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Effect on compressive and tensile strength of cement concrete road pavements due to use of Iron ore tailings as replacement to fine aggregate

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Abstract - *From the stage of quarrying the raw materials to the completion of project has resulted in stripping of earth for the use of exhaustible resources and has caused an adverse effect on the nature. This has resulted in an acute shortage of fine as well as coarse aggregates, obligating to explore the replacement for these materials without compromising the quality, environmental and economic factors. In recent years, almost every mineral producing country is facing the problem of better utilization of mine waste because of its accumulation and lack of suitable storage space. In the present study Iron Ore Tailings are used as partial replacement to fine aggregates at different percentage and the basic material properties, strength parameters are studied.*

Key Words: Iron Ore Tailings, Flexural fatigue, concrete, sand (RS), compressive and Flexural strength.

1. INTRODUCTION

Concrete is a composite construction material made primarily with cement, fine aggregate, course aggregate, and water. It also may contains chemical admixtures. But due to worldwide consumption of sand as fine aggregate in concrete is very high, thus resulting in reduction in the supply of fine aggregate to meet the need of infrastructure development. Expensive river sand is the main constituent of cement concrete which has very high demand. But due to high demand and excavation in river bed the supply of this sand is reducing and thus it's getting highly expensive.

In India 10-12 million tons of such mined ore is lost as ore tailings per year. Iron ore tailings consists of ultra-fine iron ore particles having diameter less than 150 µm, hence generally discarded. Utilization of such mineral wealth is main problem in mining industry.

This research is interested in use of iron ore tailing as sand in concrete and mortar. The successful utilization of iron ore tailing (IOT) as fine aggregate would turn this waste material into valuable resources, reduction in the strain on supply of natural sand and economy in concrete production.

1.2 Objective

- Partial replacement of iron ore tailings with the conventional sand.
- Checking the workability of the concrete when fine aggregate is replaced by iron ore tailings and comparing results with conventional results,
- Determining the Compressive and Tensile strengths of Cement Concrete when fine aggregate is replaced by iron ore tailings at different proportion.

1.3 Scope of the project: -

The increasing demand for heavy construction material like steel and iron has resulted in the establishment of many iron ore mining companies. Iron Ore Tailings (IOT) is the waste generated from iron ore industries. It can be found near industries where iron processing is carried out.

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 iron industries is used as an alternative to the river sand in the manufacturing of concrete.

2. MATERIAL

2.1 Cement: -

Ordinary Portland cement of grade 43 conforming to IS: 8112-1989 is used in the present studies. The test performed on this cement according to IS: 4031-1998 is summarized in table

2.2 Coarse Aggregates: -

Coarse aggregates are those which are retained on IS sieve size 4.75 mm. In the present study, aggregates of size

20mm and 10mm in the proportion 55 % and 45% by weight respectively are used. Proper grading of aggregates is essential to get required strength as per design mix

2.3 Fine Aggregates: -

River sand conforming to IS: 383-1970 (reaffirmed 1997) is used for the present investigation as fine aggregate. Tests on sand as per IS specifications are conducted

2.4 Iron Ore Tailings: -

Tailings are the materials left over, after the process of separating the valuable fraction from the worthless fraction of an iron ore. Iron ore tailings are the waste generated from iron ore industry after process. It is a very fine aggregate residue resulting from the extraction of iron from iron ore.

3 METHODOLOGY-

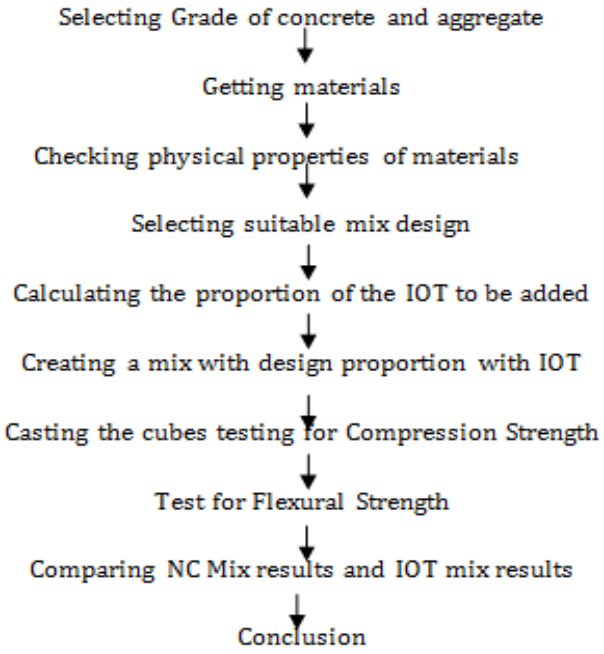
3.1.1METHODOLOGY-

- Casting of cement concrete blocks with various proportion of iron ore tailing.
- Testing aggregate for specific gravity and fineness modulus.
- Testing coarse aggregate for flakiness & elongation index.
- Testing compression strength.
- Testing flexural strength.

3.1.2 Specification for Cubes and Cylinder:-

- Total No. of cubes = 54 cubes.
- Dimension of Cube = 150mm X 150mm X 150mm.
- Total No. of Cylinders = 54 Cylinders
- Dimension of Cylinder = Diameter (D) 150mm. Height (L) 300mm.
- 3 cubes and cylinders of each proportion for each test.

3.1.3 Flow chart for completion of project work:-



3.2 COMPRESSIE STRNGTH

3.2.1 Preparation of cube specimens FOR COMPRESSIE STRNGTH

The proportion and material for making these test specimens are from the same concrete used in the field based on mix design.

3.2.2 Specimen: -

9 cubes of 150 mm X 150mm X 150mm of M20 grade for each Normal concrete mix (NC), 10% IOT mix, 20% IOT mix, 30% IOT mix, 40% IOT mix, 50% IOT Mix.

3.2.3 Precautions: -

The water for curing should be tested for 7, 21 and 28 days and the temperature of water must be at 27±2°C.

3.3 Flexural Strength

3.3.1 Specimen for Flexural Strength

9 cylinders of 150mm diameter and 300mm height of M20 grade for each Normal concrete mix (NC), 10% IOT mix, 20% IOT mix, 30% IOT mix, 40% IOT mix, 50% IOT Mix.

3.3.2 Precautions: -

The water for curing should be tested for 7, 21 and 28 days and the temperature of water must be at 27±2°C.

4 RESULTS & DISCUSSION:-

4.1 Compressive Strength:-

The cube specimens were tested in Compression Testing Machine after 7, 21, and 28 days curing period for different percent of IOT replacement Mix1(10%IOT), Mix2(20%IOT), Mix3(30%IOT), Mix4(40% IOT) and Mix5(50%IOT) and for normal concrete mix. The compressive strengths after respective curing periods are noted below

Table 5.1.1: - Results of Compressive Strength testing

Composition	Compressive Strength in N/mm²		
	7 days	21 days	28 days
0%	19.23	23.85	26.8
10%	20.12	24.62	27.6
20%	21.21	26.14	29.1
30%	22.42	27.53	30.3
40%	23.71	28.09	31.5
50%	22.18	27.32	29.9

Above results indicates that when fine aggregate is replaced by Iron Ore Tailings, compressive strength increases for all three curing periods. Whereas, it only increases for partial replacement of fine aggregate. After 50% replace strength starts decreasing

Fig.5.1.1: - Graph comparing Results of compressive strength after 7 days, 21 days, and 28 days

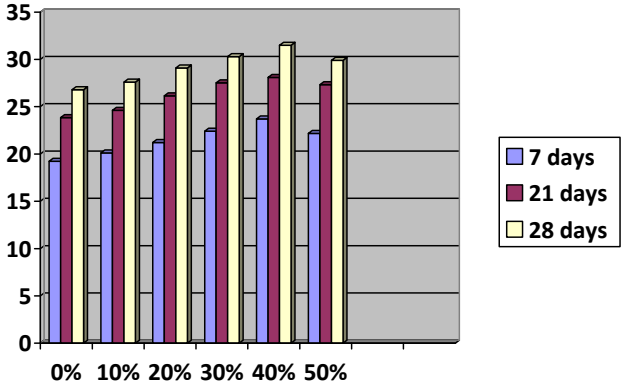
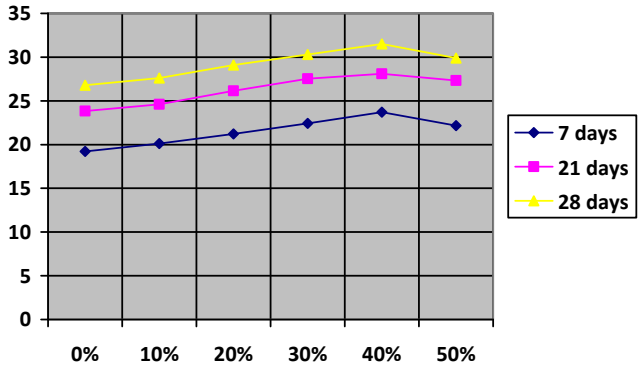


Fig.5.1.2: - Graph comparing Results of compressive strength after 7 days, 21 days, and 28 days



5.2 Flexural Strength: -

The specimens of cylinders were tested in flexural testing machine by split cylinder test as per IS codes and the flexural strength is calculated depending on the failure plane position from the supports. Values obtained for concrete with different IOT replacement levels and for the normal concrete mix are as note in table.

Table 5.2.1: - Results of Flexural Strength test

Composition	Flexural Strength in N/mm2		
	7 days	21 days	28 days
0%	3.1	3.42	3.64
10%	3.18	3.53	3.69
20%	3.29	3.6	3.79
30%	3.43	3.69	3.87
40%	3.52	3.72	3.98
50%	3.33	3.67	3.83

fig. 5.2.1: - Graph comparing Results of flexural strength after 7 days, 21 days, and 28 days

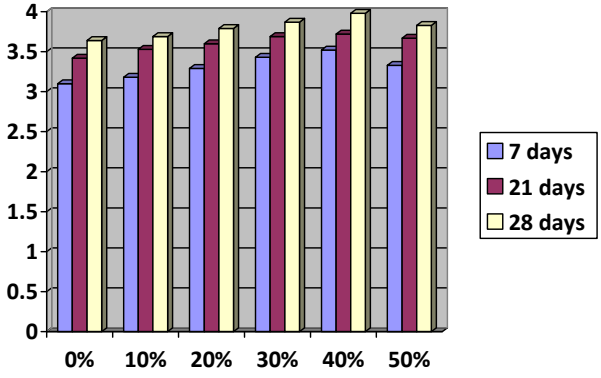
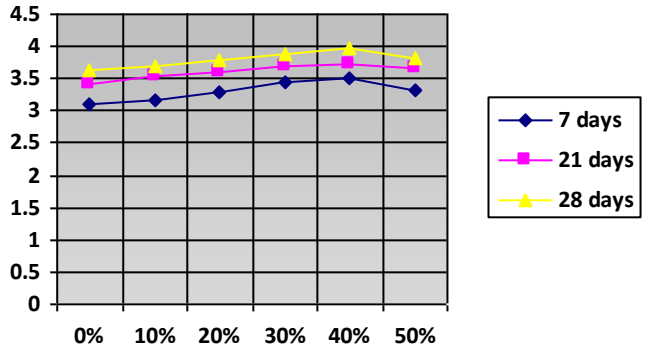


Fig. 5.2.2: - Graph comparing Results of flexural strength after 7 days, 21 days, and 28 days



Above results indicates that when fine aggregate is replaced by Iron Ore Tailings, compressive strength increases for all three curing periods. Whereas, it only increases for partial replacement of fine aggregate. After 50% replace strength starts decreasing

6.1 Conclusions: -

From the tests conducted on materials for assessing properties and tests on hardened concrete to arrive at strength properties such as compressive and flexural the following conclusions are made:

1.The IOT percentage increases workability of mix reduces hence for better workability needs use of superplasticizers is recommended.

2.The compressive strength of cement concrete is in no way affected by replacing sand by iron ore tailing. On the other hand there is an increase in the compressive strength due to sand replacement by iron ore tailing.

3.Replacement of 40% IOT gives maximum Compressive strength which is more than the reference mix (NC) and other replacement percentages.

4.Compressive Strength start decreasing after 50%IOT replacement.

5.Replacement of 40% IOT gives maximum Flexural strength which is more than the reference mix (NC) and other replacement percentages.

6.Flexural Strength start decreasing after 50%IOT replacement.

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