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Effect of Partial Replacement of Sand by Iron Ore Tailings on the Compressive Strength of Concrete

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Abstract - *Iron ore tailing (IOT) is a waste generated from iron ore industry. Millions of tonnes of IOT are produced every year in India and disposal of the same is a huge problem as it cause to environmental pollution. In other hand availability of sand is continuously depleted. Hence, partially or fully replacements of fine aggregate by the other compatible material are being researched in view of conserving the ecological balance. In this work, the effects of partial replacement of sand by iron ore tailing on the compressive strength of concrete are experimentally studied. In the present work iron tailing were used as partial replacement to fine aggregates at levels of 0%, 5%, 10%,15% and 20% and the basic material properties, strength parameters are studied. Experimental investigation was done using M25 mix and tests were carried out as per recommended procedures by relevant codes. The mix proportions used for concrete are 1: 1.484: 2.698.*

Key Words: Concrete, Compressive strength, Iron ore tailing (IOT), Fine Aggregate (FA), River sand (RS).

1. INTRODUCTION

Concrete is the most widely used composite material today. The ingredients of concrete are coarse aggregate, fine aggregate, binding material and water. Rapid increase in construction activities leads to acute shortage of conventional construction materials. It is conventional that sand is being used as fine aggregate in concrete. For the past two years, due to administrative restrictions the availability of sand in India is very low and price of sand is rapidly increases. On the other hand, the modern technological society is generating substantially high amounts of solid wastes both in municipal and industrial sectors posing challenging task for this effective and efficient disposal. In India approximately 10 – 12 million tons of such mined ore is lost as tailings. The safe disposal or utilization of such vast mineral wealth in the form iron dust has remained a major unsolved and challenging task for the Indian iron ore industry. In future, the proportion of iron ore wastes generated is likely to increase due to higher demand for iron ore as a number of steel plants have been planned for future in many parts of the country. In order to reduce the adverse impact of indiscriminate mining of natural sand, iron ore tailings which is the waste products of mining industries is used as an alternative to the river sand in the manufacturing of concrete.

1.1 Objectives

- Determining the properties of iron ore tailing and comparing the results with the fine aggregate i.e. sand.
- Partial replacement of iron ore tailing with the conventional sand.
- Determining the workability of concrete at different percentages of IOT.
- Determining the strength properties of concrete for 7, 14, 21 and 28 days

2. Material and Methodology

2.1 Material

2.1.1 Cement

For making concrete OPC 43 grade cement (JP cement) was used in the research.

2.1.2 Fine aggregate

The aggregate size is lesser than 4.75 mm is considered as fine aggregate. The sand used for the experimental programmers was locally available Narmada sand and conformed to grading zone II as per IS: 383-1970. The specific gravity were found to be 2.645

2.1.3 Coarse Aggregate

Coarse aggregates are those which are retained on IS sieve size 4.75 mm. Crushed stone angular shaped of 10 mm and 20 mm size from a local source was used as coarse aggregate. The specific gravity was found to be 2.85 for 20 mm size aggregate and 2.80 for 10 mm aggregate.

2.1.4 Iron Ore Tailing

Iron Ore Tailing is the materials left over, after the process of separating the valuable fraction from the worthless fraction of an ore. The physical property of Iron Ore Tailings which are taken from Hargrah near Sihora, Jabalpur Madhya Pradesh (India)

Fig -1: Iron Ore Tailing

Table -1: Physical Property of Iron Ore Tailing

Parameters	IOT
Particle shape	Spherical
Density	14.4 kN/ m^3
Specific gravity	3.10
Color	Dark tan (brown)
Optimum dry density (ODD)	1.71 gm/cc
Optimum moisture content (OMC)	21 %

2.2 Mix Proportion

The concrete mix is designed as per IS 10262 –2009. The grade of concrete which we adopted was M25 with the water cement ratio of 0.45. The mix proportions used for concrete are 1: 1.458: 2.529

Table -2: Mix Proportions

GRADE	CEMENT	FINE AGGREGATE	COARSE AGGREGATE	W/C RATIO
M 25	438 Kg	649.82 Kg	1181.745 Kg	0.45

2.3 Test Specimen

Cubes of size 150mm X150mm X150 mm were prepared using the standard moulds. The samples were casted using the six different percentages of iron ore tailing (0%, 5%, 10%, 15%, & 20%). The samples were demoulded after 24 hours from casting and kept in a water tank for 7, 14, 21 and 28 days curing. A total of 48 specimens are casted for testing the properties such as compressive strength.

Fig -2: Prepration of cubes

Fig -3: Demoulding of cubes

Fig -4: Cubes after curing

Fig -5: Compressive testing machine

Fig -6: Cubes specimen after testing

3. Results

The results of fresh properties of concrete such as workability by slump cone are determined and hardened properties such as Compressive Strength are presented and discussed below

3.1 Measurement of Workability

Test adopted for measurement of workability in the present investigation was Slump cone Test and the test results shown in table 3.

Fig -7: Slump cone test

Table -3: Workability (Slump Cone Test)

S.No.	Percentages of IOT	Slump in mm
1	0 %	63
2	5%	59
3	10%	53
4	15%	47
5	20%	39

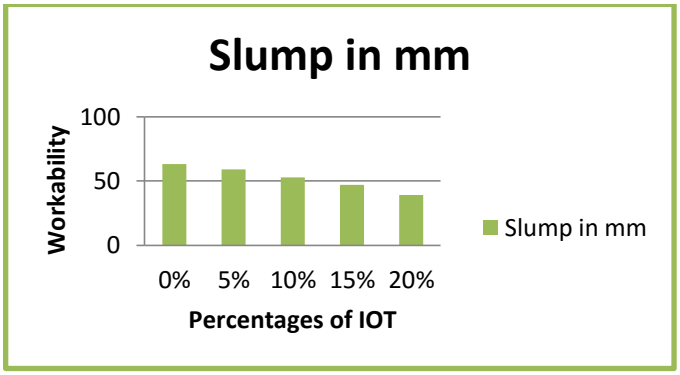

Chart -1: Workability of concrete M25 grade concrete with partial replacement of sand by IOT

3.2 Compressive Strength

Compressive strength test were conducted on 150 mm size concrete cubes in compressive testing machine accordance with the specifications of Bureau of Indian Standards. The test results are given in Table 4.

Table -4: Compressive Strength

S.No.	Percentages of IOT	Compressive Strength (mPa)			
		7 days	14 days	21 days	28 days
1	0 %	24.456	29.674	32.519	35.807
2	5%	24.948	30.444	33.674	36.178
3	10%	25.393	30.43	34.652	36.889
4	15%	25.319	31.393	35.215	37.185
5	20%	25.141	30.859	34.978	36.785

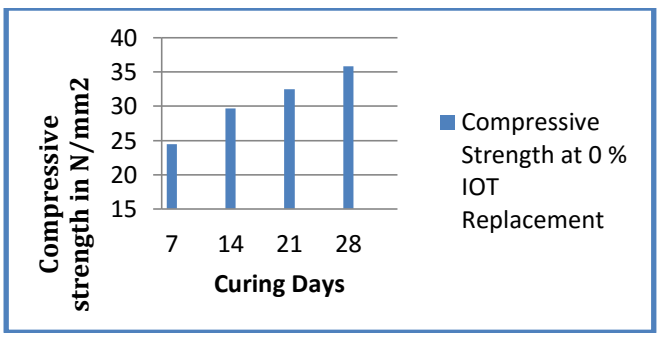

Chart -2: Compressive strength of cube with 0% replacement of sand by IOT

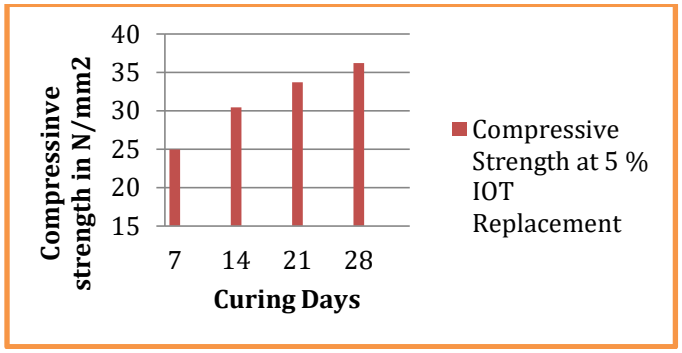

Chart -3: Compressive strength of cube with 5% replacement of sand by IOT

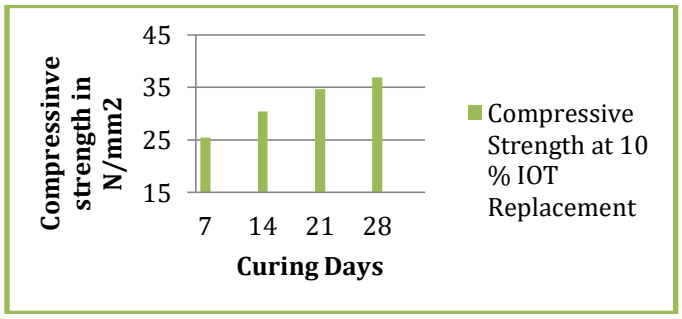

Chart -4: Compressive strength of cube with 10% replacement of sand by IOT

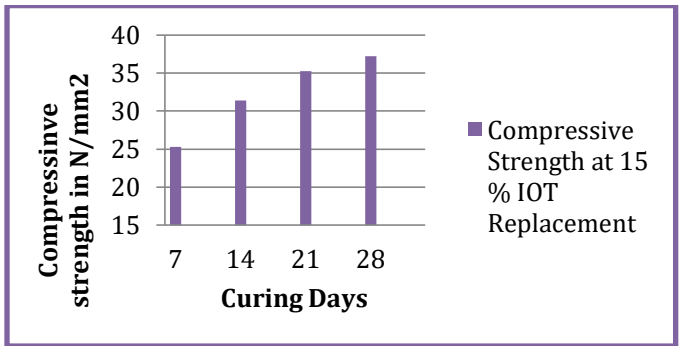

Chart -5: Compressive strength of cube with 15% replacement of sand by IOT

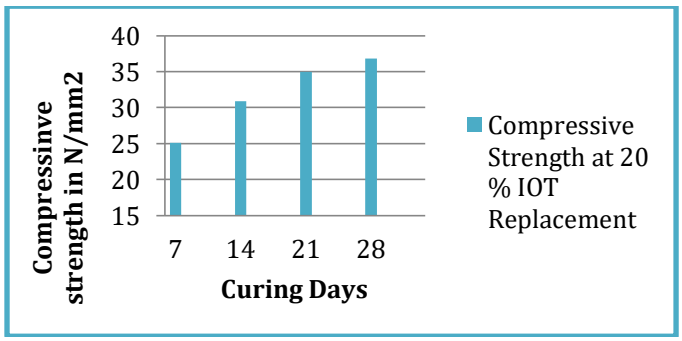

Chart -6: Compressive strength of cube with 20% replacement of sand by IOT

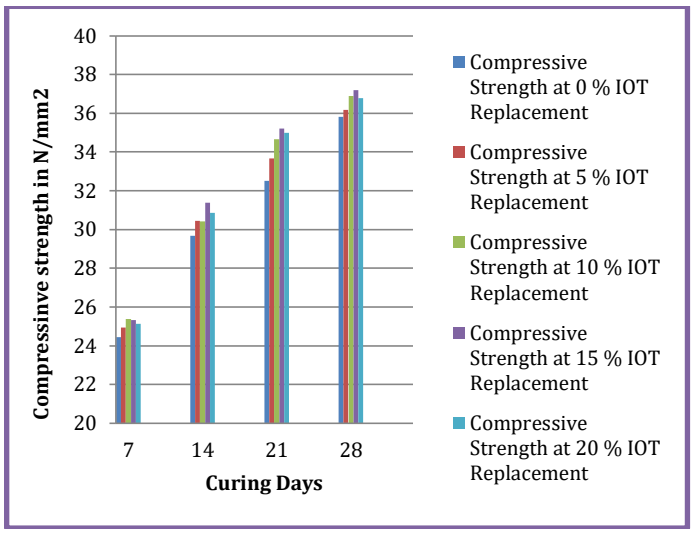

Chart -7: Compressive strength of M25 grade concrete with partial replacement of sand by IOT

4. Discussion

4.1 Workability test result

Table 3, shows the Workability of concrete mixes made with partial replacement of sand with iron ore tailing. The workability of concrete decreases by addition of Iron Ore Tailing.

4.2 Compressive Strength test result

Table 4, shows the Compressive strength of concrete mixes made with partial replacement of sand with iron ore tailing was determined at 7, 14, 21 and 28 days. It was found that Compressive strength of concrete increases gradually by addition of Iron ore tailing from 0% to 15% and after that strength of concrete decreases. Hence it can be concluded that 15% replacement of sand with IOT gives best result for compressive strength of concrete.

5. Conclusions

The following conclusions are drawn based on the above experimental study.

- As the iron ore tailing percentage increases the workability of mix reduces hence for better workability use of super plasticizers is recommended.
- Replacement of 15% Iron Ore Tailing gives best result for compressive strength.
- As percentage of iron ore tailing increases more than 15% the compressive strength of concrete decreases.

- Iron ore tailing as a replacement to the sand will solve two problems with one effort, namely, elimination of solid waste problem on one hand and provision of a needed construction material on other hand. The Iron ore tailing reduces the cost production of concrete.

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