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Study on Compressive Strength of M30 Grade Concrete with Partial Replacement Of C.A with Electrical ARC Furnace Slag

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Abstract: ***In this research we have replace different proportion percentage of normal aggregate with Electric Arc Furnace Slag aggregate and compared with conventional concrete. The compressive strength and tensile strength test is determined for different mix. The grade of concrete used is M30. Different mixes are made such as Mix A , Concrete mix without substitution of Electric arc furnace slag. Mix B, 25% replacement of coarse aggregate with Electric arc furnace slag. Mix C, 50% replacement of coarse aggregate with Electric arc furnace slag. Mix D, 75% replacement of coarse aggregate with Electric arc furnace slag. Electric Arc Furnace slag. In the experimental study we found that adding 25% of slag will increase the compressive strength as compared to conventional concrete. The EAF slag is procured from Vardhman Steel Company located at Ludhiana.***
Keywords: ***Concrete, Replacement, Electric arc furnace slag, Compressive strength, Tensile strength***

I. INTRODUCTION

Electric arc furnace slag, an industrial by-product of steel and iron manufacturing industry, must be recycled because it has increased proportionately with the development of the steel industry. Big steel plants in India generate about 29 million of tonnes of waste material annually. The waste produced from steel industry are dangerous for both industry as well as human life so it can be used in construction work so that slag can be utilized in a better manner. Electric arc furnace slag has a high specific gravity; it can produce heavy weight concrete if used as an aggregate for structural concrete. Since most heavy weight aggregates are obtained naturally, substitute aggregates must be developed for environmental preservation and protection. From this point of view, the use of EAF slag as aggregates holds great significance.



Fig 1 Electric Arc Furnace Slag

Tests are done as per the following codes of Bureau of Indian Standards. The test for compressive strength on cubes of size (150 × 150 × 150 mm) measured at 7, 21 and 28 days of curing as per IS: 516-1959 and test for tensile strength on cylinder (300 × 150 mm) measured at 7, 21 and 28 days of curing as per IS: 5816-1999.

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Various numerical calculations were performed to know about the quantity of cement, coarse aggregate and fine aggregate to be added together to form a workable mixture.

The code which we followed for mix design is IS 10262:2009, The mix design is M30

Cement: Sand: Coarse Aggregate

1: 2.06 : 2.15

II. EXPERIMENT PERFORMED

A. Compressive strength

The compression test is carried out on specimens cubical in shape of the size 150 × 150 × 150 mm. The compressive strength is determine for different mix at 7, 21 and 28 days. The test is carried out in the following steps: First of all the mould preferably of cast iron, is used to prepare the specimen of size 150 × 150 × 150 mm The concrete is poured in the mould and tempered properly so as not to have any voids. After 24 hours these moulds are removed and test specimens are put in water for curing. The top surface of these specimen should be made even and smooth. During the placing of concrete in the moulds it is compacted with the tamping bar with not less than 35 strokes per layer. The specimen is removed from the mould after 24 hours and left for curing for respective days. After 7, 14 and 28 days the specimens are tested under the load in a compression testing machine.

B. Tensile strength

When the tensile force is applied to concrete the cracks are developed so Splitting tensile strength test on concrete cylinder is a method to determine the tensile strength of concrete. The concrete is very weak in tension due to its brittle nature and is not expected to resist the direct tension it is necessary to determine the tensile strength of concrete to determine the load at which the concrete members may crack. The tensile test is carried out on specimen's cylindical in shape of the size 150 mm diameter and 300 mm length. During the placing of concrete in the moulds it is compacted with the tamping bar with not less than 35 strokes per layer. The specimen is removed from the mould after 24 hours and left for curing for respective days. After 7, 14 and 28 days all the concrete cylinder thus prepared were then tested for its compressive strength in compression Testing Machine (CTM) and accordingly its tensile strength is checked with respect to compressive strength.

The empirical formula given by Raphael for finding tensile strength of cylinder with respect to compressive strength of cylinder is

ft = 0.3(fc)^2/3

Where ft is splitting tensile strength and fc is compressive strength of cylinders

C. Mechanical Property Test for EAF Slag

The different test are conducted for EAF slag aggregate such as Impact test, Abrasion test, Crushing test and Specific Gravity test therefore all these test are compared with the properties of normal aggregate. After the experimental result conclusion it is made clear weather we can use EAF slag aggregate as road pavement also by comparing all the valves with normal aggregate test.

III.EXPERIMENTAL RESULT OBTAINED

All paragraphs must be indented. All paragraphs must be justified, i.e. both left-justified and right-justified.

A. Compressive strength

The concrete cube was prepared by mixing cement, fine aggregate and coarse aggregate in the ratio of 1:2.06:2.15 and a water content of 0.55. The mix was filled in the mould of standard vibrating machine and allowed to vibrate for a period of 2 minutes at a specified speed of 12000□400 per 8 minutes to achieve full compaction. The mould was then kept at a temperature of 27□2 C for 24 hours. The above procedure was repeated by replacing the coarse aggregate by electric arc furnace slag by, 25%, 50% and 75% of its total weight to produce concrete cubes with varying proportions of electric arc furnace slag. All the concrete cubes thus prepared were then tested for its compressive strength in compression Testing Machine (CTM).

Formula Used:

$$\text{Compressive Strength} = \frac{\text{Load In Newton}}{\text{Area of Cube } (Mm^2)}$$

Area of Cube = 150 X 150 mm

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TABLE I
COMPRESSIVE STRENGTH OF MIX A & MIX B (N/MM^2)

	MIX A				MIX B			
DAYS	SPECIMEN 1	SPECIMEN 2	SPECIMEN 3	MEAN	SPECIMEN 1	SPECIMEN 2	SPECIMEN 3	MEAN
7 DAYS	18.71	17.94	18.22	18.29	22.76	20.83	21.68	21.75
21 DAYS	25.29	26.91	26.22	26.14	35.07	35.18	34.66	34.97
28 DAYS	30.12	32.38	32.60	31.70	39.05	36.38	37.73	37.72

TABLE II
COMPRESSIVE STRENGTH OF MIX C & MIX D (N/mm^2)

	MIX C				MIX D			
DAYS	SPECIMEN 1	SPECIMEN 2	SPECIMEN 3	MEAN	SPECIMEN 1	SPECIMEN 2	SPECIMEN 3	MEAN
7 DAYS	15.84	14.61	15.11	15.18	21.04	18.67	19.64	19.78
21 DAYS	26.54	27.63	27.24	27.13	23.37	31.26	30.88	28.50
28 DAYS	28.59	28.16	28.36	28.37	32.34	33.42	31.35	32.87

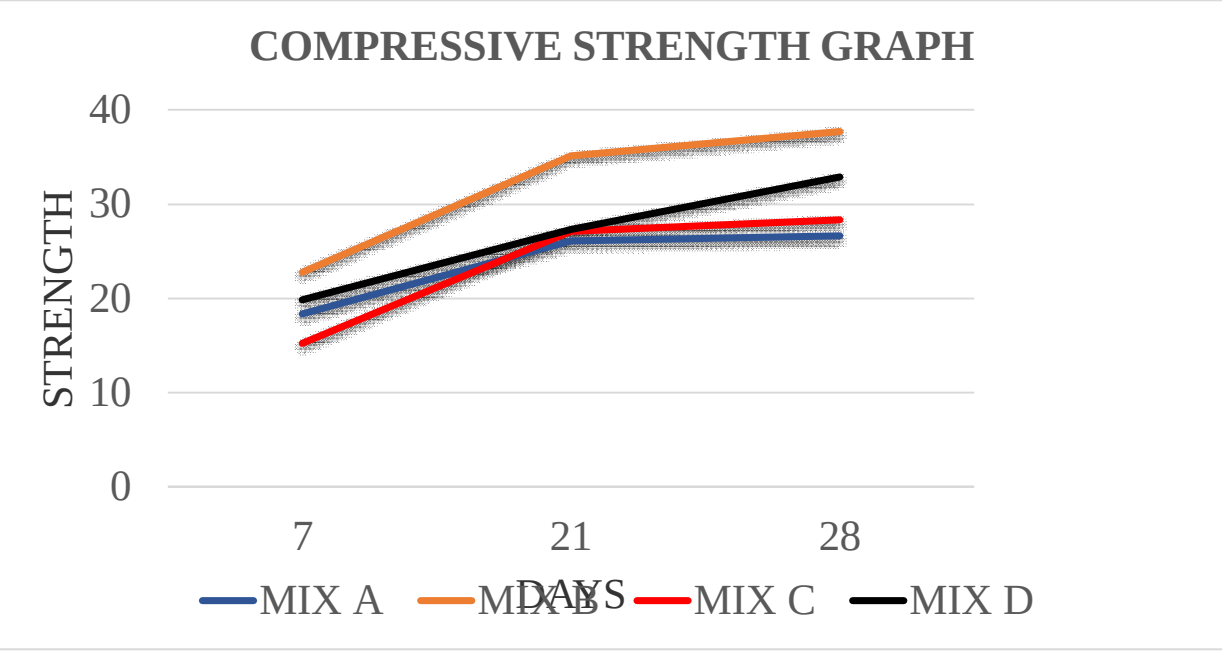


Figure 2: Line Graph Representation of Compressive Strength

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B. Tensile strength

TABLE III
TENSILE STRENGTH OF CYLINDER FOR MIX A & B (N/mm^2)

	MIX A			MIX B		
DAYS	SPECIMEN 1	SPECIMEN 2	MEAN	SPECIMEN 1	SPECIMEN 2	MEAN
7 DAYS	2.27	2.35	2.48	2.33	2.39	2.47
21 DAYS	2.58	2.62	2.60	2.55	2.56	2.55
28 DAYS	2.61	2.63	2.62	2.96	2.98	2.97

TABLE IV
TENSILE STRENGTH OF CYLINDER FOR MIX C & D (N/mm^2)

	MIX C			MIX D		
DAYS	SPECIMEN 1	SPECIMEN 2	MEAN	SPECIMEN 1	SPECIMEN 2	MEAN
7 DAYS	2.23	2.26	2.39	2.36	2.41	2.90
21 DAYS	2.49	2.53	2.51	3.32	3.39	3.35
28 DAYS	2.40	2.64	2.52	3.7	3.9	3.8

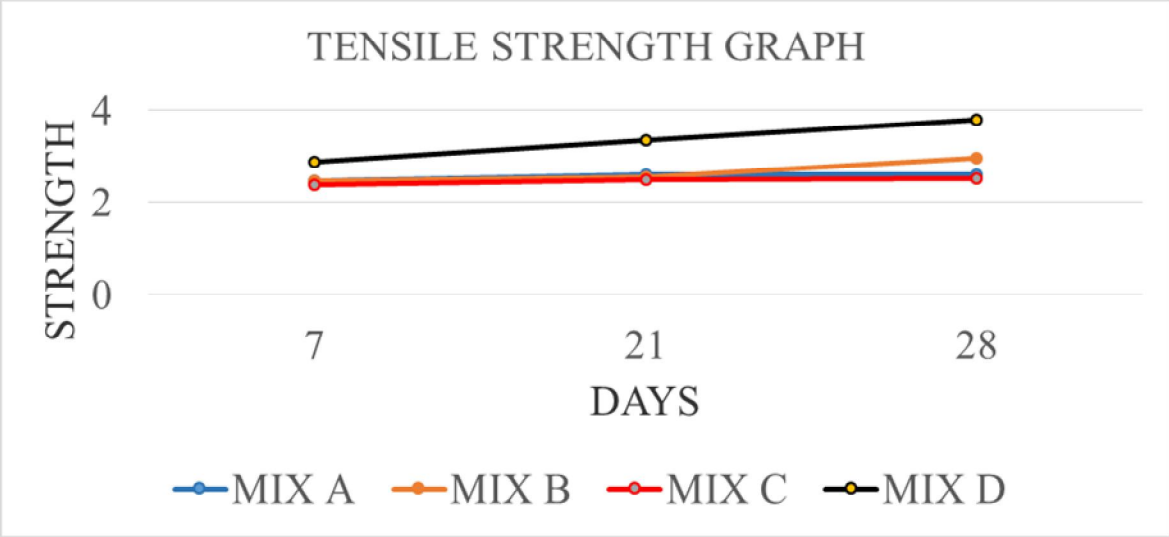


Figure 3: Line Graph Representation of Tensile Strength

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TABLE V

COMPARISON OF PROPERTIES OF COARSE AGGREGATE AND EAF SLAG

PROPERTY	COARSE AGGREGATE	EAF SLAG	RANGE
Crushing Test	19.8%	25.90%	Up to 30%
Abrasion Test	24%	18.28%	Up to 30%
Impact Test	13.15%	16.57%	10-20%
Specific Gravity Test	2.74	3.460	3.3-3.8

The electric arc furnace slag have high crushing and impact valve as compared to normal aggregate, it also have high specific gravity, but it has low abrasion valve as compared to normal aggregate test result.

IV. CONCLUSIONS

A. Electric Arc Furnace slag is a by product of steel production, which is considered to be a problematic residue to dispose safely. Using such material effectively in concrete will solve the pollution and disposal problems and it will become an economical and environmental friendly solution for the local region. Thus, it is becoming more important to find suitable alternatives for aggregates in the future. It can be used partially from the steel industries in addition to mining of natural stones.

B. The results showed that, it has properties similar to natural aggregates and it would not cause any harm if used in the production of concrete. Since the results shows that using electric arc furnace slag up to 25% of replacement as coarse aggregates in concrete has no negative effects on the short term properties, as well as the strength of hardened concrete.

C. The slight improvement in strength may be due to shape, size and surface texture of EAF slag aggregates, which provide better interlocking and bond between the particles and cement.

D. It has high specific gravity so it my produce heavy weight structure.

E. It is concluded that the strength of M30 grade of concrete is increased with using EAF slag as a 25% replacement of coarse aggregates.

F. The cost of industrial EAF slag is low as compare to the coarse aggregates hence it is economical to use the Electric arc furnace slag especially in the local regions.

G. In plane concrete application, it could be recommended that electric arc furnace slag could be utilized as coarse aggregate.

H. Electric arc furnace slag can be used in road pavement for sub base construction because it has good mechanical property as compared to normal aggregate.

I. Since the EAF slag contain more amount of calcium oxide, when water percolates through cracks or joints, the lime compound with in the concrete leached out which leads to formation of salt deposits on the surface of concrete.

V. ACKNOWLEDGMENT

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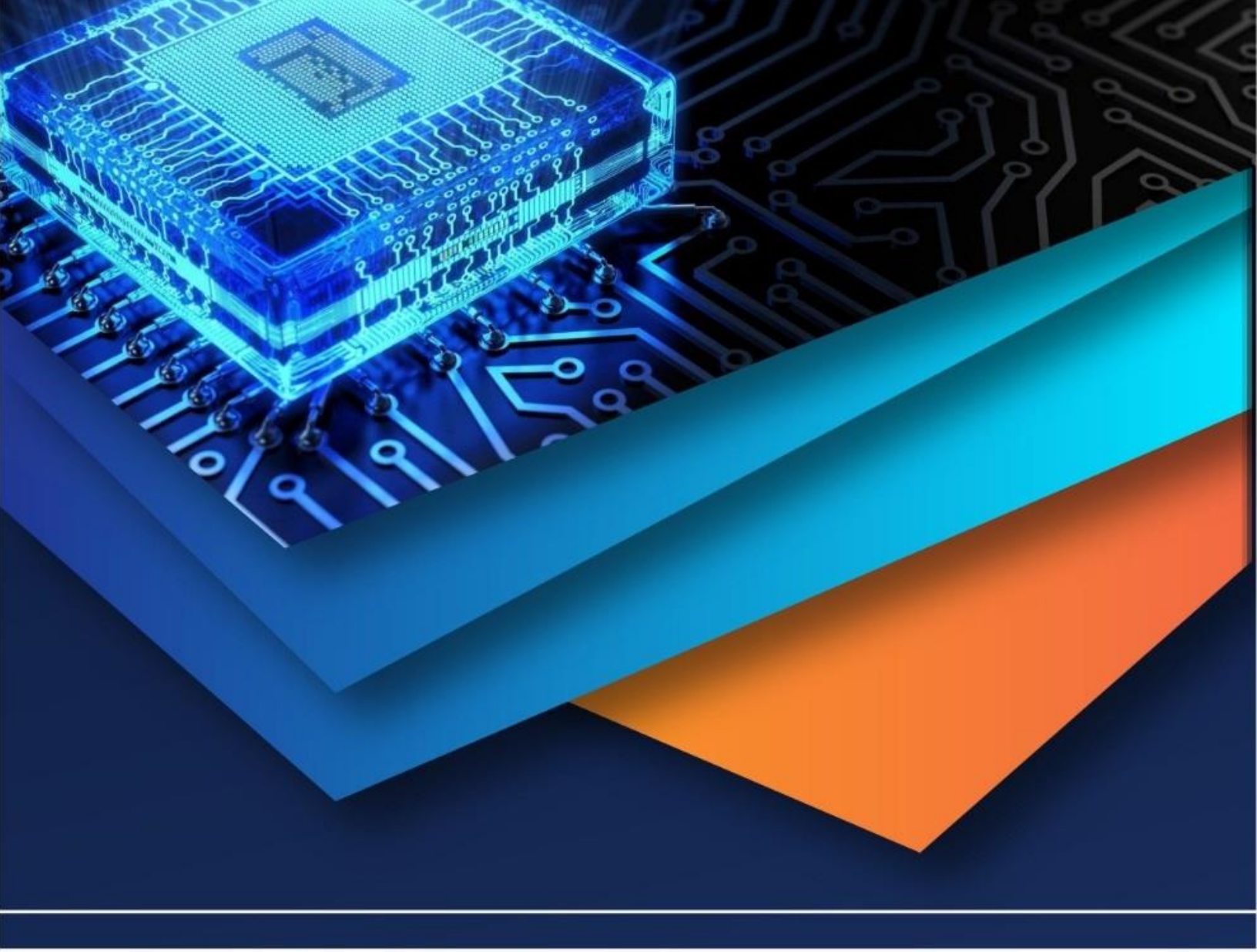
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