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Study On Partial Replacement Of Sand With Iron Ore Tailing On Compressive Strength Of Concrete

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Abstract

Advancements in technology enhances not only human comforts but also damages the environment. Although natural fine aggregates (i.e., river sand) are superior to any other material in making concrete, their availability is continuously being depleted due to the intentional overexploitation throughout the globe. Hence, partial or full replacement of fine aggregates by the other compatible materials like sintered fly ash, crushed rock dust, iron dust, glass powder, recycled concrete dust, and others 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 dust were used as partial replacement to fine aggregates at levels of 10%, 20%,40%,60% and 80% 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 1:1.7:2.6.

Keywords: *Concrete, Iron ore tailings, bulking, Compressive Strength.*

1. Introduction

Aggregates are the important constituents in the concrete composite that help in reducing shrinkage and impart economy to concrete production. Most of the aggregates used are naturally occurring aggregates, such as crushed rock, gravel and sand which are usually chemically interactive or inert when bonded together with cement. 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

The main objectives of the experiment are

- Determining the properties of iron dust and comparing the results with the conventional sand.
- Determining the bulking of sand with adding different percentage of iron dust.
- Partial replacement of iron dust with the conventional sand.
- Determining the strength properties of concrete for 7 and 28 days.

2. Material and Methodology

2.1 Material

2.1.1 Cement

Portland Pozzolana Cement of 43 grades available in local market was used in the research. The properties of Cement are as follows:

Table 1 Properties of Cement

Property	Value
Specific Gravity	3.02
Initial Setting Time	60 min.
Final Setting Time	520 min.
Normal Consistency	32%

2.1.2 Fine Aggregate

Clean River sand is used as fine aggregate. Sand used in the present work was from zone II. The specific gravity was found to be 2.53. Tests on sand as per IS specifications are conducted and results are as shown in table 2.

Table 2 Physical properties of Fine aggregates

Sr No.	Characteristics	Value
1.	Specific gravity	2.53
2.	Water absorption	0.88
3.	Moisture content (%)	1.905
4.	Fineness modulus	3.629
5.	Grading zone	Zone II

2.1.3 Coarse Aggregate

Coarse aggregates are those which are retained on IS sieve size 4.75 mm. Crushed stone angular metal of 10 mm and 20 mm size from a local source was used as coarse aggregate. The specific gravity were found to be 2.75.

2.1.4 Iron Ore Tailings

Iron Dust is the materials left over, after the process of separating the valuable fraction from the worthless fraction of an ore. Tests on Iron Ore Tailings procured from Kudremukh, Lakya Dam site were conducted. The properties of the IOTs are indicated in table 3

Figure 1 Iron Ore Tailings

Table 3 Physical properties of Iron Ore Tailings

Sr No.	Characteristics	Value
1.	Specific gravity	3.21
2.	Particle shape	Spherical
3.	Colour	Black
4.	Fineness modulus	2.545
5.	Maximum dry density	1.71 gm/cm³

The bulking phenomenon of iron ore tailings is shown in Figure 2.

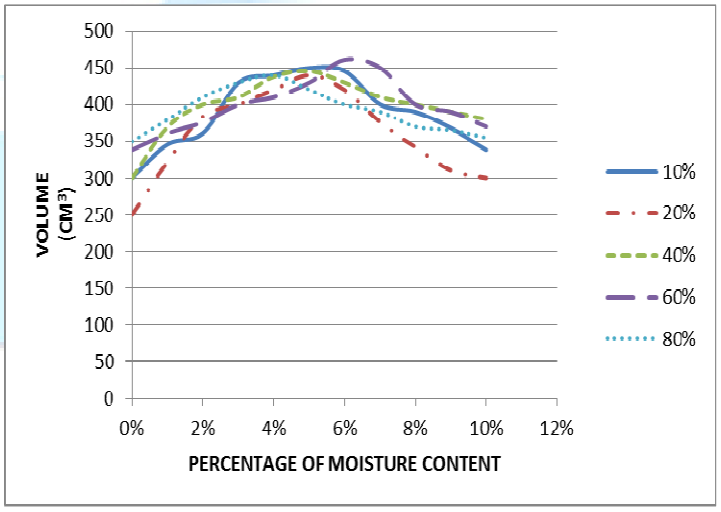

Figure 2 Bulking of iron ore tailings

2.2 Mix Proportion

The concrete mix is designed as per IS 10262 –2009, IS 456-2000 for the normal concrete. The grade of concrete which we adopted was M25 with the water cement ratio of 0.45. The mix proportions used for concrete are 1:1.7:2.6.

Table 4 MIX PROPORTION

GRADE	CEMENT	FINE AGG.	COARSE AGG.	W/C RATIO
M25	427Kg	720Kg	1124Kg	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 percentage of iron dust (0%, 10%, 20%, 40%, 60% &80%). The samples were demoulded after 24 hours from casting and kept in a water tank for7 & 28 days curing. A total of 36 specimens are casted for testing the properties such as compressive strength. The details of the specimen and their notations are given below in table 5.

Table 5 List of specimens

Sr No.	Notation	No.of Cubes
1.	C1 (CONTROL)	6
2.	C2 (10% IRON ORE TAILING)	6
3.	C3 (20% IRON ORE TAILING)	6
4.	C4 (40% IRON ORE TAILING)	6
5.	C5 (60% IRON ORE TAILING)	6
6.	C6 (80% IRON ORE TAILING)	6

Table 6 Mixture proportions of fresh concrete with 10% iron ore tailing.

	Material	C2(KG/m³)
Mixture proportions	Cement	427
	F.A	647.24
	C.A	1124
	Iron ore tailings,	71.92
	Water	192

3. Result and Discussions

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

3.1 Rheology of Concrete

Fresh Concrete or Plastic Concrete is a freshly mixed material which can be moulded into any shape. The relative quantities of cement, aggregate and water mixed together to control the properties of concrete in the wet state as well as in the hardened state.

3.2 Measurement of Workability

Tests adopted for measurement of workability in the present investigation was Slump Test and slump value is shown in table 7.

Table 7 Measurement of Workability

Designation of mix	**Slump in mm**
C1 (CONTROL)	25
C2 (10% Iron ore tailing)	20
C3 (20% Iron ore tailing)	16
C4 (40% Iron ore tailing)	10
C5 (60% Iron ore tailing)	5
C6 (80% Iron ore tailing)	4

3.3 Compressive Strength

Compressive tests were conducted on 150 mm size concrete cubes in accordance with the specifications of Bureau of Indian Standards. The test results are given in Table 8.

Table 8 Compressive Strength

Sr No.	%AGE OF IRON DUST	COMPRESSIVE STRENGTH (MPa)	
		7 days	28 days
1.	0% (control)	21.1	33.27
2.	10% (replacement with sand)	21	27.5
3.	20% (replacement with sand)	13.7	19

4.	40% (replacement with sand)	12.9	17.1
5.	60% (replacement with sand)	11	16.9
6.	80% (replacement with sand)	9.3	13.4

Figure 3 Testing of concrete on UTM.

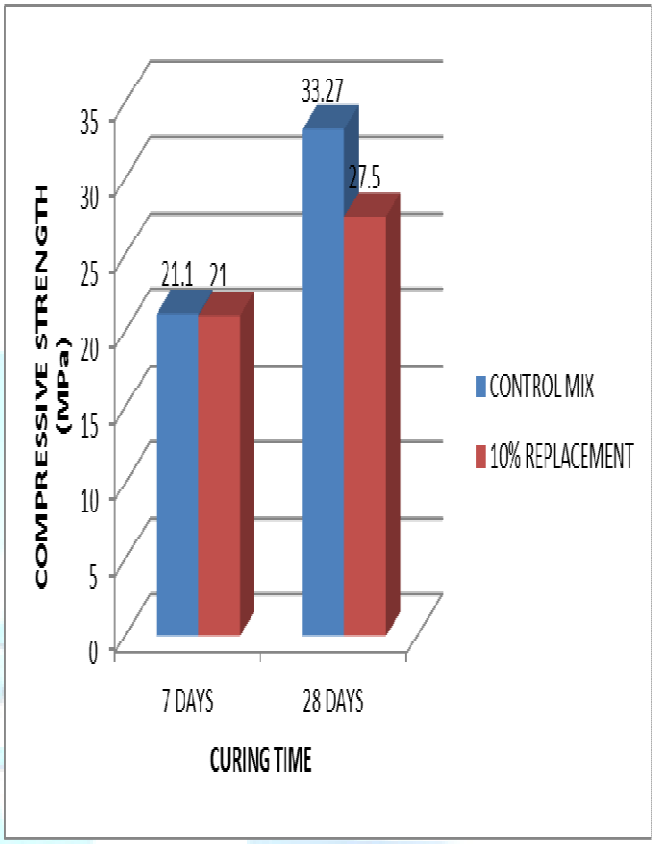

Figure 4 Compressive strength of cube with 10% replacement of sand by iron ore tailings

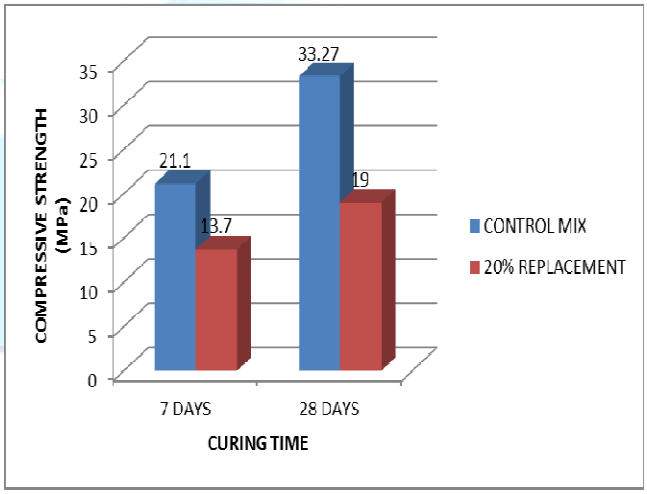

Figure 5 Compressive strength of cube with 20% replacement of sand by iron ore tailings

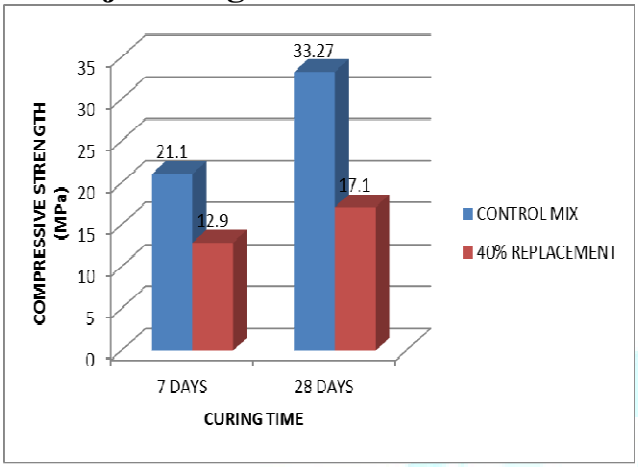

Figure 6 Compressive strength of cube with 40% replacement of sand by iron ore tailings

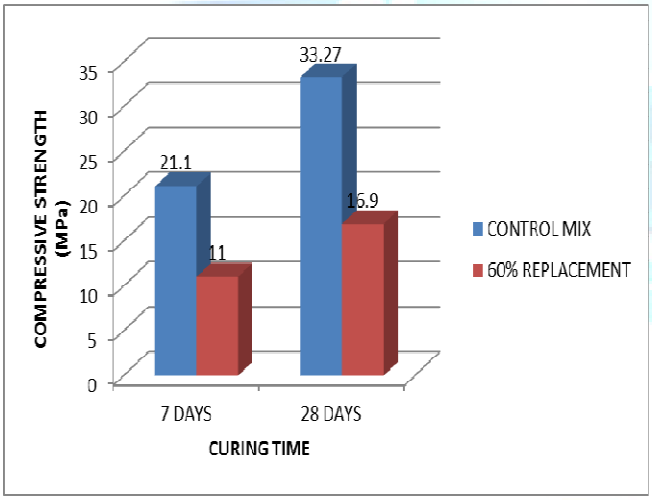

Figure 7 Compressive strength of cube with 60% replacement of sand by iron ore tailings

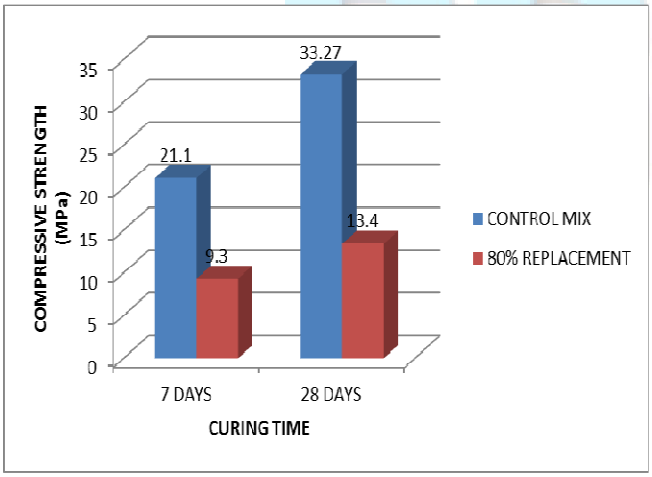

Figure 8 Compressive strength of cube with 80% replacement of sand by iron ore tailings

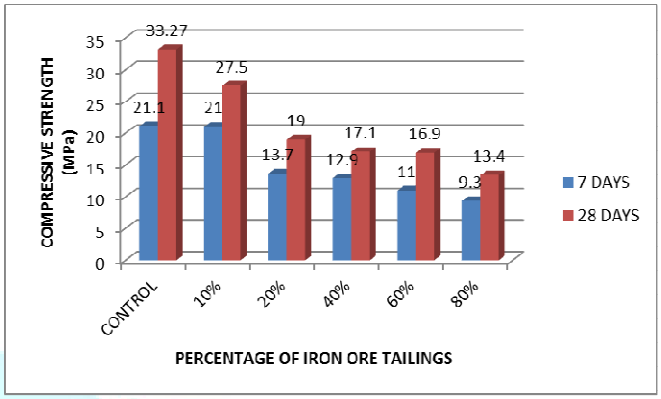

Figure 9 Compressive strength of M25 grade concrete with partial replacement of sand by iron ore tailings

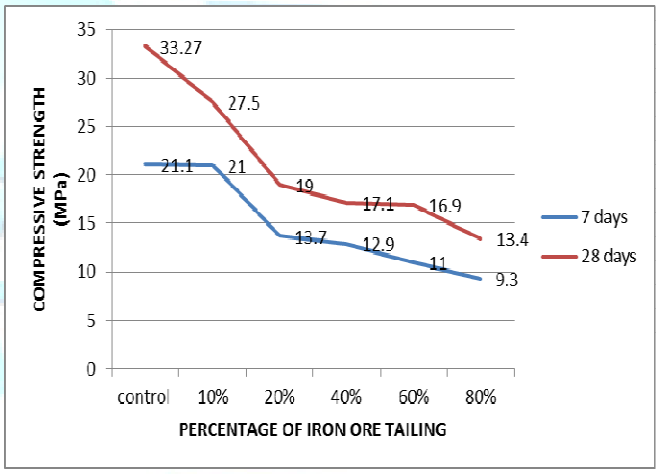

Figure 10 Compressive strength of concrete with different percentage og iron ore tailing at the end of 7 & 28 days

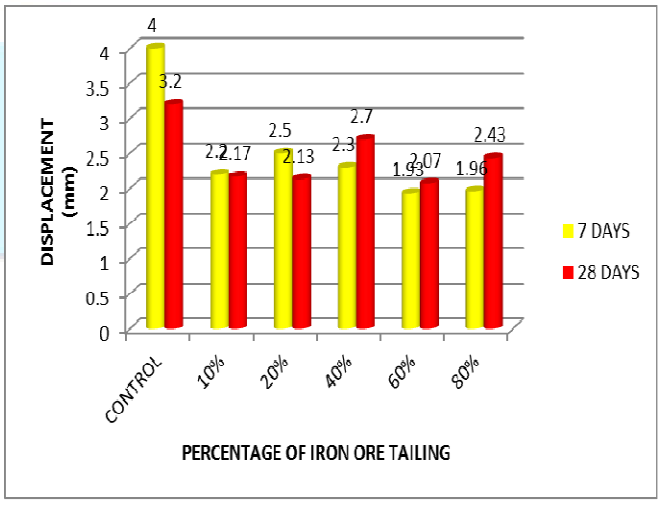

Figure 11 Displacement of M25 grade concrete with different percentage of iron ore tailings

4. Discussion

4.1 Compressive Strength test results

Table 5, shows the Compressive strength of concrete mixes made with and without iron dust was determined at 7 days as well as 28 days. It was found that Compressive strength of concrete decreases gradually by addition of Iron Dust from 0% to 80%. There is decrease in compressive strength as compared with normal plain concrete (without iron dust).

5. Conclusions

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

- As the iron dust percentage increases the workability of mix reduces hence for better workability use of superplasticizers is recommended.
- Replacement of 10% Iron dust gives approx. same compressive strength after 7 days curing which is equal to control mix and more than other replacement percentages.
- Due to very fine form of iron dust it gives some amount of bulking on exposed surface of the cube.
- As percentage of iron dust increases than compressive strength of concrete decreases.

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