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SLAG THE BEST OPPORTUNITY TO SAVE NATURAL RESOURCES

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ABSTRACT

Millions of tonnes of slag are produced in India and abroad on annual basis. The slag has two aspects i.e., right use and wrong use. As per as the right use of slag is concerned that can be used as a raw material in the process of concrete strength and on the other hand the wrong use of slag which is produced at high volume is to throw the slag in the environment which deteriorates the efficiency of the environment. Most of the researchers and Government agencies are working on the programme to safeguard the environment through different means. As for as the present research is concerned the researcher has utilized the iron slag as the partial replacement of cement in the process of concrete production. The study concludes that the use of iron slag in the process of concrete strength is beneficial up to the replacement percentage of 30 in cement. Iron slag can be used up to the replacement percentage of 30 with all the ingredients of concrete as for as the previous researches are concerned. Which means that around 30% of the natural resources can be saved and on the other hand the environment can be saved by around 30% of waste which is utilized in the process of concrete production, hence around 30% of the iron slag need not to be dumped in land fills.

Keywords: Slag, Iron Slag, Compressive Strength and Concrete Strength

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1. INTRODUCTION

Slag is the waste by-product produced by the manufacturing industries, specially produced by industries which are mainly associated with steel and iron in bulk quantity on annual basis during their various manufacturing processes such as welding, combustion process, metallurgical and smelting processes. The annual production of slag on worldwide and in India is 50 million metric tonnes and 19 million metric tonnes. Different processes are used in

production of such waste mainly basic oxygen steel and electric arc furnace which are known by BOS and EAC abbreviations respectively. As the slag contains the similar characteristics with natural resources so they can be utilised in concrete production rather than direct consumption of limited natural resources for the development of strength in concrete. In most of the developed countries more than half percentage of slag which is produced on annual basis is consumed in different manufacturing processes like as road construction especially Asphalt wearing courses etc. Due to the high consumption of concrete and the scarcity of natural resources slag plays an important role in stabilizing the variations.

Objectives

- To study the applicability of iron slag as a partial replacement of cement.
- To study the maximum replacement percentage of cement by iron slag.

2. MATERIAL USED

Cement, Sand, Coarse Aggregate, Water and Iron Slag

Cement

For the purpose of proper bonding cementious material has been used for adequate strength and durability because cement possesses both adhesive and cohesive properties. OPC 43 grade one of the commonly used cement has been used in the present study and was tested according to IS: 8112 and its specific gravity was found 3.13.

Table 1 Characteristics of Cement and their values

Sr. No.	Characteristics	Values Obtained Experimentally	Values Specified By IS 8112:1989
1.	Specific Gravity	3.13	-
2.	Standard Consistency, percent	29%	-
3.	Initial Setting Time, minutes	33 min	30 (minimum)
4.	Final Setting Time, minutes	8 hour 25 min	600 (maximum)
5.	Compressive Strength		
	3 days	23.33 N/mm2	23 N/mm2(min)
	7 days	34.25 N/mm2	33 N/mm2(min)
	28 days	44.4 N/mm2	43 N/mm2(min)

Sand: A Fine Aggregate

On the basis of the tests the physical properties of the sand (zone 2) has been found as: specific gravity (2.46), bulk density (1.3kg/m3), fineness modulus (2.62), and water absorption (0.86) which conforms to IS 383-1970.

Coarse Aggregate

The coarse aggregates (angular) confirming to IS 383-1970 with a specific gravity of 2.70 and fineness modulus was found to be 5.82

Water

Clean portable water is used of ph value 7

Iron Slag

The iron slag used was taken from Gobindgarh Punjab and the fineness modulus of that slag was 2.10

Figure 1 Iron Slag

3. DESIGN MIX:

Design mix for M40 grade of concrete was prepared with cement (419kg/m3), fine aggregate (739kg/m3), coarse aggregate (1076kg/m3) and water (160kg/m3). Design mix was prepared as per IS 456-2000 and IS 10262-1982 with the partial replacement of cement by iron slag with 0% , 5% , 10% , 20% , 30% and 40%. Nine cubes of 150x150x150 mm of each replacement percentage were casted and were left for curing, three cubes of each replacement percentage were taken after 7 days, 14 days and 28 days. The obtained results are shown in the table 1.2.

4. TEST CONDUCTED

Compression testing machine was used to find the compressive strength of cubes after 7, 14 and 28 days of age strength.

Figure 2 Compressive Testing Machine

Table 2 Results Obtained (N/mm^2)

Replacement % of Cement	7 days	14 days	28 days	7-14 days Avg. % Increased	14-28 days Avg. % Increased
0%	28.30	35.30	39.5		
	27.20	34.80	40.9		
	28.60	36.70	40.4		
Average	28.03	35.60	40.26	27%	13%
5%	29.04	36.40	41.11		
	28.26	36.60	40.21		
	30.50	35.80	41.01		
Average	29.26	36.16	40.77	24%	12.74%
10%	30.90	36.97	43.71		
	32.20	38.21	43.27		
	31.27	35.61	42.61		
Average	31.45	36.93	43.19	17.42%	16.95%
20%	32.97	38.87	45.67		
	33.71	42.55	46.13		
	33.10	41.13	44.24		
Average	33.26	40.85	45.34	22.82%	10.99%
30%	34.27	43.71	46.55		
	35.59	41.21	48.23		
	35.82	42.88	45.89		
Average	35.22	42.60	46.89	20.95%	10.07%
40%	32.89	41.55	45.23		
	30.81	39.32	42.03		
	36.27	37.87	41.60		
Average	33.32	39.58	42.95	18.78%	8.51%

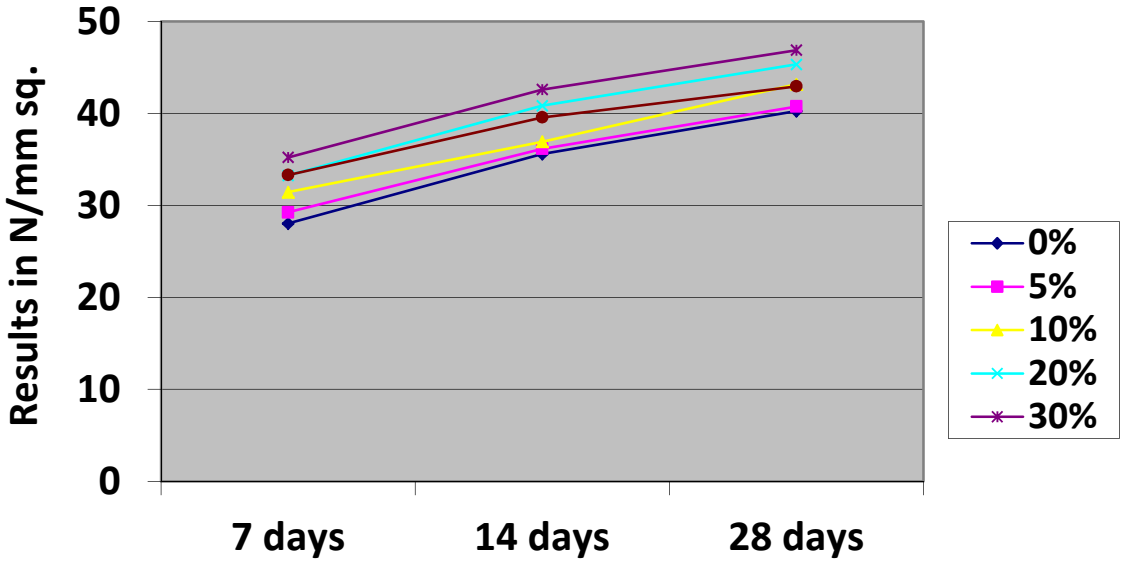

Figure 3 Graphical representation of Partial Replacement of Cement

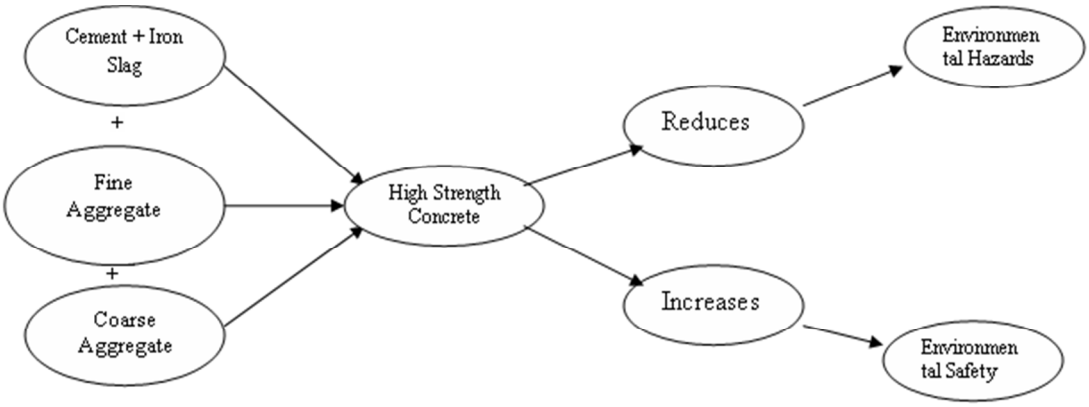

Figure 4 Research Model

The above model depicts that the proper mix of cement, iron slag, fine aggregate and coarse aggregate gives high strength concrete, it also provides environmental safety by reducing the cement percentage as cement production is directly related to release of more carbon dioxide gases in environment which increases the earth's temperature, pollution and directly lead to global warming.

5. CONCLUSION

The results obtained depicts that the use of iron slag for concrete production is very beneficial to achieve the high strength as per the following results:

1. The study shows that the compressive strength increased at 5%, 10%, 20%, 30% and 40% replacement of cement by iron slag after 7 days by 4.38%, 12.20%, 18.65%, 25.65% and 18.55%, after 14 days by 1.57%, 3.73%, 14.74%, 19.66% and 11.17% and similarly after 28 days by 1.26%, 7.27%, 12.61%, 16.46% and 6.68% respectively.
2. The overall replacement percentage in terms of compressive strength is found to be maximum at 30% replacement of cement by iron slag.
3. The early age gain strength is very high in all replacement mixes.
4. The present study concludes that the iron slag can be replaced with all the ingredients of concrete because some of the researchers have used iron slag with rest of the ingredients.

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