unreinforced shotcrete which can be applied with weld mesh reinforcement because of its quicker setting property. Glass fiber concrete are mainly used in building panels and as architectural precast concrete. This material is good in making shape on the front of any building and it is less dense than steel. The important effect of durability of concrete is its permeability it will reduce the amount of water needed to produce a given slump and fly ash concrete is less permeable. In pozzolanic activity, it will make more durable CHS as it will fill capillaries and blocked the water channels which are accompanied by the water soluble lime. It will also improve corrosive protection by decreasing concrete permeability. It will also increase the resistance of sulphate and decrease alkali silica reactivity. At this point a different between class C and class F need to be made. Fly ash will improve both their permeability and general durability of concrete. Same of class C could be used to mitigate in reactions, but it will be used at the rate of cement replacement.

2. LITERATURE REVIEW

Shah (1987) reported that many of the current applications of fiber reinforced concrete involve the use of fibers ranging around 1 % by volume of concrete. It was suggested that fibers do not influence the tensile strength of the concrete and that only after the concrete has cracked do the fibers contribute by bridging the cracks. Recently, it has been possible to incorporate relatively large volumes (ranging up to 15%) of steel, glass, and synthetic fibers in concrete. With such a large volume of fibers in concrete its result shows that the fibers may substantially increase the tensile strength of concrete.

Al-Tayyib et al. (1990) reported that adding polypropylene fibers (0.2% by volume of concrete) to concrete mixes increases the properties of both fresh and hardened concretes. This investigation polypropylene fiber reinforcement has no noticeable effect in retarding corrosion of reinforcing steel in concrete. It was concluded that results of the electrical resistivity, water absorption and permeability tests also do not show any significant improvement due to the inclusion of polypropylene fibers.

Ezeldin et al. (1991) presented an experimental program designed to study the mechanical properties of rapid-set materials reinforced with steel fibers. The primary variables of this study are: (a) rapid-set cementing materials; (b) fiber type; and (c) fiber content. Three commercially available rapidset materials were investigated in the experiments. The result showed that steel fibers can be successfully mixed with rapid set materials up to a quantity of 75 lb/cu yd (45 kg/m^3). And

reported that the mechanical properties depends on the fiber shape, aspect ratio and its content.

Saluja et al. (1992) carried the experiments on steel fiber concrete to find out compressive strength and concluded result shows that steel fibers are effective in increasing the compressive strength up to 1.0 percent fiber content, beyond which the increase is not much effective.

Banthia et al. (1994) examined the Bond-slip characteristics for three deformed steel fibers bonded in concrete with different strengths. Fibers were aligned at 0, 15, 30, 45, and 60 degree with respect to the loading direction and complete loadversus-slip curves were obtained. Its obtained bondslip characteristics of fibers aligned with respect to the loading direction were significantly superior to those for inclined fibers.

Balasubramanian et al. (1996) examined that addition of fibers, even in a small quantity, considerably improves the impact resistance of concrete. Among trough shaped, crimped shaped and straight fibers. Its result shows crimped fibers were found more effective in improving impact strength and at 0.5 % volume of crimped fibers the impact strength was trebled as the age of concrete increased from 28 days to 90 days.

3. MATERIALS

Ordinary Portland Cement (OPC) Here Khyber OPC 43 grade is used. The cement used in this experimental work is 43 grades ordinary Portland cement. All properties of cement are tested by referring IS 12269-1987 specification for 43 Grade ordinary Portland cement. The specific gravity of the cement is 3.15. The initial and final setting times were found as 90 min. and 180 min. respectively. Standard consistency of cement was 31.25%.

FINE AGRREGATE Locally available sand passed through 4.75mm IS sieve is used. The specific gravity of 2.69 and fineness modulus of 2.66 are used as fine aggregate. The loose and compacted bulk density values of sand are 1094 and 1162kg/m3 respectively having water absorption of 1.45%.

Table-Difference between Physical Properties of Sand & Fly Ash

Properties	Fine Aggregate (Sand)	Fly Ash
Specific gravity	2.70	1.24
Bulk Density (kg/m3)	1808	838
Size (mm)	Below 4.75	Below 4.75
Fineness modulus	2.66	2.70

COARSE AGGREGATES Crushed aggregates available from local sources has been used. The course aggregates with a maximum size of 20mm having the specific gravity value of 2.958 and fineness modulus of 7.136 are used as coarse aggregate. The loose and compacted bulk density value of coarse aggregates are 1467 and 1629 kg/m3 respectively the water absorption of 1.26%.

FLY ASH Firstly coal is a crushed into fine powder in grinding mills. Its coal fine powder is then transferred into the boiler. In the boiler the coal is undergoing combustion producing heat with a temperature up to 1500 degrees. At this temperature, non-combustible minerals melt in the furnace and fuse together. Its mineral are taken away from the burning region by exhaust or flue gases. After a while these minerals are cooled and form spherically glassy particles which are known as fly ash. The fly ash particles are then collected by mechanically and electrostatic precipitators from the exhaust gases.

STEEL FIBER Steel fibers are formed from low carbon content iron .The inclusion of fiber especially steel fibers in concrete significantly enhances the flexural strength, ductility and toughness. Because of its nonflexibility it gives more strength. The most important thing describing a fiber is its aspect ratio. Aspect ratio is the length of fiber divided by an equivalent diameter of fiber, where equivalent is the diameter of the circle with an area equal to the cross sectional area of fiber.

The Steel fiber that have been used in this project were having aspect ratio of 50 with cylindrical hooked geometry. The typical diameter of fibers lies in the range of 0.25-0.75 mm. l Length of these fibers is 30 mm and the diameter of steel fiber used is 0.6 .Density of steel fiber is 7900 kg/cum.

GLASS FIBER Fibers are the principal load carrying members while the matrix surrounded keep them in desired location and direction. Load transfer acting on medium between fiber and protecting from environmental damage. Fiber are used modulus of elasticity 86GPA. Filament diameter is 12 micros. Specific gravity 2.68 length 12mm. the no. of fiber per kg is 212 million. The fiber provided reinforcement for the matrix and other useful function in fiber rein forced composition material. Glass fiber can be incorporated into a matrix either in continuous or discontinuous (chopped) lengths. Durability was poor with the original type of glass fiber since the alkalinity of cement reacts with its silica. In the 1970s alkali resistance glass fiber were commercialized. Alkali resistance is achieved by adding zirconia to the glass. The higher the zirconia content the better the resistance to alkali attack. The best fiber have zirconia contents of 19%or higher

4. OBJECTIVE

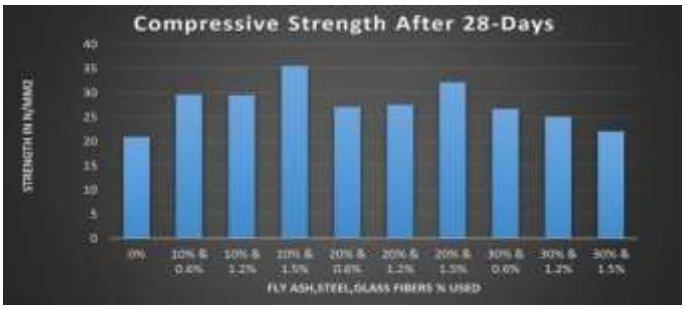
- To check compressive strength of concrete by partially replacing cement with fly ash.
- To check compressive strength of concrete by adding steel fiber and glass fiber.
- To check the compressive strength test on compression testing machine.
- To check the split tensile strength of concrete by partially replacing cement with fly ash.
- To check the split tensile strength of concrete by adding steel and glass fiber.
- To check the split tensile strength test on universal testing machine.
- To check the flexural strength of concrete by partially replacing cement with fly ash.
- To check the flexural strength of concrete by adding glass and steel fiber.
- To check the flexural strength test on universal testing machine.
- To check workability of concrete by partially replacing fly ash and addition steel and glass fiber.
- To check the cost analysis in optimum and nominal mix.

5. EXPERIMENTAL INVESTIGATION

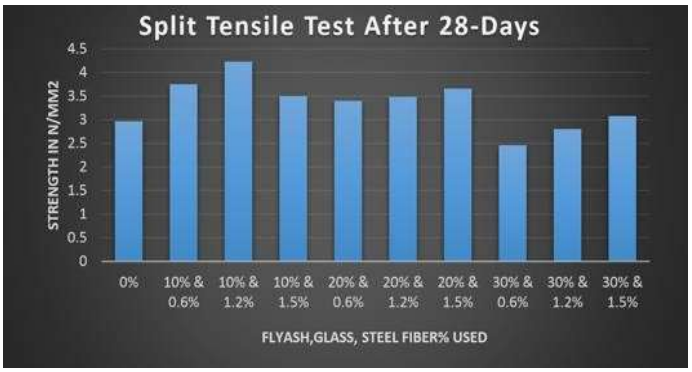
The experimental program is planned to quantify the compressive strength, Flexural strength, Split tensile Strength and Workability using fly ash steel fiber and glass fiber at various Percentage level will be used in the investigation to observe the effect of different combination of ash and fibers level in contributing the compressive, flexural and split tensile strength at various stages of curing, concrete cubes of size 150mm X 150mm X 150mm were casted. 90 cubes were casted for determination of compressive strength. After 24 hours, the specimen were demoulding and subjected to water curing. The compressive test were carried out by Compression Testing machine (CTM). Splitting Tensile test and flexural tensile test were carried out by Universal testing machine (UTM). Before testing the cubes were air dried for two hours. Crushing loads were noted and average compressive strength of 3 specimen each for the determined at 7, 14 and 28 days. For splitting tensile strength cylindrical mould of size 150mm X 300mm and for flexural test concrete beam of size 700mm X 150mm X 150mm was used throughout the investigation. Workability of each batch of concrete mix was determined by carrying out slump test. The test was carried out as per specifications confirming IS: 1199- 1959. Slump measure was recorded in terms of mm.

6. RESULTS AND DISSCUSSION

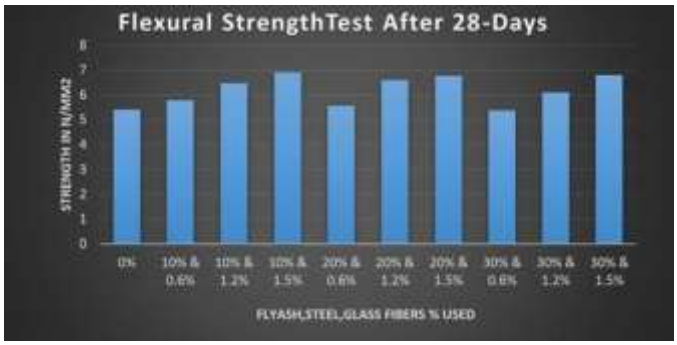
6.1 COMPRESSIVE STRENGTH



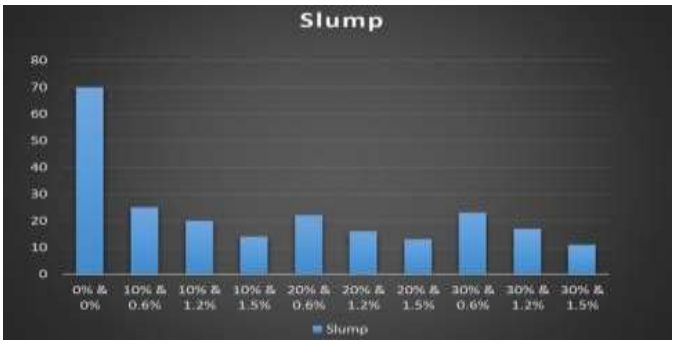
6.2 SPLIT TENSILE STRENGTH



6.3 FLEXURAL STRENGTH



6.4 WORKABILITY TEST



7. CONCLUSION

This project was completed with the main purpose of discovering the feasibility of using fly ash as a partial replacement of cement with addition of glass and steel fibers. The addition of glass and steel fibers plays a very important role in increasing strength and minimizing the concrete cracks.

- As part of the investigation, concrete mixes with different contents of fly ash as replacement of cement and glass&steel fibers were made and cast into concrete cubes, cylinders and beams then cured in water.
- A slump test was also performed to check the workability of the concrete mixes immediately after the mixing process of the ingredients was completed. From the test results, following conclusions were made
- The compressive strength of concrete reaches highest, when the cement has been replaced by 10% of fly ash and with addition of 1.5% of glass&steel fiber. This is due to the fact that the fly ash acts as pozolonic material and it combines with free lime to form CSH, which imparts strength to the concrete. Also by adding fibers, the bond between different constituents become very strong which in turn imparts strength to the concrete.
- The split tensile strength is maximum when cement is replaced by 10% fly ash and addition of 1.2% glass&steel fiber.
- The value of flexural strength increases mainly due to addition of glass&steel fibers and it was recorded highest when cement was replaced by 10% of fly ash and with addition of 1.5% of fibers.
- It goes on increasing continuously when there is increase in the amount of fly ash. This is due to the fact that fly ash being spherical, small, fine particles that required very low content of water to mix with free lime. But by adding glass steel fiber, the workability goes on decreasing and it reaches minimum for 1.5% fibers.

8. REFERENCES

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