Use of Iron Slag as Partial Replacement of Sand to Concrete

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ABSTRACT:- **The environment problems are very common in India due to generation of industrial by-products. Due to industrialization enormous by-products are produced and to utilize these by-products is the main challenge faced in India. Iron slag is one of the industrial by-product from the iron and steel making industries. In this paper, the compressive strength of the iron slag concrete was studied. The results confirm that the use of iron slag overcome the pollution problems in the environment. The results shows that the iron slag added to the concrete had greater strength than the plain concrete.**

Index Terms:- **Compressive strength, , Concrete, Curing, Iron slag.**

I INTRODUCTION

As slag is a industrial by- product, its productive use grant an chance to relocate the utilize of limited natural resources on a large scale. Iron slag is a by product obtained in the manufacture of pig iron in the blast furnace and is produced by the blend of down-to-earth constituents of iron ore with limestone flux. Iron and steel slags can be differentiating by the cooling processing when removed from the furnace in the industry. Mostly, the slag consists of, magnesium, aluminium

silicates calcium and manganese in various arrangements. Even though the chemical composition of slag same but the physical properties of the slag vary with the varying method of cooling. The slags can be used as cement major constituents as they have greater pozzolanic properties.

II MATERIALS

The material used in this study was available locally. Ordinary Portaland Cement (OPC) of 43 Grade (JK cement) was used in this investigation. The cement was free from lumps. The physical properties of the cement as determined from various tests conforming to Indian Standard IS: 8112:1989 were listed in Table I. The aggregates having maximum size of 20 mm was used this study and were tested as per IS: 383-1970. The specific gravity of coarse aggregate was 2.69 and fineness modulus of coarse aggregates was 6.95. The fine aggregate was natural sand of maximum size of 4.75mm. The specific gravity of fine aggregate was 2.54 and fineness modulus of fine aggregates was 2.62. Its grading confirmed to zone II. The Iron Slag was obtained from the Dhiman Iron and Steel industry located at Mandi Gobindgarh, Punjab. The Fineness Modulus of iron slag was 2.10 and was in black grey colour.

Table I Properties of OPC 43 Grade Concrete

Sr. No.	Characteristics	Values Obtained Experimentally	Values Specified By IS 8112:1989
1.	Specific Gravity	3.12	-
2.	Standard Consistency, percent	29	-
3.	Initial Setting Time, minutes	155	30 (minimum)
4.	Final Setting Time, minutes	337	600 (maximum)
5.	Compressive Strength 3 days 7 days 28 days	 23.8 N/mm^2 35.3 N/mm^2 46.7 N/mm^2	 23/mm^2(minimum) 33/mm^2(minimum) 42/mm^2(minimum)

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III EXPERIMENTAL PROCEDURE

3.1 Mixture Proportioning

The two types of mixture were prepared in this investigation. The reference concrete mixture composed of cement (360 kg/m^3), fine aggregate (573.86 kg/m^3), coarse aggregates (1233.54 kg/m^3) and water to cement ratio is 0.5. The other concrete mixtures were prepared with the iron slag replacing 10 %, 20 % and 30 % of fine aggregates with the same amount of cement, coarse aggregates and same water cement ratio. The curing period of all the concrete mixes was 7, 28 and 56 days.

Figure 3.1 Dry mix of cement, sand, aggregate and iron slag

3.2 Test Procedure and Results

Test specimens of size 150 × 150 × 150 mm were prepared for testing the compressive strength concrete. The concrete mixes with varying percentages (0%, 10%, 20% and 30%) of iron slag as partial replacement of fine aggregate (sand) were cast into cubes for testing.

In this study, to make concrete, cement and fine aggregate were first mixed dry to uniform colour and then coarse aggregate was added and mixed with the mixture of cement and fine aggregates. Water was then added and the whole mass mixed. The interior surface of the moulds and the base plate were oiled before concrete was placed. After 24 hours the specimens were removed from the moulds and placed in clean fresh water at a temperature of $27^0 \pm 2^0$C. The specimens so cast were tested after 7, 28 and 56 days of curing measured from the time water is added to the dry mix. For testing in compression, no cushioning material was placed between the specimen and the plates of the machine. The load was applied axially without shock till the specimen was crushed. Results of the compressive strength test on concrete with varying proportions of iron slag replacement at the age of 7, 28 and 56 days are given in the Table II.

The cube strength results of concrete mix are also shown graphically in Figure 3.2. The compressive strength increases as compared to control mix as the percentage of iron slag was increased. After adding 10% iron slag in the mix, there was an increase of 26% after 7 days, 50% increase after 28 days and 43% increase after 56 days as compared to the control mix. By adding 20% and 30% iron slag , there was large amount of increase in percentage i.e. 68%, 91%, 78% and 125%, 113% , 87% after 7, 28 and 56 days respectively.

Table II: Compressive strength of concrete mixes of specimen size 150 × 150 × 150 with iron slag

Mix	Compressive Strength (N/mm^2)			Average Compressive Strength (N/mm^2)		
	7 days	28 days	56 days	7 days	28 days	56 days
CM	20.58	25.79	32.55	19.75	26.09	32.05
	20.54	26.12	33.87			
	18.13	26.36	29.74			
10%	27.7	37.88	45.87	25.02	39.33	46.06
	24.25	39.68	45.06			
	23.13	40.44	46.60			
20%	35.21	51.86	59.15	33.52	49.90	57.07
	31.65	49.55	54.31			
	33.71	48.31	57.77			
30%	45.15	56.40	57.55	44.44	55.68	60.21
	41.84	57.37	62.13			
	46.35	53.28	60.97			

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Figure 3.3 shows the variation of percentage increase in compressive strength with replacement percentage of iron slag. The results also indicate that strength gain at early age for 7 and 28 days was higher when compared to the control mix if 30% of fine aggregate is replaced by iron slag.

IV CONCLUSIONS

The strength characteristics of concrete mixtures had been computed in the present work by replacing 10%, 20% and 30% iron slag with the sand. On the basis of recent testing, subsequent conclusions were drawn.

- After adding 10% iron slag in the mix, there was an increase of 26% after 7 days, 50% increase after 28 days and 43% increase after 56 days as compared to the control mix. By adding 20% and 30% iron slag , there was large amount of increase in percentage i.e. 68%, 91%, 78% and 125%, 113% , 87% after 7, 28 and 56 days respectively.

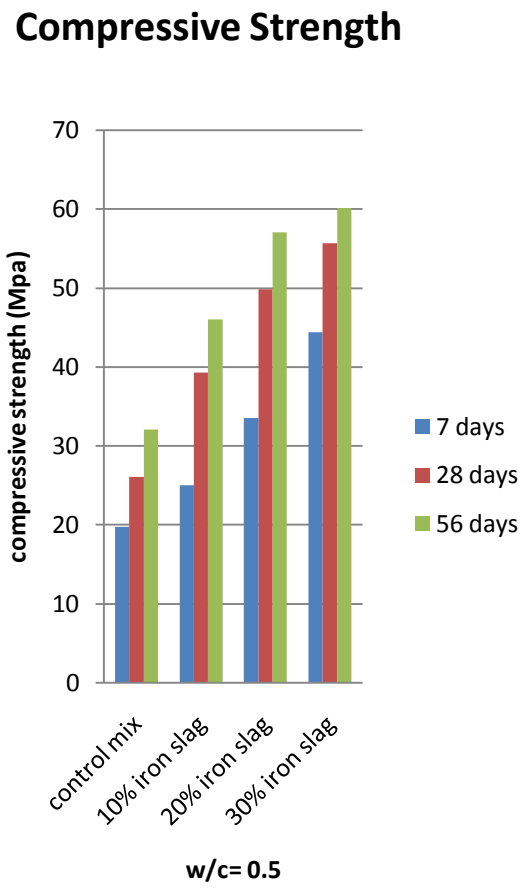

Fig. 3.2: Compressive strength of iron slag concrete

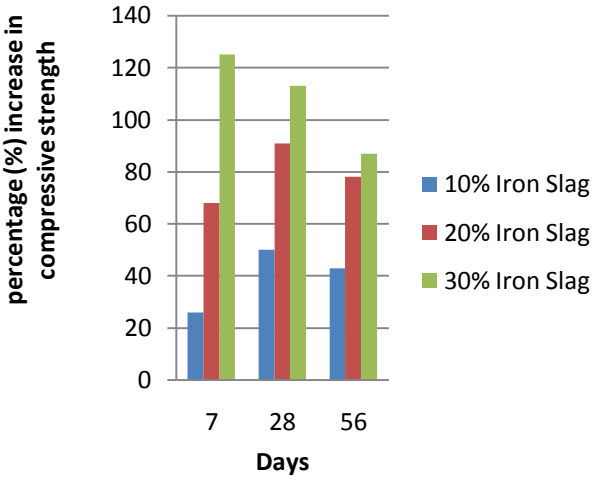

Fig. 3.3: percentage (%) increase in compressive strength of iron slag concrete

Figure 3.4 Compressive strength test in progress

- With the increase of percentages of iron slag in the concrete mix, the compressive strength also increases.
- The early age strength gain is higher as compared to later ages if 30% of fine aggregate is replaced by iron slag.

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