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Improvement of Properties of Iron Slag in Concrete

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Abstract:

Skillful waste administration is a fundamental part of reasonable iron industry. In this specific situation, the board of waste methods decreasing waste where conceivable and reutilization of materials which may some way or another become squander. The executives of strong waste practices has distinguished the decrease, reusing, and reuse of squanders as significant for the board of economical assets. Iron slag, a side-effect acquired from Iron arrangement during the partition of the liquid Iron from debasements in heaters. A liquid fluid dissolve got from slag is an unpredictable silicates and oxides that set on cooling. A fractional substitution of Iron stag is alluded in this investigation as far as fine total material. This examination is done to comprehend the impacts regarding compressive, elastic and flexural strength. It will supportive for different scientists to find out about this field.

The point of this test is to examine the impact of Iron Slag as halfway supplanting of Fine Aggregate with 0%, 10%, 20%, 30%, and 40% are tried for M25& M30 evaluation of cement after 7, 14, 28 and 50 days water restoring. The outcome shows that variety in much strength for Fine total swapped by Iron slag for 7, 14, 28 and 50 days water relieving.

Keywords: Concrete, Iron slag, Fine Aggregates, Compressive Strength, Flexural Strength and Tensile Strength

1. INTRODUCTION

Aggregate are idle grainy materials, for example, sand, rock or squashed stone that are a final result in their own privilege and are a fundamental fixing in cement. Total, which contributes 60 to 75 percent of the absolute volume of cement, are separated into two significant classes - fine and coarse. Fine totals usually includes regular sand or squashed stone with greatest particles going through a strainer of 4.75mm. Fine aggregate(natural sand) which has been washed and sieved to eliminate bigger particles for example in excess of 5 mm. IS determinations arrange the sand into four zones according to its evaluating as fine total of reviewing Zone-1 to evaluating Zone-4. The four evaluating zones which shows that it become better from Zone-1 to Zone-4 dynamically from 90% to 100% of the fine total passes 4.75 mm IS strainer and 0 to 15% passes 150 micron IS sifter which relies upon its reviewing zone. Iron slag, a side-effect got from Iron

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development, is delivered by the cycle of division of the liquid Iron from contaminations in Iron-production heaters. A liquid fluid dissolve got from slag is an intricate silicates and oxides that set on cooling. Basically all Iron is made in coordinated Iron plants utilizing such a the fundamental oxygen measure or in claim to fame Iron plants (smaller than normal factories) utilizing an electric circular segment heater measure. These days open hearth heater measure is of no utilization.

The point of this investigation is to examine the impact of Iron Slag as halfway supplanting of Fine Aggregate with 0%, 10%, 20%, 30%, and 40% are tried for M25& M30 evaluation of cement after 7, 14, 28 and 50 days water restoring. The outcome shows that variety in much strength for Fine total substituted by Iron slag for 7, 14, 28 and 50 days water restoring.

2. LITERATURE REVIEW:-

[1]**Gurpreet Singh, Rafat Siddique (2016).,** Durability characteristics of self-compacting concrete (SCC) made with iron slag (IS) are presented in this paper. For this purpose, initially, a control SCC was designed, and then fine aggregates were partly (0, 10, 25 and 40%) replaced with iron slag. Various tests were done for fresh SCC properties, compressive strength and durability properties such as rapid chloride permeability, water absorption, resistance to sulphate attack and ultra-sonic pulse velocity up to the age of 365 days. SEM and XRD analysis was also carried out. The test result shows that SCC incorporating iron slag gives better strength and durability than control mixture of SCC, and can be suitably used in SCC.

[2]**Shriraksha Javali, A. R. Chandrashekar, Sujay Raghavendra Naganna (2017),** the granular iron slag was partially substituted at 10, 20, 30 and 40% of natural sand to find the overall optimal blend. The strength and durability properties of the M40 grade concrete employing these two admixture combinations were analysed. It was noticed that the strength and durability properties of the eco-concrete produced by incorporating aluminium dross –5% and iron slag –20% were comparable to that of conventional concrete. Furthermore, from the toxicity analysis, it was seen that the leaching of heavy and trace elements from the eco-concrete was negligibly small and within the limits. In near future, the cost-effective, eco-friendly materials and technologies can be opted as a perpetual strategy to overcome severe material shortages for resource conservation and economy.

[3]**J.Vijayaraghavan (2017),** From the study, it has been concluded that 40% of copper slag, 40% iron slag and 25% of recycled concrete aggregate possess more strength than conventional

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concrete mix. However, further research work opportunities were suggested in the conclusion of the study to shed more light on effective sustainability on construction materials.

OBJECTIVES

To determine the optimum quantity of Iron slag as a fine aggregate to enhance the strength of concrete by conducting related tests like Compressive strength, Tensile strength and Flexural strength at replacement level of 10%,20%,30% and 40%.

3. MATERIALS USED:

3.1. Cement: As per IS 8112-1989, ordinary Portland cement of grade 43 is used. The initial setting time of cement is 30 minutes and 3.15 is the specific gravity of cement.

3.2. Fine Aggregate: Natural river sand which is locally available obtained from the Beehar river of Rewa City is used as fine aggregates. Natural sand passing through 4.75mm sieve and retained on the 600 micron sieve with the specific gravity of 2.65 was used. Zone 2 was the grading of the aggregate.

3.3. Coarse Aggregate: Aggregates greater than 4.75mm are considered as Coarse aggregate. Crusted coarse aggregate of 20mm downsize were used with fineness modulus of 4.32 and a specific gravity of 2.84.

3.4. Iron Slag: In this experiment the Iron slag collection is done from locally available iron furnace. Nowadays Iron products are used everywhere. Iron is durable and strong. It is obtained either from conversion of iron to Iron slag in a BOF (Basic Oxygen Furnace) or by the melting of scarp to make Iron in the EAF (Electric Arc Furnace).

3.5. Water: As per the IS: 456-2000 Specifications , clean and potable water was used.

CHARACTERISTICS APPLICATION: Iron slag is used in many fields of construction industry where its distinct characteristics can be put to effective use such as road base course material, course aggregate for concrete, calcium silicate fertilizer, blending material for Portland cement and soil improvement.

4. METHODOLOGY:

In this study, $M_{25,}$ $M_{30,}$ mix proportion is designed as per the guidelines of Indian Standard recommended method IS 10262:2009. Cement of 43 grade is used; also zone 2 is taken into

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account from IS 383(1970). Iron slag is replaced by 10%, 20%, 30% and 40%.The coarse aggregate of size 20mm is selected which is retained on 10mm sieve. Fine aggregate passing through 4.75mm sieve and retained on 600micron sieve used.

5. EXPERIMENTAL TESTS AND RESULTS:

5.1 SLUMP CONE TEST:

To study the Workability of fresh concrete, slump cone test is conducted. This test was carried out for M 25 & M 30 grade of concrete; the results are tabulated and plotted below.

Table 1.Slump test results for M25 and M30 grade of concrete

Sr. No.	% Replacement of Fine Aggregate by Iron Slag	Slump Value In MM For M 25	Slump Value In MM For M 30
1	0%	75	75
2	10%	73	69
3	20%	66	61
4	30%	55	52
5	40%	52	48

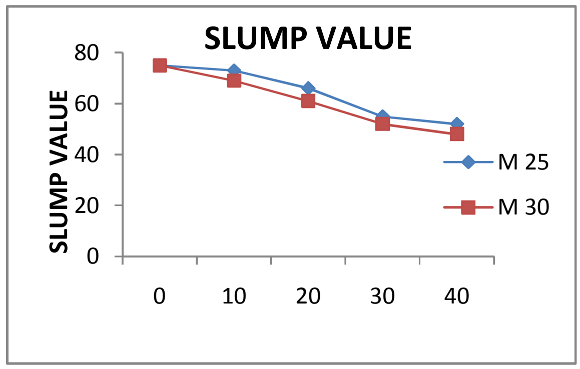


Figure 1: Slump Values of M 25 and M 30 grade of concrete

COMPACTION FACTOR:

As per IS: 1199 – 1959, to find the workability conducted by using Compacting factor apparatus. For the determination of workability of concrete this test is known for its accuracy. The test results are tabulated and plotted below.

Table 2.Compaction factor test results of M25 and M30 grade of concrete

Sr. No.	% Replacement of Fine Aggregate by Iron Slag	Compaction factor Value in MM for M 25	Compaction factor Value in MM for M 30
1.	0%	0.845	0.855
2.	10%	0.848	0.861
3.	20%	0.853	0.868
4.	30%	0.858	0.877
5.	40%	0.864	0.884

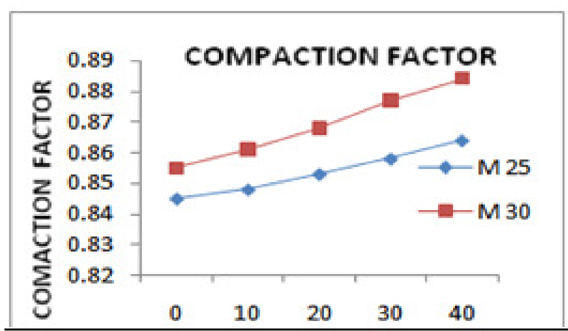


Figure 2: Compaction factor graph for M 25&M 30 grade of concrete

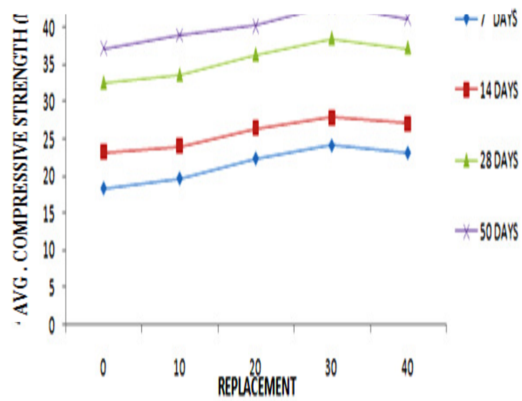
5.2 COMPRESSIVE STRENGTH TEST:

- Concrete cubes (150mmx150mm) were casted for 0%, 10%, 20%, 30%, 40% replacement of Iron. The compressive strength for M25 grade of concrete is tested for 7, 14, 28 and 50 days of curing and the results are tabulated and plotted below.

Table 3.Avg.Compressive strength test results for M25 grade of concrete

Sr. No.	% Replacement of Fine Aggregate by Iron Slag	Average Com-Pressive Strength (N/mm^2)	Average Com-pressive Strength (N/mm^2)	Average Com-pressive Strength (N/mm^2)	Average Com-pressive Strength (N/mm^2)
		7 DAYS	14 DAYS	28 DAYS	50 DAYS
1.	0%	18.30	23.23	32.54	37.19
2.	10%	19.63	24.10	33.60	39.03
3.	20%	22.32	26.44	36.33	40.26
4.	30%	24.06	27.92	38.50	37.22
5.	40%	23.08	27.14	37.22	41.26

Figure 3: Compressive Strength Graph for M 25 grade of Concrete



- Concrete cubes (150mmx150mm) were casted for 0%, 10%, 20%, 30%, 40% Iron slag replacement. The compressive strength for M30 grade of concrete is tested for 7, 14, 28 and 50 days of curing and the results are tabulated and plotted below.

Table 4.Avg.Compressive strength test results for M30 grade of concrete

Sr. No.	% Replacement of Fine Aggregate by Ironl Slag	Average Com-pressive Strength (N/mm^2)	Average Com-pressive Strength (N/mm^2)	Average Com-pressive Strength (N/mm^2)	Average Com-pressive Strength (N/mm^2)
		7 DAYS	14 DAYS	28 DAYS	50 DAYS
1.	0%	22.77	27.19	39.25	42.48
2.	10%	24.69	28.73	40.50	43.85
3.	20%	26.85	30.13	42.50	46.15
4.	30%	28.44	31.98	45.35	44.21
5.	40%	27.48	31.22	44.21	47.25

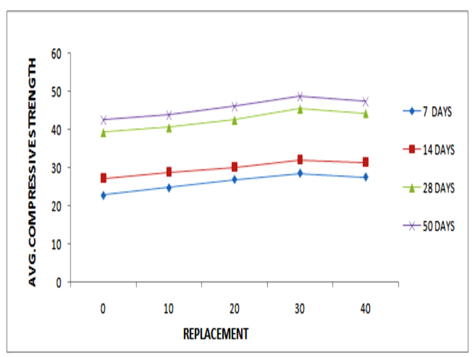


Figure 4: Compressive Strength Graph for M 30 grade of Concrete

1. From both of the above graph i.e. M25 and M30, the compressive strength of concrete is increased gradually from 0% to 20% and achieved a maximum value at a replacement of 30% Iron slag in fine aggregate afterwards decreased for 40% replacement of Iron slag.
2. However compressive strength of concrete for the partial replacement of Fine aggregate with Iron slag of 40% does not show major decrement as compared to 30% and can be use by control mix.

5.3 SPLIT TENSILE STRENGTH TEST:

- Concrete cylinders (150mmx300mm) were casted for 0%, 10%, 20%, 30%, 40% replacement of Iron slag. The split tensile strength for M25 and M30 grade of concrete is tested for 28 days of curing and the results are tabulated and plotted below.

Table 5.Avg.Tensile strength test results for M25 and M30 grade of concrete

Sr. No	% Replacement of Fine Aggregate by Iron Slag	Average Tensile Strength for M25. (N/mm^2)	Average Tensile Strength for M30. (N/mm^2)
		28 DAYS	28 DAYS
1.	0%	2.533	3.376
2.	10%	2.663	3.496
3.	20%	2.75	3.666
4.	30%	2.956	3.906
5.	40%	2.866	3.793

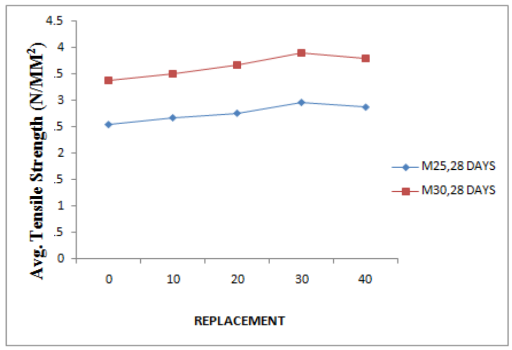


Figure 5: Tensile Strength Graph For M25 & M30 at 28 Days.

1. From both of the above graph i.e. M25 & M30 grade of concrete, the Split tensile strength of concrete is increased gradually from 0% to 20% and attained a maximum value at a replacement of 30% Iron slag in fine aggregate afterwards decreased for 40% replacement of Iron slag.
2. However Split tensile strength of concrete for the partial replacement of Fine aggregate with Iron slag of 40% does not show major decrement as compared to 30% and can be use by control mix.

5.4. FLEXURAL STRENGTH TEST:

- Concrete beams (500mmx100mmx100mm) were casted for 0%, 10%, 20%, 30%, 40% replacement of Iron slag. The Flexural strength for M25 & M30 grade of concrete is tested for 28 days of curing and the results are tabulated and plotted below.

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Table 6 .Avg. flexural strength test results for M25 and M30 grade of concrete

Sr. No	% Replacement of Fine Aggregate by Iron Slag	Average Flexural Strength for M25. (N/mm^2)	Average Flexural Strength for M30. (N/mm^2)
		28 DAYS	28 DAYS
1.	0%	2.730	3.352
2.	10%	2.972	3.457
3.	20%	3.491	3.801
4.	30%	3.733	4.183
5.	40%	3.422	3.974

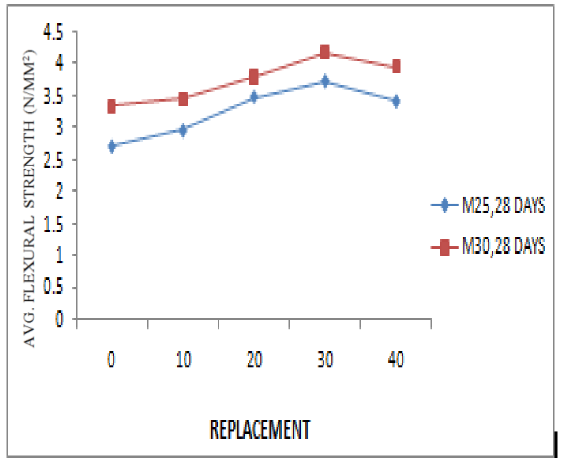

Figure 6: Flexural Strength Graph for M25 & M30 at 28 Days.

1. From the above Graph i.e. M25 & M30 grade of concrete, the Flexural Strength of concrete is increased gradually from 0% to 20% and attained a maximum value at a replacement of 30% Iron slag in fine aggregate afterwards decreased for 40% replacement of Iron slag.
2. However Flexural strength of concrete for the partial replacement of Fine aggregate with Iron slag of 40% does not show major decrement as compared to 30% and can be use by control mix.

6. CONCLUSIONS:

Based on the deep study of experimental results and discussions the following conclusions are made.

1. Comparison and observations for the compressive strength, flexural strength and split tensile strength of normal concrete and concrete with Iron slag as partial replacements, the results shows that the strength of the normal concrete is slightly lower than the Iron slag replaced concrete.
2. The increment in compressive strength is about 31.47% for 7 days curing 20% for 14 days curing 18% for 28 days while at 40% a slight decrement of 4.2% noted for 7 days and 3.4 % for 28 days of curing as compared to 30%.
3. The increment in compressive strength of M 30 grade of concrete is about 24.9% for 7 days of curing 17.5% for 14 days of curing and 15.5% for 28 days of curing while at 40% a slight decrement of 3.6% noted for 7 days and 2.5% for 28 days of curing as compared to 30%.

4. The split tensile strength increases with increase in percentage of Iron slag up to 30% by weight of fine aggregate. The increment in split tensile strength is about 16.7% for 28 days curing for M 25 grade of concrete and increment about 15.6% for 28 days curing for M 30 grade of concrete.
5. The Flexural strength increases with increase in percentage of Iron slag up to 30% by weight of fine aggregate. The increment in flexural strength test is about 36.7% for 28 days curing for M 25 grade of concrete and 24.7% for 28 days curing for M 30 grade of concrete.
6. From the results of compressive strength, split tensile strength, flexural strength 28 days curing, 30% replacement of fine aggregate by Iron slag is the optimum percentage of replacement of M 25 & M 30 grade of concrete.

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