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Experimental Study on Glass Fibre Reinforced Steel Slag Concrete with Fly Ash

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Abstract **- Concrete is a mixture of cement, fine aggregate, coarse aggregate and water. Globally concrete is the backbone for the large development of infrastructure. With the experimental investigations and proven results mineral admixtures and other waste materials are used in the concrete successively. In this present experimental study, the flexural strength of beam for both the conventional concrete and steel slag glass fibre reinforced fly ash concrete is compared for M30 grade of concrete. The test to be done is having 1% of glass fibre to the volume of concrete, steel slag is added at a constant percentage of (30%) by weight of fine aggregate throughout this experimental study. The mineral admixture fly ash has been added at three different percentages (ie; 5%, 10% and 15%) by weight of cement. Flexural strength of beam is identified.**
Keywords: **Glass Fibre, Steel Slag, Concrete, Fly Ash**

I. INTRODUCTION

Concrete is a mixture of cement, fine aggregate, coarse aggregate and water. Globally concrete is the backbone for the large development of infrastructure viz., buildings, industrial structures, bridges and highways etc. leading to the utilization of large quantity of concrete. In today's situation concrete needs special combinations of performance and uniformity requirements that cannot be always achieved by using conventional constituents and normal mixing. This leads to search for admixtures to improve the performance of the concrete. With the experimental investigations and proven results mineral admixtures and other waste materials are used in the concrete successively.

II. REVIEW OF LITERATURE

In India, more than 70 thermal power plants are the source of fly ash. More than 110MT of coal is used annually and 40MT of fly ash is produced every year. If used their disposal needs 28,300 hectares storage land, which may further cause severe ecological problems. Fly ash may be utilized in production of concrete in many forms such as cement clinker in manufacture of cement as cementitious material for partial replacement of sand and as coarse aggregate by making sintered of fly ash aggregate. Some of the literature reviews supporting my project topics are discussed in detail below.

Prof. Mrs. A. I. Tamboli *et al.*, (2015), studied compressive strength of steel slag aggregate and artificial sand in concrete. This research deals with substantial replacement of natural aggregates and natural sand used in concrete. In this study coarse aggregate were partially replaced with steel slag aggregate with different replacement percentage in concrete i.e. 0%, 10%, 20%, and 30%.

Virendra Kumara K. N and S. B. Anadinni *et al.*, (2015), studied the suitability of steel slag and e-sand in glass fibre fly ash based concrete.

P. S. Kothai and R. Malathy *et al.*, (2014), analysed the Utilization of steel slag in concrete as a partial replacement material for fine aggregates. In this experimental investigation an attempt is made to study the effect of partial replacement of fine aggregate by steel slag in the mechanical properties of M20 grade concrete.

M. Soundar Rajan *et al.*, (2014), studied the strength properties of concrete by partially replacement of sand by steel slag. The primary aim of this research was to evaluate the strength of concrete made with steel slag as replacement for fine aggregates.

III. CONCRETE MIX DESIGN AS PER INDIAN STANDARD

The mix was designed for the characteristic compressive strength of 30 N/mm^2 as per IS guidelines and proportioning by weight and volume were arrived. All the materials were weighed and used.

The concrete mix details are furnished below:

1. Proportioning

Grade designation	: M30
Type of cement	: OPC
Maximum size of aggregate	: 20 mm
Maximum water cement ratio	: 0.45
Minimum cement content	: 320 Kg/m3
320 Kg/m3 (other than 20 mm)	
Workability	: 100 mm
Exposure condition	: Severe condition
Method of concrete placing	: Pumping
Degree of supervision	: Good
Chemical admixture	: Super Plasticizer

2. Test Data for Materials

Cement used : OPC
Specific gravity of cement : 3.15
Specific gravity of coarse aggregate: 2.74
Specific gravity of fine aggregate : 2.74

3. Target Mean Strength

f'ck = fck + 1.65s
= 30 + 1.65s
= 38.25 N/mm2

4. Selection of Water Cement Ratio

Maximum water cement ratio : 0.45
Selection of water content
From table 2
Maximum water content : 197 litre (100mm slump)
Assuming that using plasticizers the content may be reduced up to 20%
By reduction up to 11 % = 197 x 0.89
= 175.33 lit

5. Calculation of Cement Content

Water cement ratio : 0.45
Cement content : 389.62 kg/m3
389.62 kg/m3 > 320 kg/m3
Hence ok.

6. Volume of Coarse Aggregate and Fine Aggregate

Volume of CA for w/c ratio of 0.45 = 0.56
Volume of FA = 1 – 0.56
= 0.38

7. Mix Calculations

Volume of concrete = 1 m3
Volume of cement = (Mass of cement/Specific gravity of cement) x (1/1000)
= (389.62/3.15) x (1/1000)
= 0.124 m3
Volume of water = (175.33/1) x (1/1000)
= 0.17533 m3
Volume of Chemical Admixtures = Mass of Admixtures/ Sp.gravity of Admixtures)x (1/1000)
= (7.8/1.062) x (1/1000)
= 0.00735 m3
Volume of all aggregates = 1-(0.138+0.175+0.00735)
= 0.679 m3
Mass of CA = 0.679 x 0.56 x 2.74 x 1000
= 1041.86 kg
Mass of FA = 0.679 x 0.44 x 2.74 x 1000
= 818.60 kg

8. Mix Proportions for Trial Number Cement

Cement : 389.62 kg/m3
Fine aggregate : 818.60 kg/m3
Coarse aggregate : 1041.86 kg/m3
Water : 175.33 litre
Admixtures : 7.8 kg /m3
Water-cement ratio : 0.45

IV. RESULTS AND DISCUSSION

TABLE I COMPRESSIVE STRENGTH RESULTS

% Replacement of Steel Slag	7 Days N/mm^2	28 Days N/mm^2
0%	23.17	33.11
20%	24.25	35.37
30%	28.88	39.12
40%	26.8	36.16

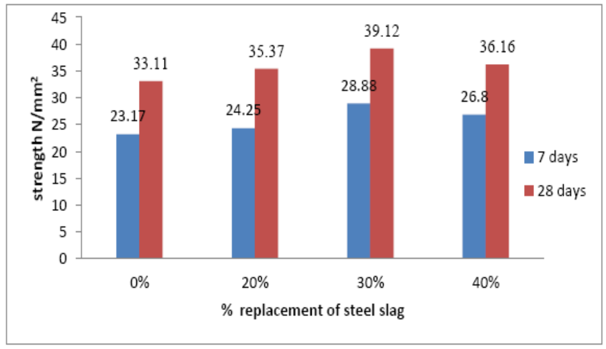

Fig. 1 Compressive strength test result for steel slag

The above chart represents the strength of the cube in 7 days, 14 days, and 28 days for both conventional concrete and replacement of cement in concrete by different ratios of Steel slag. When compared with the conventional concrete this figure shows the increment in the strength and when it reaches to an optimum rage it shows slight decrement so hence concluded that the maximum compressive strength is obtained at the optimum range of 30% replacement.

TABLE II SPLIT TENSILE TEST RESULTS

% Replacement of Steel Slag	7 Days N/mm^2	28 Days N/mm^2
0%	2.73	3.9
20%	3.12	4.45
30%	3.34	4.8
40%	3.09	4.57

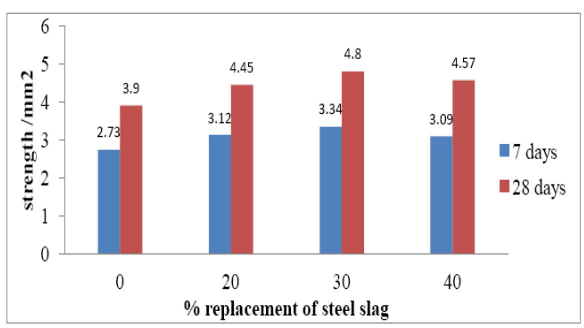

Fig. 2 Split tensile strength test result for steel slag

The above chart shows detail description of steel slag concrete for 7 days and 28 days of curing. When compared with the conventional concrete this figure shows the increment in the strength and when it reaches to an optimum rage it shows slight decrement so hence concluded that the maximum tensile strength is obtained at the optimum range of 30% replacement.

TABLE III FLEXURAL STRENGTH TEST

% Replacement of Steel Slag	28 Days N/mm^2
0%	4.1
20%	5.2
30%	5.82
40%	5.64

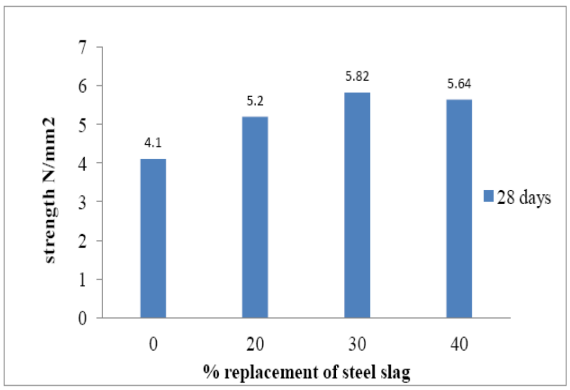

Fig. 3 Flexural strength test result for steel slag

For the above chart shows the detail description of steel slag concrete for 28 days of curing. When compared with the conventional concrete this figure shows the increment in the strength and when it reaches to an optimum rage it shows slight decrement so hence concluded that the maximum Flexural strength is obtained at the optimum range of 30% replacement.

TABLE IV SPLIT TENSILE STRENGTH TEST FOR THE REPLACEMENT OF 30% STEEL SLAG

Sl no	Name of Specimen	% of replacement (SS+FA+GF)	Tensile strength N/mm^2			
			7 days	Mean value	28 days	Mean value
1	S0C1	0+0+0	2.29	2.73	4.12	3.9
	S0C2		2.32		3.98	
	S0C3		2.73		3.99	
2	S30C1	30+5+1	3.3	3.2	4.4	4.45
	S30C2		3.15		4.56	
	S30C3		3.3		4.35	
3	S30C1	30+10+1	3.6	3.57	5.1	5.1
	S30C2		3.55		4.9	
	S30C3		3.57		4.97	
4	S30C1	30+15+1	3.28	3.21	5.1	4.59
	S30C2		3.19		4.85	
	S30C3		3.23		4.84	

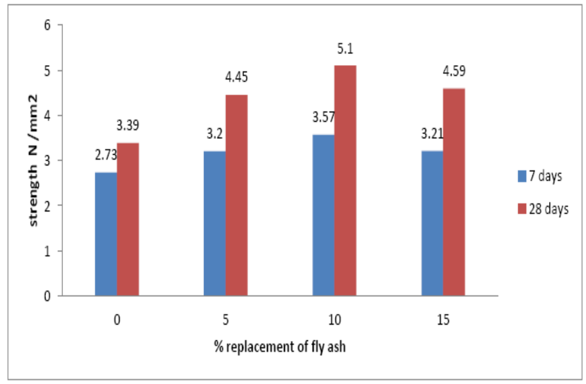

Fig. 4 Split tensile strength test for the replacement of 30% steel slag

When compared with the conventional concrete this figure shows the increment in the strength at 10% and when it reaches to an optimum rage it shows slight decrement so hence concluded that the maximum Tensile strength is obtained at the optimum range of 10% replacement.

TABLE V FLEXURAL STRENGTH TEST ANALYSIS FOR 28 DAYS CURING

Sl no	Name of Specimen	% of replacement (SS+FA+GF)	Flexural strength N/mm^2	
			28 days	Mean value
1	F0P1	0+0+0	4.85	4.1
	F0P2		4.9	
	F0P3		4.62	
2	F30P1	30+5+1	5.33	5.33
	F30P2		5.32	
	F30P3		5.31	
3	F30P1	30+10+1	6.08	6.04
	F30P2		6.09	
	F30P3		6.11	
4	F30P1	30+15+1	5.6	5.61
	F30P2		5.58	
	F30P3		5.62	

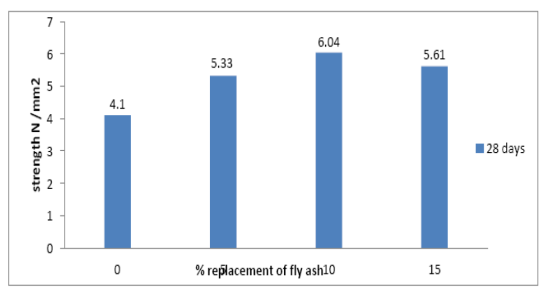

Fig. 5 Flexural strength test result for fly ash at 28 days

For the above figure shows the detail description of Glass fibre reinforced steel slag concrete with fly ash for 7 days and 28 days of curing. glass fibre(1%) and steel slag (30%) were added. When compared with the conventional concrete this figure shows the increment in the strength at 10% and when it reaches to an optimum rage it shows slight decrement so hence concluded that the maximum Flexural strength is obtained at the optimum range of 10% replacement.

V. CONCLUSION

This study was carried to obtain the results, test conducted on the glass fibre reinforced steel slag concrete with different percentages. The following conclusion could be drawn from the present work:

1. At the optimum percentage (30%) of steel slag the mechanical properties of the concrete increased at 10%.
2. At 20% of concrete proportion there is a considerable reduction in the mechanical strength.
3. The result showed that addition of steel slag, fly ash and glass fibre in to OPC mixture enhanced its compressive strength as well as the tensile and flexural strength.
4. Also it increased the workability of the fresh concrete due to the addition of super plasticizer and fly ash to the concrete.
5. In general from the above study it was incurred that, the performance of glass fibre reinforced steel slag fly ash concrete proves to be better than the normal concrete and very much comparable with other fiber reinforced concrete regarding its mechanical properties.
6. Based on the finding of this study, the following conclusions were drawn: addition of glass fibre increases flexural and compressive strength of concrete. Addition of glass fibres in the concrete mix significantly influenced the cracking behavior and ultimate strength of beams.

VI. FUTURE SCOPE OF THE PROJECT

1. The waste material steel slag can be used as supplementary cementious material in concrete for the purpose of construction.
2. As well as it act as a good binding material when used for the replacement of fine aggregate.
3. Steel slag can achieve good strength when compared to normal concrete.
4. Replacement in different percentages of fly ash to concrete judge an optimum percentage of better strength result than plain concrete.
5. Research on steel slag, glass fibre and fly ash can minimize the cost and at the same time achieve good strength and durability.

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