STRENGTH PROPERTIES OF TERNARY BLENDED FIBER REINFORCED CONCRETE

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ABSTRACT: Cement industry may be one amongst the key sources of environmental pollution so the reduction of cement demand should be improved. Ground granulated blast furnace slag (GGBS) and silica fumes (SF) are the by-products of industries and it ought to be reused to scale back the waste pollution. Thus, this study investigated the employment of Ground granulated blast furnace slag and silica fume as a cement replacement in ternary homogenized cements on mechanical properties of mortar. In this experimental work cement is replaced by GGBS by 40%, 50%,60%,70% with respect to 5%,7.5%,10% of SF. Optimum mix is found from the total 12 mixes. Compressive strength of ternary blended concrete is higher than the regular concrete. Steel fibers are added at 0.5%,1.0%,1.5%, and 2.0% $v_f$to the optimum mix. Compressive strength test, flexural strength test, split tensile strength test, young's modulus test are conducted for the four mixes. Ternary blended cement mortar containing 7.5%SF and 50%GGBS by weight contribute in giving compressive strength higher than the regular concrete, The incorporation of FA with SF can enhance workability of blended cement mortar.

I. INTRODUCTION

Cement and concrete have high demand each in building and infrastructure development. Cement industry may be a one in every of the most important sources of environmental pollution. Main pollution of cement productions include; cement dirt, air pollution, water pollution, solid waste pollution sound pollution, ground vibration and resources depletion attributable to staple extraction. Moreover, carbon dioxide emission from burning method of cement business is that the main reason behind global warming. Therefore, the reduction of cement demand must be discussed to improve environmental pollution from cement industry. Nowadays, blended cement with pozzolanic materials such as fly ash (FA), granulated blast furnace slag (GGBS), silica fume (SF) and other natural pozzolona materials is widely used in cement and concrete construction by replacing part of cement especially Ground granulated blast furnace slag (GGBS or GGBFS) is obtained by quenching molten iron slag (a by-product of iron and steel-making) from a blast furnace in water or steam, to produce a glassy, granular product that is then dried and ground into a fine powder. Silica fume, also known as micro silica, is an amorphous (non-crystalline) polymorph of silicon dioxide silica. It is an ultrafine powder collected as a by-product of the silicon and ferrosilicon alloy production and consists of spherical particles with an average particle diameter of 150 nm. GGBS and SF is by-product from industry and supplementary cementitious materials. Ternary blended cement mixes with 42.5% OPC, 50% GGBS and 7.5% SF produced strengths higher to that of the control mix. This research work investigated the compressive strength of ternary blended cement concrete containing Ground granulated blast furnace slag and Silica fume. The successful utilization of GGBS and SF in ternary combination with OPC for making concrete would further add value to these wastes and reduce the volume of OPC currently required for civil engineering and building works

II. MATERIALS AND METHODOLOGY

Ordinary Portland cement was used in this research the chemical compositions OPC, FA and SF powder are given in Table1. River sand with specific gravity of 2.65 was used in the fine aggregate of mortar.

Table I Chemical composition of materials used in this research.

Property	Ordinary Portland cement	Ground granulated blast furnace slag	Silica fume
SiO2 content (%)	21	35	99.86
Al2O3 content (%)	5	12	0.043
Fe2O3 content (%)	3	1	0.040
CaO content (%)	62	40	0
Specific surface(m2/kg)	370	400	16500
Specific gravity	3.15	2.94	2.22

In this study, M30grade of concrete was used for entire study. GGBS was used to replace part of cement at 40%, 50%, 60% and 70% by weight while SF was used to replace part of cement at 5%, 7.5% and 10% by weight, respectively. Steel fibers of 0.5%, 1.0%, 1.5%, and 2.0%vf to the optimum mix from the above different proportions of ternary blended concrete. The fine aggregate to binder ratio of 1.25,coarse aggregate to binder ratio of 2.5and water to binder ratio of 0.4 were used. The mix proportions of different mixes are summarized in Table 2. The concrete mixes were mixed and cast into 100mmx100mmx100mm specimens and compacted using vibrator table. The mortar specimens were stored in

molds for 24 h. After demoulded cubes are kept in normal water for curing,the compressive strength was tested after end of respective curing periods. optimum mix is found out from the above 12 mixes and further research is continued by adding steel fibers of 0.5%,,1.0%,1.5%,2.0%vf to this mix. Concrete mixes were mixed and cast into 100mmx 100 mmx 100mm cubes, 500mmx 100mmx 100mm prisms, 100mmx 200mm cylinders, 150mmx 300mm cylinders.

Properties of steel fibers:

Sno	property	Value
1	Density	7850kg/m^3
2	Length of single fiber	35mm
3	Diameter of single fiber	0.55mm
4	a/d ratio	54.5
5	Type of fiber	Hooked

Table 2. Mix proportion of different mixes (kg/m^3)

Mixes	Materials					
	OPC	SF	GGBS	FA	CA	WATER
M_0	492.50	0	0	614.90	1134.57	197
M_1	270.87	24.62	197.00	614.90	1134.57	197
M_2	221.65	24.62	246.25	614.90	1134.57	197
M_3	172.50	24.62	295.50	614.90	1134.57	197
M_4	123.12	24.62	344.75	614.90	1134.57	197
M_5	258.62	36.93	197.00	614.90	1134.57	197
M_6	209.31	36.93	246.25	614.90	1134.57	197
M_7	160.06	36.93	295.50	614.90	1134.57	197
M_8	110.21	36.93	344.75	614.90	1134.57	197
M_9	246.25	49.25	197.00	614.90	1134.57	197
M_{10}	197.00	49.25	246.25	614.90	1134.57	197
M_{11}	147.75	49.25	295.50	614.90	1134.57	197
M_{12}	98.50	49.25	344.75	614.90	1134.57	197

III. TESTS CONDUCTED

Compression strength test: Compression strength test was conducted for different mixes for 7days and 28 days using compression test machine and the results were tabulated accordingly.

A. Flexural strength test: Flexural strength test was conducted on prisms of dimensions 100mm x 100mm x 500mm for 7days and 28days using flexural test machine and the results were tabulated

B. Split tensile test: Split tensile test was conducted on cylinders of dimensions 100mm x 200mm for 7days and 28days using compression test machine and the results were tabulated

C. Young's modulus test: Young's modulus testwas conducted on cylinders of dimensions 150mm x 300mm for 7days and 28days using compression test machine and the results were tabulated.

IV. RESULTS AND DISCUSSIONS

Effect of Binder Combination on Strength Characteristics

The results of the compressive strength of concrete containing ternary binder of OPC-GGBS-SF and that of the reference concrete are summarized in Table 3. Each value is the average of a triplicate test result

Table3. Results for compression strength test for ternary blended concrete

Mixes	Compressive strength(MPa)	
	7days	28days
M_0	37.5	38.9
M_1	33.5	38.2
M_2	29.0	39.2
M_3	26.1	37.1
M_4	25.2	25.7
M_5	27.9	35.4
M_6	29.4	43.7
M_7	24.6	35.2
M_8	17.2	25.5
M_9	33.8	39.9
M_{10}	31.9	41.7
M_{11}	26.8	34.6
M_{12}	21.1	27.7

Fig1 explains the compressive strength for the total 12 mixes with respective to the nominal mix of strength 38.9MPa for 28 days

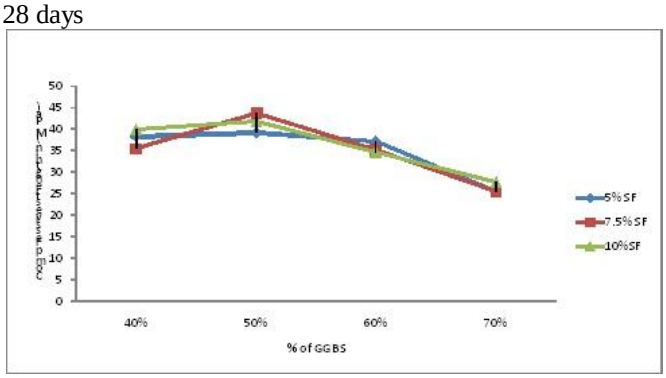

Fig1: Compression strength test graph for ternary blended concrete for 28days

From the above Table3 M6has got maximum compressive strength of 43.7MPa compared to other mixes for 28days. So replacing of cement by 50% GGBS and 7.5% SF gives higher strength than nominal mix. For the above mix steel fibers are added by 0.5%, 1.0%, 1.5%, 2.0% of the volume of concrete. Table4 shows the compressive strength, flexural strength, split tensile strength, young's modulus of the 4

different proportions of steel mixes. Table4. Results for compressive strength, flexural strength, split tensile strength, Young's modulus for ternary blended fiber concrete Fig2, fig3, fig4, fig5 shows the values ternary blended fiber reinforced concrete of the respective tests

Mixes	Compressive strength(MPa)		Flexural strength(MPa)		Split tensile strength		Young's modulus	
	7days	28days	7days	28days	7days	28days	----------	28days
M_{61}	33.5	45.5	2.35	4.65	1.68	3.78	----------	29286
M_{62}	35.7	48.3	2.59	5.10	1.81	4.04	----------	32995
M_{63}	35.2	46.4	2.88	5.57	1.97	4.42	----------	33609
M_{64}	33.1	42.2	3.07	6.70	2.08	4.47	----------	33850

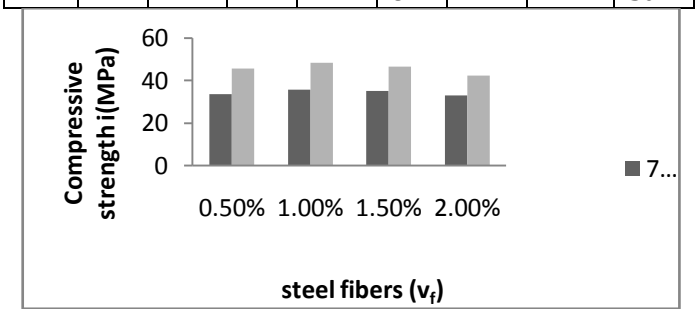

Fig2: Compression strength for ternary blended fiber concrete of 7days and 28days

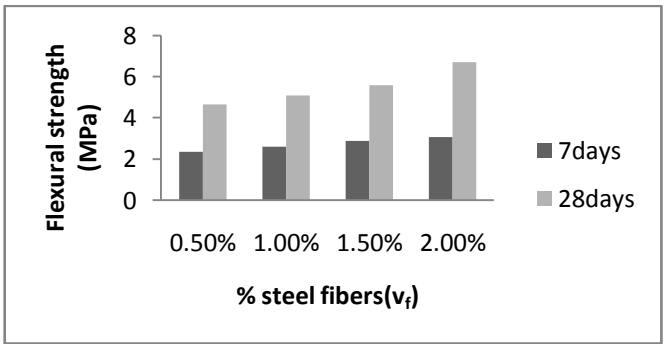

Fig3: Flexural strength test for ternary blended fiber concrete of 7days and 28days

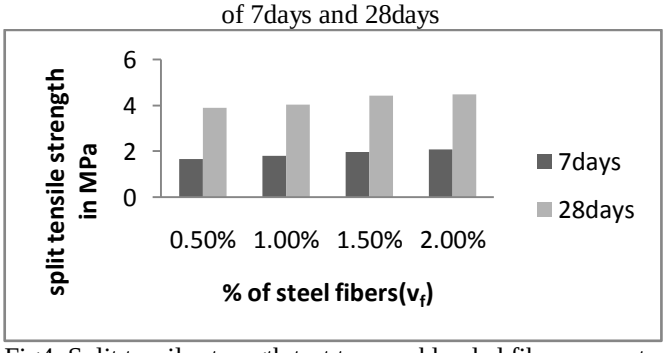

Fig4: Split tensile strength test ternary blended fiber concrete for 7days and 28days

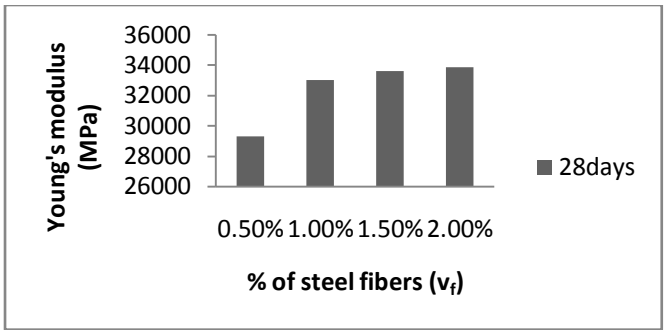

Fig4: Young's modulus for ternary blended fiber concrete of 28days

V. CONCLUSIONS

Based on the different mixes and various tests conducted the conclusions were

- With the replacement of cement by 50%GGBS and 7.5% silica fume gives high compressive strength values compared to nominal mix
- Among the different percentages of steel fibers i.e. 0.5%, 1.0%, 1.5%, 2.0% the optimum percentage which yielded higher compressive strength is 1.0%. hence percentage of steel fiber is confined to 1%
- Among the different percentages of steel fibers i.e. 0.5%, 1.0%, 1.5%, 2.0% the optimum percentage which yielded higher flexural strength is 2.0%. hence percentage of steel fiber is confined to 2%
- Among the different percentages of steel fibers i.e. 0.5%, 1.0%, 1.5%, 2.0% the optimum percentage which yielded split tensile strength is 1.5%. hence percentage of steel fiber is confined to 1.5%
- Among the different percentages of steel fibers i.e. 0.5%, 1.0%, 1.5%, 2.0% the optimum percentage which yielded higher young's modulus is 2.0%. hence percentage of steel fiber is confined to 2%

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