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EXPERIMENTAL INVESTIGATION OF REPLACEMENT OF RIVER SAND WITH IRON SLAG SAND

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Abstract- The main scope of this study is the validity of the replacement of natural sand with iron slag sand. This research work is to cover the percentage of replacement of river sand with iron slag sand. Iron slag sand generated as a by-product in iron and steel industries is usually disposed of by delivering to landfills. Proper utilisation of iron slag in R.C.C. could be an interesting method for the aforementioned waste disposal with the added advantage of conservation of natural resources and as an economically viable alternative. In the current scenario where the availability of natural sand has diminished considerably and the excessive exploitation is leading to environmental problems like sliding of river shores, have caused the rivers to change their flow direction, etc., the possibility of replacing river sand with iron slag sand in concrete manufacturing could be a possible alternative. This project examines the possibility of preparing R.C.C. using iron slag sand with physical properties similar to those of using R.C.C. natural sand as fine aggregate. Detailed systematic investigations of the mechanical, chemical, and physical properties of iron slag sand in comparison with that of river sand in R.C.C. were performed.

Keywords - Iron slag sand, Physical properties iron slag sand, Workability testing, Compressive strength test, Split tensile strength test, and Durability testing.

I. INTRODUCTION

The most widely used fine aggregate for the construction of R.C.C. is the natural sand extracted from the river beds. However, the availability of river sand for the preparation of R.C.C. has become scarce due to the excessive and non-scientific methods of mining from the river beds, further causing environmental threats like lowering of the water table, sinking of the bridge piers, sliding of river shores, etc. The present scenario demands to identify of an alternate material for the fine aggregate (river sand) for making reinforced cement concrete which in turn depends on several factors such as their availability, physical properties, mechanical properties, and chemical ingredients.

A few decades there is an experiment done on the replacement of river sand with artificial stone crushed sand with few percentages of replacement but again the problem is created is stone mining, stone mining done is in large amounts so their large amount impact created on the stone quarries so reduce that effect, there is one more alternative to be searched for replacement of river sand is iron slag sand.

Iron slag sand is a good solution for the problem generated regarding natural sand. Iron slag sand generated from the iron industry as fine aggregate is of particular interest because of multiple reasons. There use can considerably reduce the problem of dumping waste products generated as a by-product of iron industries as well as it simultaneously helps the preservation of natural fine aggregate resources. However, some obstacles to the use of iron slag aggregate in concrete exist which include the limitations on water absorption and a lack of knowledge about the behavior of concrete made of iron slag as fine aggregate. It has to be noted that to ensure the construction of durable R.C.C. structures, the application of concrete meeting the required specifications is of utmost importance. In this study, we address these issues and explore the possibilities of replacing fine aggregates in reinforced cement concrete with Iron slag sand.

II. OBJECTIVE OF INVESTIGATION

- To determine the percentage of iron slag sand which gives maximum strength when compared to the control mix.

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- To check the workability of concrete using waste iron slag sand.
- To safely use the by-product of steel in concrete.

III. MATERIAL PROPERTIES

A. Cement

For this research, locally available cement which is of the ordinary Portland cement type (53 grade) was used throughout the work. Sp. gravity of cement is 3.14.

B. Physical properties of river sand

The locally available fine aggregate used was 4.75 mm in size confirming zone II with a Sp. gravity 2.71. The testing of sand was conducted as per IS 383-1970. Water absorption and fineness modulus of sand was 1.35% and 3.61 respectively.

C. Physical properties of coarse aggregate

Crush stone aggregate of size 20 mm is used throughout the experimental work. The coarse aggregate used was 20mm and less in size with a sp. gravity of 2.82. Testing of coarse aggregate was conducted as per IS 383-1970. Water absorption and fineness modulus of aggregate was 0.7% and 4.58 respectively.

D. Water

The water used was potable, color and odor less that is free from organic impurities of any type.

E. Physical properties of slag sand

Iron slag Sand of size 4.75mm is used throughout the experimental work.

Table -1 Physical Properties of Slag Sand

Sr. No.	Property	Result
1.	Particle shape and size	Flaky and cubical, below 4.75mm
2.	Grading Zone	Zone II
3.	Fineness modulus	3.62
4.	Specific gravity	2.76
5.	Bulk Density	1.273
6.	Silt content	Nil
7.	Surface moisture	Nil

IV. EXPERIMENTAL WORK AND TESTS

A. Concrete mix design

Concrete mix design is the process of selecting suitable ingredients and determining their relative amounts to produce concrete of the required strength, durability, and workability as economically as possible.

Table-2 Mix Design of River Sand for M_{30} Grade of Concrete

Sr.No.	Ingredients	Results
1.	Cement	472 kg/ m^3
2.	Water	198 lit/ m^3
3.	Fine aggregate	760 kg/m^3
4.	Coarse aggregate	1049 kg/m^3
5.	Water cement ratio	0.42

Design proportion for M_{30} grade of concrete = 1: 1.61: 2.223

B. *Workability Test*

A Slump Cone test was conducted to investigate of workability of fresh concrete. The following table shows the slump value for all proportions.

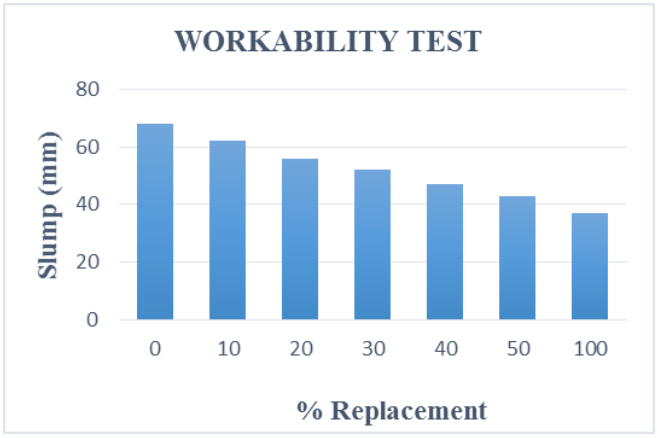

Figure No.: 1 Comparative study of slump test values of concrete with natural sand replacement with iron slag sand.

VI. TEST RESULTS

A. Compressive Strength Test

A cube compression test is performed on standard cubes of size 150 x 150 x 150 mm after 3, 7, and 28 days of immersion in water for curing.

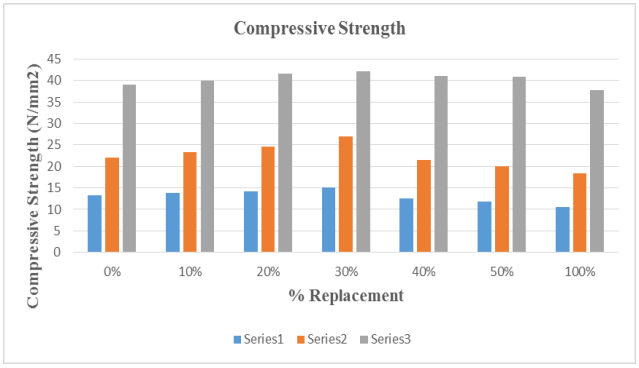

Figure No.: 2 Comparative study of compressive strength of concrete cube with river sand replacement with slag sand.

B. Split Tensile Test

The split tensile test is well known indirect test used to determine the tensile strength of concrete. A cylinder is tested after 28 days.

Split tensile strength of cylinder specimens is determined by placing between the two plates of compression testing machine, plywood strips of 3 mm thick, 25 mm wide, and 300 mm long, were placed between the plates and surface of the concrete specimens.

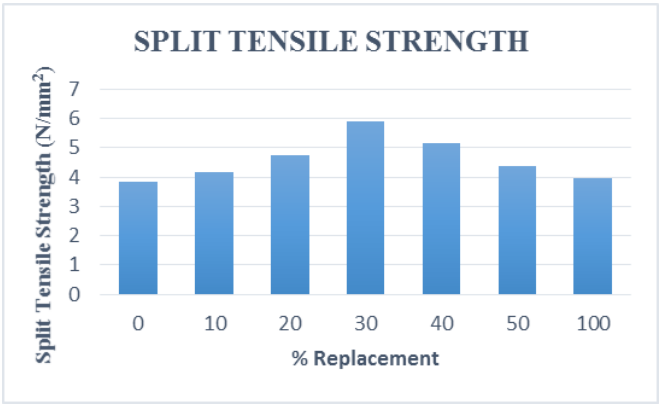

Figure No.: 3 Comparative study of Split Tensile strength of concrete with natural sand replacement with iron slag sand for 28 days.

C. *Rebound hammer test*

The rebound hammer test is used to find out the compressive strength of concrete cube by using the rebound hammer as per IS:13311 (Part II)-1992.

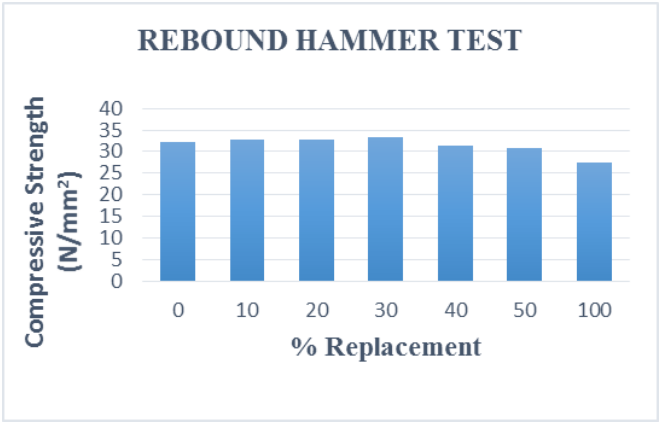

Figure No. : 4 Comparative Compressive Strength of concrete cube from Rebound Number.

D. Pull out Test

Specimens are prepared by filling the concrete of M30 grade in a mold having internal dimensions 150 mm X 150mm X 150 mm and inserting the mild steel or TMT bar at the center of the specimen. Specimens are cured for 28 days and tested in UTM. 3 cubes of each variation were cast for the conduction of the test and cured for 28 days underwater.

This test method covers to determine the pullout strength of hardened concrete by measuring the force required to pull an embedded metal insert and the attached concrete fragment from a concrete test specimen.

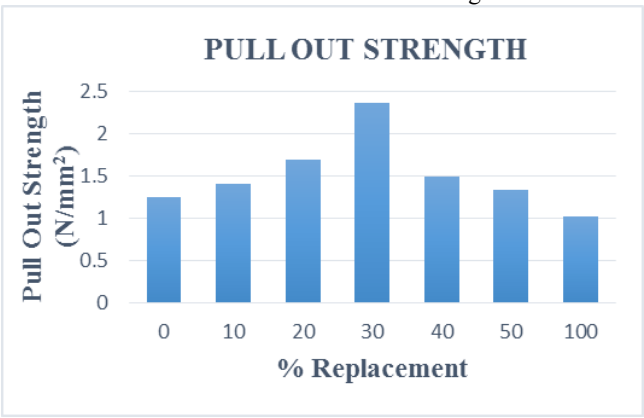

Figure No.: 5 Comparative Pull out the strength of concrete with natural sand replacement with iron slag sand for 28 days.

VII. CONCLUSION

Based on experimental observations, the conclusions can be established:

1. As the Percentage of slag sand in concrete increases, the workability of concrete decreases.
2. Replacement of river sand with iron slag sand in concrete increases the compressive strength of concrete by up to 30% replacement as compared to conventional concrete.
3. Replacement of river sand with slag sand in concrete also increases the split tensile strength of concrete by up to 30% replacement as compared to conventional concrete.
4. From a strength point of view, partial replacement of natural sand with slag sand shows positive results.
5. The pull-out strength increases with the percentage increase of iron slag sand in concrete.
6. The use of iron slag sand in concrete will minimize the disposal problem of waste iron slag generated during the manufacturing of steel and prove to be eco-friendly.

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