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REPLACEMENT OF NATURAL SAND BY IRON SLAG SAND

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ABSTRACT

The objective of this research is to study the validity of the replacement of natural sand by iron slag sand. This work is intended to cover percentage of replacement of natural sand by iron slag sand. Iron slag sand generated as a by-product in iron and steel industries, is usually disposed by delivering to landfills. Effective utilization of iron slag in reinforced cement concrete 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., possibility of replacing river sand with iron slag sand in concrete manufacturing could be a possible alternative. This project examines this possibility of preparing reinforced cement concrete using iron slag sand with physical properties similar to those of reinforced cement concrete using 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 reinforced cement concrete were performed.

KEYWORDS: Iron slag sand, Physical properties iron slag sand, comparison of physical properties of natural sand and iron sand.

INTRODUCTION

The most widely used fine aggregate for the construction of Reinforced Cement Concrete is the natural sand extracted from the river beds. However, the availability of river sand for the preparation of Reinforced Cement Concrete has become scarce due to the excessive and non-scientific methods of mining from the river beds, further causing environmental threats like lowering of water table, sinking of the bridge piers, sliding of river shores etc. The present scenario demands identification 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.Before few decades there is experiment done on the replacement of natural sand by artificial stone crush sand with few percentage of replacement but again problem is created is stone mining, stone mining done is in large amount 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 natural sand is iron slag sand.

Iron slag sand is good solution for above problem generated regarding natural sand. Iron slag sand generated from the iron industry as fine aggregate is of particular interest because of multiple reasons. Their use can considerably reduce the problem of dumping of waste products generated as a bye product of iron industries as well as it simultaneously helps the preservation of natural fine aggregate resources. However, some obstacles for the use of iron slag aggregate in concrete exist which includes the limitations on water absorption and 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 reinforced cement concrete 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 by Iron slag sand.

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MANUFACTURING PROCESS OF IRON SLAG SAND

- Step 1.Melting of ores
- Step 2.Separation of slag material
- Step 3.Slag crushing process
- Step 4. Iron slag sand

Fig.1. Iron Slag Sand

OBJECTIVE

- To study the effect of varying percentage of iron slag sand as a partial replacement of natural sand in concrete.
- To determine the percentage of iron slag sand which gives maximum strength when compare to control mix.
- To check the workability of concrete using waste iron slag sand.
- To safely use the by-product of steel in concrete.

MATERIAL PROPERTIES

A. Physical properties of cement

Ordinary Portland cement of grade 53 cement is used throughout the experimental work.

Tab.1. Physical properties of cement

Sr. No.	Physical Property	Results	IS 8112:1989 Specifications[6]
1.	Fineness of cement	490 m^2/kg	370 m^2/kg(minimum)
2.	Soundness of cement	3.0 mm	10 mm
3.	Specific Gravity	3.15	3.15
4.	Initial Setting time	86 Min	30 Min
5.	Final Setting Time	536 Min	600 Min

B. Physical properties of river sand

River Sand of size 4.75mm is used throughout the experimental work

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Tab 2. Physical properties of river sand

Sr. No.	Property	Result
1.	Particle shape and size	Rounded,below 4.75mm
2.	Fineness modulus	3.61
3.	Specific gravity	2.71
4.	Silt content	Nil
5.	Surface moisture	Nil

C. Physical properties of coarse aggregate

Crush stone aggregate of size 20 mm is used throughout the experimental work.

Tab3. Physical properties of Crush stone aggregate

Sr. No.	Property	Result
1.	Particle shape and size	Angular, 20mm
2.	Fineness Modulus of coarse aggregate	4.58
3.	Specific Gravity	2.82
4.	Surface Moisture	Nil

D. Physical properties of Iron slag sand

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

Tab 4. Physical properties of Iron 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

CONCRETE MIX DESIGN

Mix design is process of selecting suitable ingredients of concrete and determining their relative amounts with the objective of producing a concrete of the required, strength, durability, and workability as economically as possible.

Tab 5.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

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Tab 6.Mix design of Iron slag 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	= 774 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: 1.63: 2.223

METHODOLOGY

In present study cube compression test, flexural test on beams and Cylindrical split tensile test on self-compacting concrete with constant fraction of steel fiber were carried out.

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. The compressive strength of specimen is calculated by the following formula:

$$f_{cu} = P_c / A$$

Where

P_c = Failure load in compression, KN

A = Loaded area of cube, mm^2

B. Split Tensile Test

The split tensile test is well known indirect test used to determine the tensile strength of concrete. Due to difficulties involved in conducting the direct tension test, a number of indirect methods have been developed to determine the tensile strength of concrete. In these tests, in general a compressive force is applied to a concrete specimen in such a way that the specimen fails due to tensile stresses induced in the specimen. The split tensile strength of cylinder is calculated by the following formula,

$f_t = 2P / \pi LD$

Where,

f_t = Tensile strength, MPa

P = Load at failure, N

L = Length of cylinder, mm

D = Diameter of cylinder, mm

C. Flexural Test

Standard beams of size 150 x 150 x 700mm are supported symmetrically over a span of 400mm and subjected two points loading till failure of the specimen. The deflection at the center of the beam is measured with sensitive dial gauge on UTM. The two broken pieces (prisms) of flexure test are further used for equivalent cube compressive strength. The flexural strength is determined by the formula,

$$f_{cr} = P_f L / bd^2$$

Where,

f_{cr} = Flexural strength, MPa

P_f = Central point through two point loading system, KN

L = Span of beam, mm

b = Width of beam, mm

d = Depth of beam, mm

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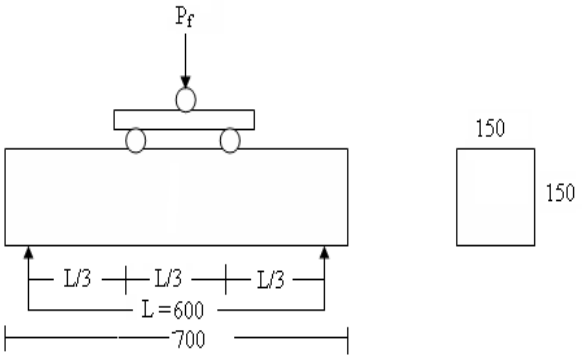

Fig.1. Two point loading setup in flexure test

(All Dimensions are in mm)

CONCLUSION

The above manuscript gives the possibilities of using iron slag sand, a waste product generated from iron and steel industries, as a replacement for river sand as fine aggregates in reinforced cement concrete constructions. In this regard detailed systematic investigations of the physical properties of iron slag sand in comparison with that of river sand for M_{30} grade concrete mix proportions were performed. Results suggest that the physical properties of iron slag sand aids in increasing the workability of concrete. Fineness modulus, specific gravity and water absorption coefficients of iron slag sand are within permissible limits. Surface compositional analysis shows that the slag is mainly composed of Si and that the Fe content is smaller. Evaluation of the hardened concrete properties like compressive and split tensile strengths indicated that the best results were obtained for an optimal replacement of river sand by iron slag sand. the above values suggest that an effective utilization of iron slag in reinforced concrete is possible without compromising on the quality and this could be an interesting method for the industrial waste disposal with the added advantage of conservation of natural resources and as an economically viable alternative.

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