EXPERIMENTAL STUDY ON STRENGTH PROPERTIES OF STEEL FIBERS & GLASS FIBERS USING FLY ASH BASED CONCRETE

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Abstract: **Concrete is the widely used construction material in civil engineering field. The demand and cost of cement is increasing day to day, so experts are looking for supplementary materials with the main objective of reducing solid waste disposal problem, by using waste as supplementary by maintaining the same properties or by enhancing the properties, by using selected materials. Fly ash which is a solid waste generated from thermal power station is used in partial replacement of cement in various proportions which is environmental friendly and also different fibers are also used to increase tensile strength and reduce cracks in the concrete. Concrete is the most vital material in the modern construction. Which has been in practice from olden days but concrete suffers from low tensile strength, limited ductility and little resistance to cracking. To overcome these weaknesses a new variety of concrete is desired. Therefore here is an experimental study proposing changes to the conventional concrete to increase fire resistance, increase crack resistance, increase ductility and flexural strength by partial replacement of fly ash to the cement and introducing fibers in the preparation of the concrete.**

Keywords: **Fly ash, Fibers, Ductility, Solid waste disposal, tensile strength.**

I. INTRODUCTION

Fly ash is by-product obtained from the thermal power plants obtained from combustion of coal. Generally fly ash has higher impact on the environment because of presence of heavy metals like mercury, cadium, boron. Fly ash being a byproduct was been used in landfilling as solution for solid waste disposal purpose where in which these heavy metals leach through this landfills and effect the health of the surrounding population. But India is only country whose 70% of population depends on thermal power which means higher coal consumption resulting in higher fly ash production which should properly disposed. Fly ash production is shown in table given below

Table 1: Fly Ash Production

Years	Ash Production(MT)
1995	75
2000	90
2010	110
2020	140

Our paper deals with effective use of fly ash as a construction material which can be replaced up to 25% by weight of cement. This can be one the innovative technique which can compensate high production of fly ash. We all are aware of the fact that concrete is weak in tension and strong in compression in order to compensate the tension in the concrete we use either reinforcement or fibers in concrete it is hard to reinforce very thin members so we use fibers to reinforce thin members. Fiber is a small piece of reinforcing material possessing some characteristic property. Fiber is often described with a parameter called "aspect ratio". Generally aspect ratio of fiber ranges from 30 to 150. Steel fibers are most commonly used fiber which is generally round in shape. Glass fibers are also used in conjunction of cement in order to reduce alkaline effects; it also enhances the tensile strength of concrete to 1020N/sq.mm to 4080n/sq.mm

II. PROPERTIES OF MATERIALS USED IN STUDY

Fly Ash Properties

Fly ash which is also known as pulverized fuel ash. Fly ash is one of the residues generated by coal of combustion, and is composed of the fine particulate matter that are comes out of boiler with the flue gases. Ash that which settles in the bottom of the boiler is called bottom ash. Fly ash is generally obtained using electrostatic precipitators or other equipment before the flue gases reach the chimneys of coal-fired power plants and together with bottom ash is taken away from the boiler is known as coal ash. Depending upon the source and process by which coal being burned, the components of fly ash change considerably, but all fly ash includes considerable amounts of silicon dioxide (SiO2) both in amorphous and crystalline forms, aluminum oxide (Al2O3) and calcium oxide (CaO), the main mineral compounds in coal-bearing rock strata. Properties of fly ash so tested in lab are given below in table

Table 2: Cement and Fly Ash Chemical Components

S. No	Major Components		Cement	Fly Ash
01	Silicon Dioxide	SiO_2	20.0%	55.59%
02	Aluminium Oxide	Al_2O_3	4.90%	26.64%
03	Ferric Oxide	Fe_2O_3	2.30%	9.50%
04	Calcium Oxide	CaO	65.0%	2.30%
05	Magnesium Oxide	MgO	3.10%	0.60%
06	Sodium Oxide	Na_2O_3	0.20%	0.23%
07	Potassium Oxide	K_2O	0.40%	0.40%
08	Sulphur Oxide	SO_3	2.30%	0.44%
09	Loss of Ignition		2.40	4.30

Steel Fibers

We all know that concrete is weak in tension and strong in compression in order to compensate the tension in the concrete we use either reinforcement or fibers in concrete it is hard to reinforce very thin members so we use fibers to reinforce thin members. Fiber is a small piece of reinforcing material possessing some characteristic property. Fiber is often described with a parameter called "aspect ratio". Generally aspect ratio of fiber ranges from 30 to 150. Steel fibers are most commonly used fiber which is generally round in shape. The diameter varies from 0.25 to 0.75mm. Use of fibers enhances properties like flexural strength, impact, and fatigue strength of concrete. Steel fibers have wide range of application in road construction, airfield, and bridge decks. Properties of steel fibers are given below in the table

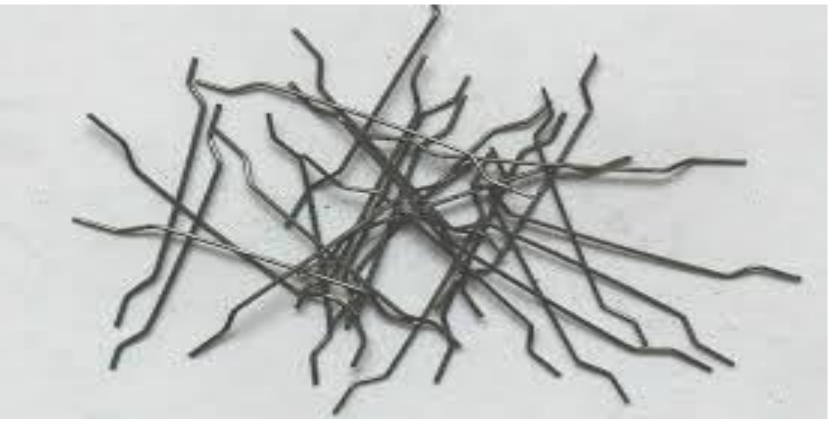


Fig.1 Steel Fiber

Table 3: Properties of Steel Fibers

Fiber Type	Hooked End Steel bar
Fiber length	35mm
Fiber diameter	0.55mm
Aspect Ratio	63.64
Orientation	Random

Glass Fibers

This study includes replacement of glass fibers from 0.1 to 0.4 percent by weight of cement; generally concrete produced by glass fibers is called GRC (glass fiber reinforced concrete). GR mortar is used for fabricating concrete products of section ranging from 3 to 12 mm thick, methods of manufacturing glass fibers include spraying, casting, spinning extruding and pressing. Each method of manufacturing gives us a different end product depending upon the end use. Applications of the GRC include cladding of the buildings used in temporary and permanent building formworks, pressure pipes, decorative grills, sun breakers, shutters and park benches. The properties of glass fiber used in the study are given below table.

Fig.2 Glass Fiber

Table 4: Properties of Glass Fiber

Fiber Type	E Glass Fiber
Fiber length	25mm
Fiber diameter	0.1mm
Aspect Ratio	250
Orientation	Random

III. EXPERIMENTAL PROCEDURE

This experiment has been carried on cubes, cylinders and beams. The various tests and details have been conducted on the materials and specimens. The testing procedure incorporated in this experiment is presented in the subsequent sections.

IV. CASTING AND MIXING PROPORTION

First a layer of coarse aggregate is spread over the tray. Then fibers are spread randomly over the aggregate. Then cement and fine aggregate are added into the mix. Then in water content which should be added the super plasticizer is added, and is added to the concrete mix. Here 6 cubes, 6 cylinders and 6 beams are casted according to the percentage respectively. Size of the cube-150mm x 150mm x 150mm, size of the cylinder-300 x 150ᶲ and size of the cylinder-500mm x 100mm x 100mm. the specimens were casted and after 24 hours were remolded from the molds and curing done for 7 days and 28 days respectively. The mix proportion of the M25 grade concrete obtained 1:2.25:3.76.

Table 5: Material Test Properties

S. No	Particulars of test	Test results
1	Specific gravity of coarse aggregate	2.8
2	Specific gravity of fine aggregate	2.67
3	Specific gravity of fly ash	2.2
4	Sieve analysis of fine aggregate	Zone II

V. TESTING RESULTS AND VALUES

Compressive Strength Test: The cubes are testing in the compression testing machine for the compressive strength. The specimen is placed in the center of the space in the testing machine and the load is applied uniformly without any external or internal shock. The increase of the load bearing capacity and the limit at where the specimen failed has been obtained. The testing of the 3 specimens of 0% fiber 12 specimens for steel fiber (1%,1.5%,2% % 2.5%) and 12 specimens of glass fiber (0.1%,0.2%,0.3% &0.4%) for 7 days and 28 days individually are taken and the results has been obtained.

Fig.3 Compressive testing of steel fiber cube

Fig.4 compressive testing of glass fiber cube

Split Tensile Strength Test: the split tensile also has been tested in the compression testing machine by placing perpendicularly longitudinal position and the load is applied, then the load bearing of the cylinders are obtained accordingly and the load where the specimen has failed has been noted.3 specimens for fly ash at 0% fiber and 12 specimens for steel fiber (1%,1.5%,2% % 2.5%) and 12 specimens of glass fiber (0.1%,0.2%,0.3% &0.4%) for 7 days and 28 days are taken.

Fig.5 Split tensile strength testing of specimen

Flexural Strength Test: In this modulus of rupture is calculated by testing specimens in the universal testing machine. In this line of fracture is the main important property in formulating the modulus of rupture.

The modulus of rupture is denoted by "fcr".3 specimens for fly ash at 0% fiber and 12 specimens for steel fiber (1%,1.5%,2% % 2.5%) and 12 specimens of glass fiber (0.1%,0.2%,0.3% &0.4%) for 7 days and 28 days are taken.

The 'f' value is mainly based on the shortest distance of line fracture 'a'

If 110mm < a < 133mm, fcr = 3PL/bd2

If a > 133mm, f cr= PL/bd2

If a < 110mm, the test shall be discarded.

Fig.6 Flexural strength testing of specimen

VI. RESULTS OBTAINED

Table 6: Optimum Value Of Fly Ash

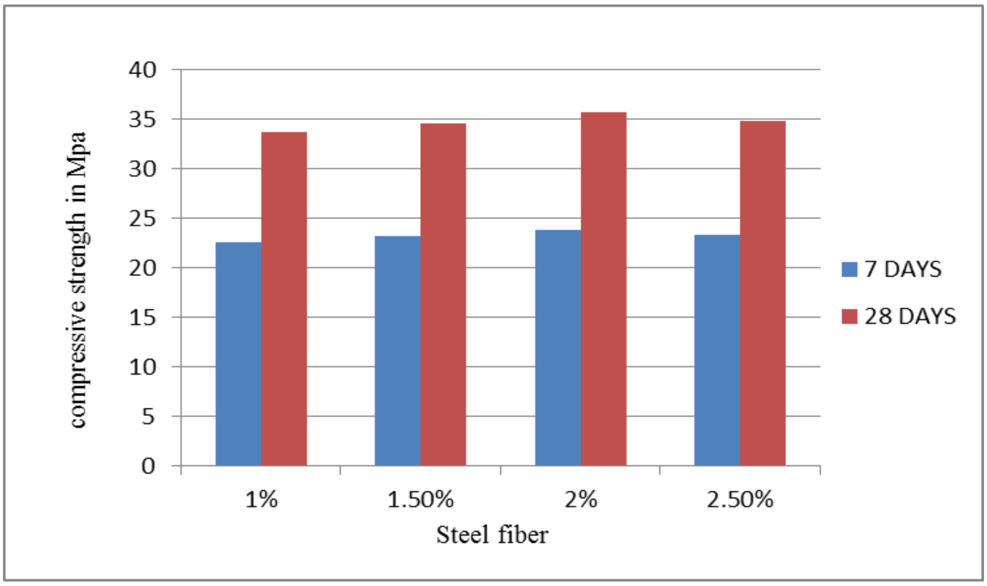
	7 DAYS	28 DAYS
FLY ASH 15%	22.54	31.89
FLY ASH 20%	23.56	32.54
FLY ASH 25%	24.84	33.52
FLY ASH 30%	23.54	32.32

Table 7: Strength values of the steel fiber specimens

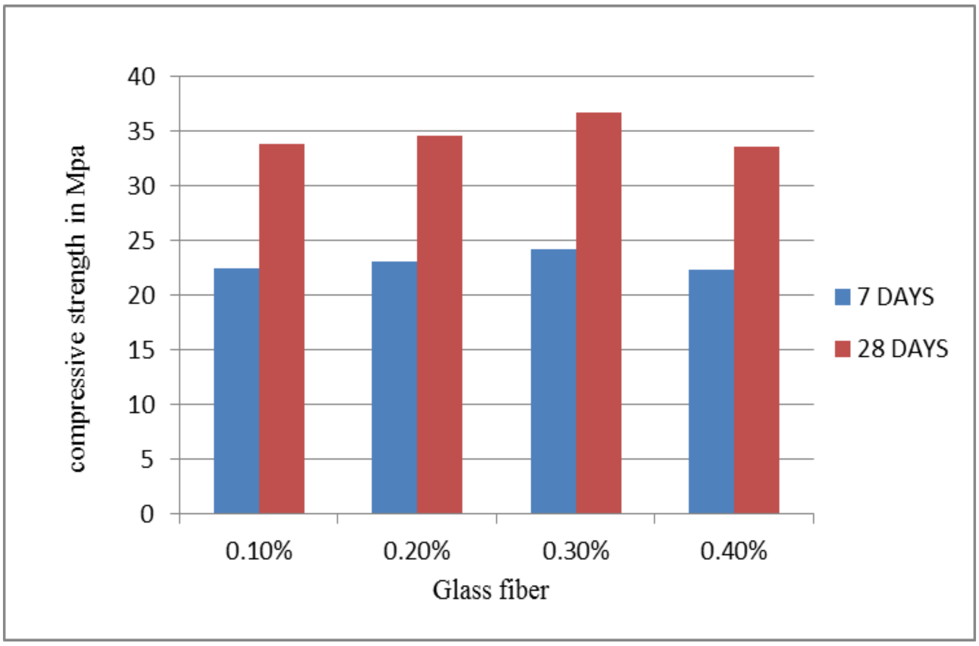
Steel %	TESTING					
	COMPRESSIVE STRENGTH		SPLIT TENSILE STRENGTH		FLEXURAL STRENGTH	
	7 DAYS CUBES	28 DAYS CUBES	7 DAYS CYLINDERS	28 DAYS CYLINDERS	7 DAYS BEAMS	28 DAYS BEAMS
1 %	22.56	33.67	2.4	3.58	2.44	3.65
1.5%	23.15	34.65	2.61	3.92	2.8	4.21
2%	23.82	35.68	2.75	4.12	3.05	4.56
2.5%	23.3	34.89	2.52	3.82	2.76	4.13

Table 8: Strength values of the glass fiber specimens

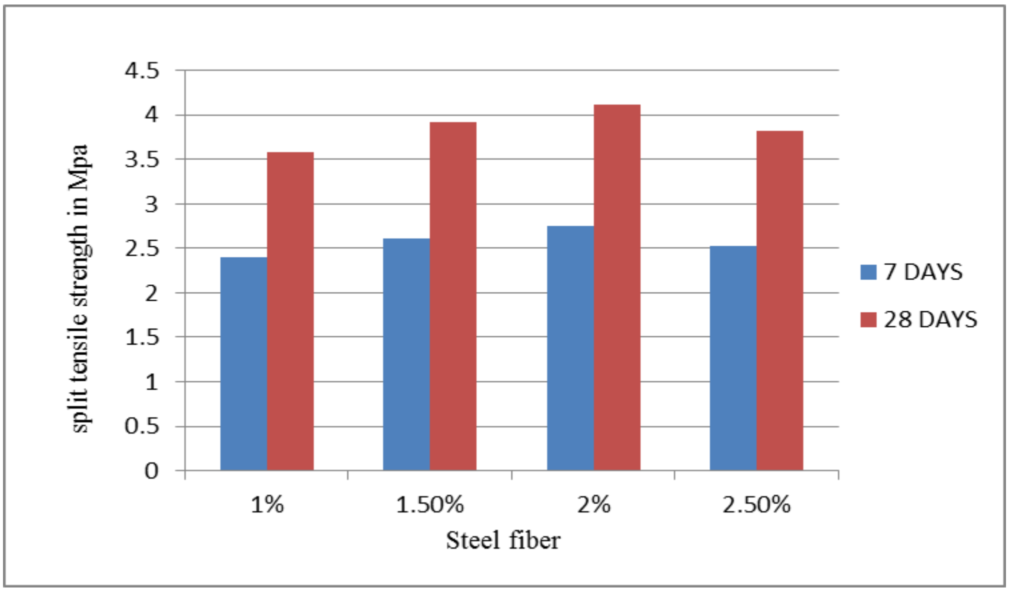
Glass %	TESTING					
	COMPRESSIVE STRENGTH		SPLIT TENSILE STRENGTH		FLEXURAL STRENGTH	
	7 DAYS CUBES	28 DAYS CUBES	7 DAYS CYLINDERS	28 DAYS CYLINDERS	7 DAYS BEAMS	28 DAYS BEAMS
0.1 %	22.5	33.84	2.65	3.96	2.22	3.31
0.2%	23.04	34.56	2.8	4.19	2.26	3.38
0.3%	24.23	36.68	2.92	4.32	2.34	3.5
0.4%	22.34	33.56	2.72	4.05	2.28	3.34



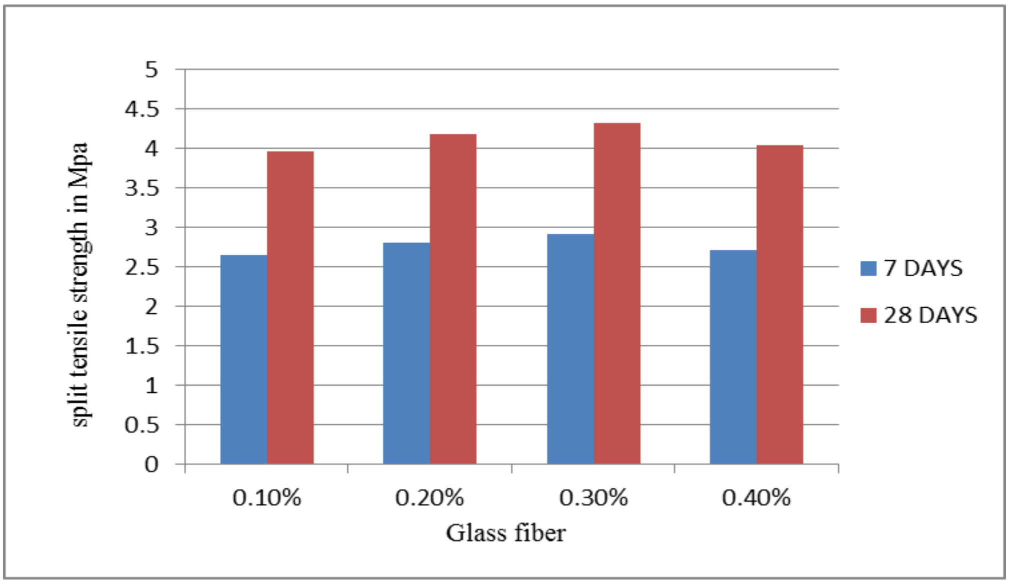
Graph 1:Compressive Strength of Steel Fiber



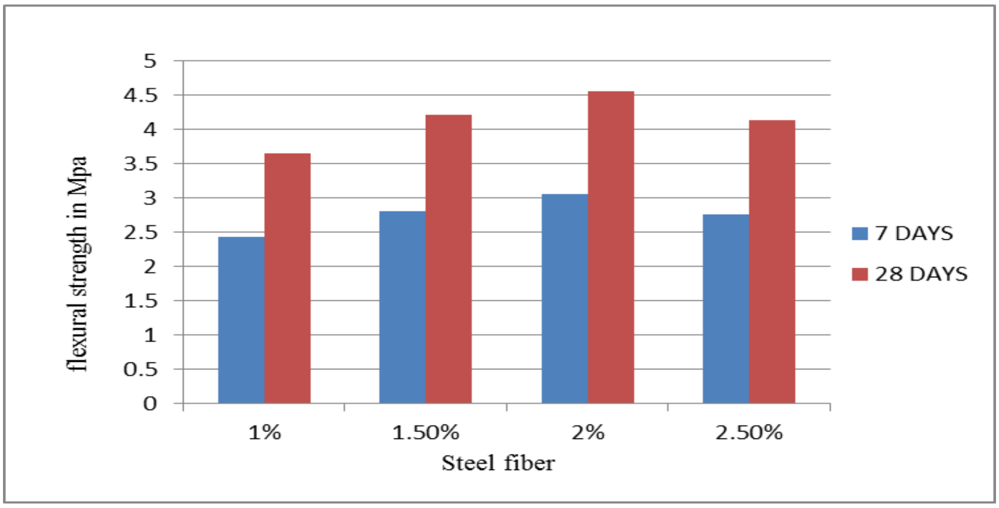
Graph 2:Compressive Strength of Glass Fiber



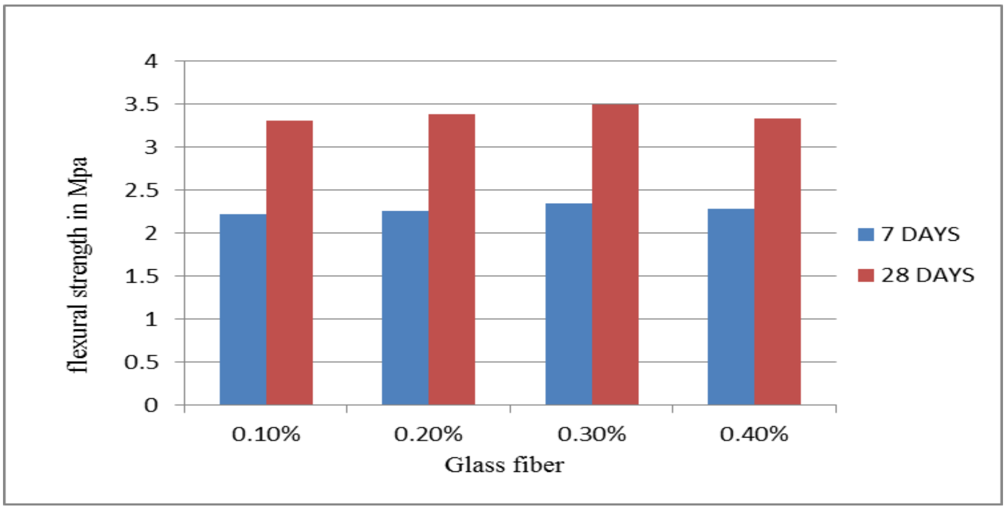
Graph 3:Split Tensile Strength of Steel Fiber



Graph 4:Split Tensile Strength of Glass Fiber



Graph 5:Flexural Strength of Steel Fiber



Graph 6:Flexural Strength of Glass Fiber

VII. CONCLUSION

In this experimental study the comparative study is done between steel fiber and glass fiber based fly ash concrete. The replacement of fly ash (class f) to the cement optimum is 25%.this study shows that strengths are higher when the steel fiber is added to the concrete but to compare the percent of steel fiber is more to the glass fiber, and there is also the case that the glass fiber is cannot added too much in the concrete. For strength we can use steel fibers but in the economical point of view we can use glass fiber.

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