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# I-sand: An Environmental Friendly Sand used in Reinforced Cement Concrete Construction

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**Abstract -** *Now a day's erosion of rivers and considering environmental issues, there is a scarcity of river sand. The demand of natural sand is very high in developing countries to satisfy the rapid infrastructure growth. Hence it is necessary to find alternative to 'River Sand'. Benefits of using I sand: Cost reduction; social benefits; Mass utilization of waste material is possible in construction by using steel slag as a partial replacement material for fine aggregates in concrete. Waste or discarded materials produced commonly in industries, factories or mechanical plants are increasing daily thereby constituting increased pollution in environment. Global ferrous scrap availability stood at 750 MT in 2017, 630 MT of which was recycled. Even after recycling, around 120 MT (16% of total) scrap disposed in landfill. The scrap is expected to reach about 1 BT in 2030 and 1.3 BT in 2050. Concrete using I-Sand gives equal or more compressive strength than concrete using River Sand. Therefore to reduce threat to environment as well as society due to rapid extraction of sand from river bed, we can use iron waste as partial replacement to river sand.*

***Key Words:*** Concrete, Compressive strength, Industrial sand (I- Sand), Fine Aggregate, River sand (RS).

## 1. INTRODUCTION

The increasing demand for construction materials, coupled with the depletion of high-quality river sand, has prompted researchers and engineers to explore alternative materials that can effectively replace or supplement traditional aggregates. One such material that has gained attention is iron sand, also known as iron ore sand, due to its unique composition and potential benefits in construction applications.

Traditionally, river sand has been a key component in concrete production, providing a fine aggregate that contributes to the workability, strength, and durability of the material. However, the extraction of river sand has raised environmental concerns, including ecosystem disruption, habitat destruction, and alteration of river courses. This has led to the need for sustainable alternatives that can maintain or improve the performance of concrete while reducing the ecological impact associated with sand extraction. This paper aims to provide an overview of the current state of research and development regarding the utilization of iron sand as a partial replacement for river sand in concrete production. It will delve into the key characteristics of iron sand, its influence on the fresh and hardened properties of concrete, and its potential economic and environmental advantages. By exploring this innovative approach, we contribute to the growing body of knowledge surrounding sustainable construction materials and their role in addressing the challenges of modern construction practices.

## 2. OBJECTIVES

1. To cast the concrete blocks using I-Sand as partial replacement to river sand.

2. To find out the compressive strength of the concrete blocks using I sand and river sand.

3. To analyze the comparative cost study of river sand and I Sand.

## 3. MATERIALS AND METHODS

### 3.1 Material

#### 3.1.1 Cement

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

#### 3.1.2 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 sand and conformed to grading zone II as per IS: 383-1970. The specific gravity were found to be 2.645

#### 3.1.3 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.

#### 3.1.4 Iron waste

Iron waste is collected from Shree Sai agencies, Bhosari Pune. Cost = 15 Rs/kg. This waste is generated from automobiles part.

***Fig -1**: Industrial Sand*

***Table -1:** Physical Property of I-Sand found from Factory*

| SR No. | Characteristics | Values |
|---|---|---|
| 1 | Colour | Greyish black |
| 2 | Specific Gravity | 3.66 |
| 3 | Density | 2040 kg/$m^3$ |
| 4 | Solubility | Insoluble in hot and cold water |

### 3.2 MIX PROPORTION

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.

### 3.3 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$^0$ ± 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.

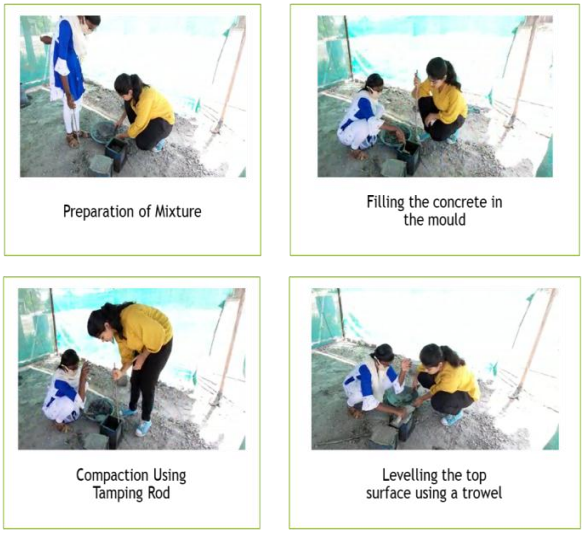


***Fig -2**: Casting of Blocks*

***Fig -3**: Curing of cubes*

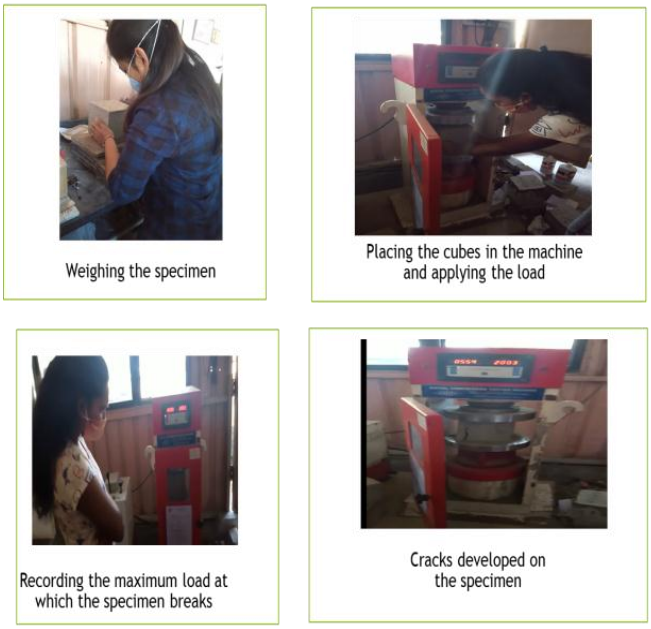


***Fig -4**: Compressive strength testing*

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

| Mix | Compressive Strength (N/mm²) | | | Average Compressive Strength (N/mm²) | | |
|---|---|---|---|---|---|---|
| | 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 | | | |

Chart 2 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.

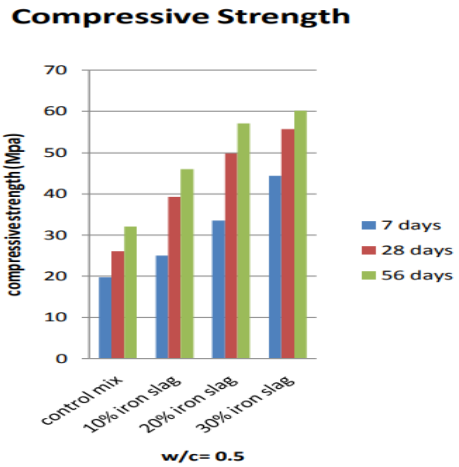


***Chart 1:** Compressive strength of iron slag concrete*

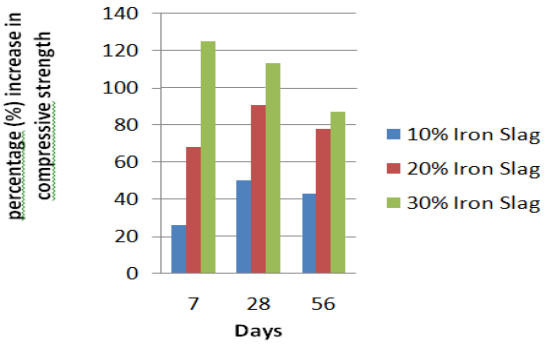


***Chart 2:** Percentage (%) increase in compressive strength of iron slag concrete*

## 4. WORKABILITY OF CONCRETE

Test adopted for measurement of workability in the present investigation was Slump cone Test.

### 4.1 PROCEDURE

### 4.2 RESULT AND DISCUSSION

| S.No. | Percentages of IOT | Slump in mm |
|---|---|---|
| 1 | 0 % | 63 |
| 2 | 10% | 59 |
| 3 | 20% | 53 |
| 4 | 30% | 47 |

***Table 3:****Workability (slump cone test)*

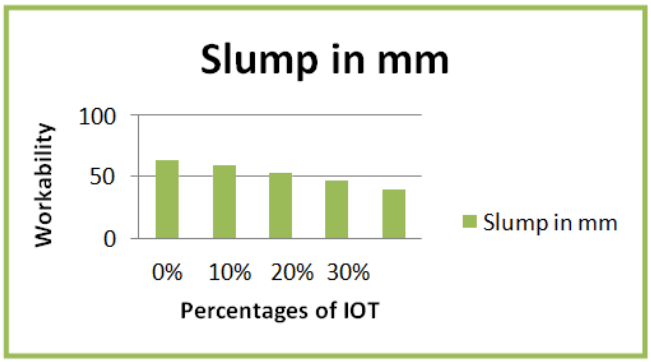


***Chart -3****: Workability of concretewith partial replacement of sand*

## 5. CONCLUSION

The use of Iron sand, a waste cheap material used as fine aggregates in the partial substitution of natural aggregates with steel slag aggregates permits the following: Gain of compressive strength, Tensile strength, Flexural strength , Modulus of elasticity of concrete up to an optimum value of replacement. Mass utilization of waste material is possible in construction by using Iron sand as a partial replacement material for fine aggregates in concrete.

With the reference of above research papers compressive strength of concrete : Iron waste can be replaced up to 15% of river sand, Above 15% the strength is slightly decreasing. (As per properties of iron waste) As the percentage of iron waste increases in concrete the workability is decreasing.

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

As the iron sand percentage increases the workability of mix reduces hence for better workability use of super plasticizers is recommended.

Iron sand 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 sand reduces the cost production of concrete.

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