International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 05 Issue: 05 | May-2018 www.irjet.net p-ISSN: 2395-0072

Partial Replacement of River Sand (RS or 0% slag sand) with Iron Ore Slag Sand (SS)

Sagar Gotur[1], Madhan M B[2], Sethupathy G[3], Arun A[4], Divya Nair[5]

[1,2,3,4] *Student @ RGIT, Bangalore, Karnataka*
[5] *Assistant Professor, Dept. of Civil Engineering, RGIT, Bangalore, Karnataka, India*

Abstract – *River sand is a widely used building material as fine aggregate as a component in concrete. It gives durability workability and strength which are important factors that help in construction process. One of the major drawbacks is that it is causing rapid extraction of sand from river bed which in turn has a negative effect on the environment. The idea of using iron ore slag sand Partially gives us a platform to use it as an alternative building material replacing river sand. This study aims at the partial replacement of slag sand with River Sand using M30 grade. The casted molds of slag sand and River Sand were cured for 7,14 and 28 days and tested for Compressive Strength, Split-Tensile Strength and Flexural Strength.*

Key Words: River sand, Iron ore slag sand, partial replacement.

1. INTRODUCTION

Rapid extraction of sand from river bed causing so many problems like losing water retaining soil strata, deepening of the river beds and causing bank slides, loss of vegetation on the bank of rivers, disturbs the aquatic life as well as the agriculture due to lowering of water table in the well, etc. The heavy exploitation of river sand for construction purposes leads to various harmful problems. Therefore, construction industries of developing countries are in stress to identify alternative materials to replace the demand for river sand [4]. Hence, it can be replaced by Compatible Iron Ore Slag Sand partially which meets the technical requisites of fine aggregate that is used as building material

2. MATERIALS AND METHODOLOGY

2.1 GENERAL

The present study deals with the partial replacement of slag sand with river sand and results obtained for tests conducted on river sand and slag sand. chemical analysis (quantum lab solutions, Bangalore Karnataka India), Compressive Strength, Split-Tensile Strength and Flexural Strength were done.

2.2 MATERIALS

Materials used for the preparation of concrete are Coarse aggregate, Cement and Fine aggregate as River Sand and Iron Ore Slag Sand for their concrete respectively.

2.3 METHODOLOGY

The concrete was produced by replacing river sand with 10%, 20%, 30% of slag sand, using M30 grade as per IS 10262:2009 OPC 43 grade cement was used and the water cement ratio is taken as 0.5, the concrete batch was hand mixed on water-tight, non-absorbent platform with a shovel, trowel and necessary equipment's which gave thoroughly blended concrete that is uniform in color were checked. The properties of materials that are used in production concrete were tested according to codal requirements of IS10262:2009, IS383:1983, IS456:2000.

2.4 MIX DESIGN

The mix proportioning was done according to IS 10262 2009 in order to design concrete mix. Mix design was prepared using M30 grade with variation of percentages of SS from 10%, 20% and 30% by replacing RS and the below table shows the values of the mix.

Grade designation	M30
Type of cement	OPC 43 grade
Maximum nominal size of aggregate	12mm to 20mm
Maximum cement content	400 kg/m^3
Maximum water cement ratio	.55
Workability	50mm to 75mm
Exposure condition	Moderate(plain concrete)
Degree of super vison	Good
Type of aggregate	Crushed angular aggregate
Maximum fine aggregate content	700.45 kg/m^3
Maximum course aggregate content	1158.16 kg/m^3
Chemical admixture	Not used

3. PARTIAL REPLACEMENT OF RIVER SAND WITH SLAG SAND

3.1 GENERAL

River sand is a mineral that is extracted from the river bed and it is a building material that is used widely used it has silicon dioxide as a major component which has a property of giving strength to concrete.

Slag Sand or Blast furnace sand is a by-product that is obtained at the end of steel manufacturing plant. It is a non-metallic product, consisting of silicates and alumina silicates it does not contain any material that might affect the strength and durability of the concrete.

Replacement of RS with SS partially in 10%, 20%, 30% to make use of SS that is being generated as an end waste product in iron ore manufacturing plant. In order to know the detail of both RS and SS we study their comparison so that we can find both their chemical compounds in detail which will help in the further studies.

3.2 COMPARITIVE STUDY

The comparative study will help us to know the similarities of RS and SS and also provides a provision of understanding its application when its replaced partially and impact of the same.

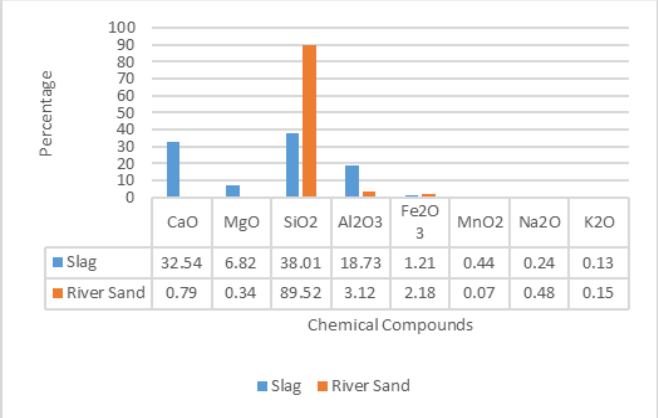
The slag sand and river sand pass through 4.75mm IS sieve complexly and retain in 90micron IS sieve similar to that of fine aggregate. Both sands according to shape is classified into sub angular to sub round having minimum voids ranging from 32% - 33% giving minimum ratio of surface area thus requiring minimum cement paste to make a good concrete and if it is sub angular voids ranging from 38% - 40% giving us workable concrete specific gravity that obtain is 2.69 which is between 2.5 – 2.7 range of natural fine aggregate which produce concrete with unit weight ranging from 23 – 26 KN/m^3

Chemical examination of Blast furnace of Slag Sand and River sand shows no content of any reactive form of minerals which could cause alkali aggregate reaction to occur vesicular nature of particles can promote to good interlocking between the particles

3.3 CHEMICAL ANALYSIS OF RIVER SAND AND IRON ORE SLAG SAND

Chemical Compounds	River Sand	Slag Sand
CaO	0.79	32.54
MgO	0.34	6.82
SiO_2	89.52	38.01
Al_2O_3	3.12	18.73
Fe_2O_3	2.18	1.21
MnO_2	0.07	0.44
Na_2O	0.48	0.24
K_2O	0.15	0.13

Table 1: Compounds of RS and SS

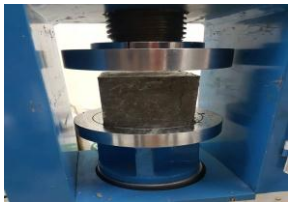


Graph 1: Chemical compound comparison of RS and SS

The above chemical analysis shows distribution of chemical compounds present in different percentages of Slag Sand and River Sand and the comparison between them. SiO_2 is the major component in the river sand where as in slag sand CaO and SiO_2 are the major components in the slag sand. Henceforth replacing partially river sand with slag sand will be having no negative effect on the concrete since slag sand does not contain deleterious material.

4. RESULTS AND DISCUSSION

4.1 COMPRESSIVE STRENGTH TEST



Compressive strength is the capacity of the material to withstand loads tending to reduce size, as opposed to tensile, which withstands loads tending to elongate

Here we use compression testing mission to find the value of compressive strength of concrete cube by applying load until the material fails which is having a dimension of 15cm X 15cm X 15cm

Compressive strength = F/A

Where, F= Load applied [N]

A=Area [mm²]

COMPRESSIVE STRENGTH of 0% Slag sand (N/mm²)			
Sl no	7 Days	14 Days	28 Days
1	32.66	30.22	30.22
2	26.22	29.25	32.55
3	28	30.66	33.87
Average	28.96	30.04	32.21

Table 2: Compression strength of 0% Slag sand

COMPRESSIVE STRENGTH of 10% Slag Sand (N/mm²)			
Sl no	**7 Days**	**14 Days**	**28 Days**
1	21.77	34.6	35.11
2	26.66	35.11	35.55
3	26.22	30.66	33.33
Average	24.9	33.5	34.7

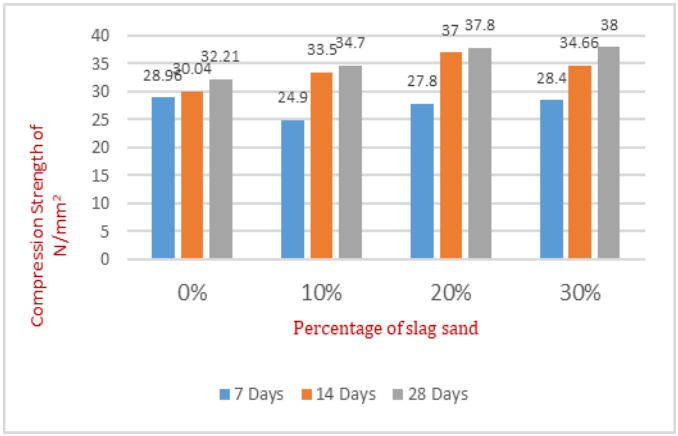
Table 3: Compressive strength of 10% Slag Sand

COMPRESSIVE STRENGTH of 20% Slag Sand (N/mm²)			
Sl no	7 Days	14 Days	28 Days
1	28.44	36.44	37.33
2	30.22	38.22	38.22
3	24.44	36.44	37.33
Average	27.8	37	37.8

Table 4: Compressive strength of 20% Slag Sand

COMPRESSIVE STRENGTH of 30% Slag Sand (N/mm²)			
Sl no	7 Days	14 Days	28 Days
1	29.77	33.33	40.88
2	30.22	33.77	36
3	25.33	36.88	37.77
Average	28.4	34.66	38

Table 5: Compression strength of 30% Slag sand

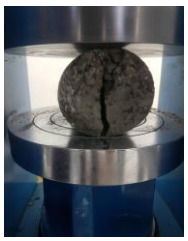


Graph 2: Compressive strength Comparison

The compressive strength of RS or 0% slag sand was found to be increasing 10.09% from 7 days to 28 days.

- The compressive strength of 10%,20%&30% slag sand was found to be at an increasing rate in ascending order as the percentage of slag sand increases.

4.2 SPLIT-TENSILE STRENGTH



The concrete is very weak in tension due to brittle nature and is not expected to resist the direct tension. The concrete develops cracks when subjected to tensile forces. Thus, it is necessary members may crack.

Here we take the cylindrical molds that has been casted and place them and apply the load in CTM and wait until the material fails or breaks and note down the breaking load.

Split tensile strength =2P/pi DL

P= applied load

D= diameter of the specimen

L= length of the specimen

Therefore, P= Tsp x pi DL/2

Expected load = p x f.s

Therefore, split tensile strength is T = 2P/pi DL

SPLIT TENSILE STRENGTH of 0% Slag Sand (N/mm²)			
Sl no	7 Days	14 Days	28 Days
1	10.8	14	16.55
2	12.73	15.27	12.73
3	16.55	14.51	15.91
Average	13.36	14.59	15.1

Table 6: Split Tensile Strength of 0% Slag Sand

SPLIT TENSILE STRENGTH of 10% Slag sand (N/mm²)			
Sl no	7 Days	14 Days	28 Days
1	12.09	12.98	14
2	12.23	13.87	13.75
3	10.18	12.47	14.51
Average	11.5	13.1	14.1

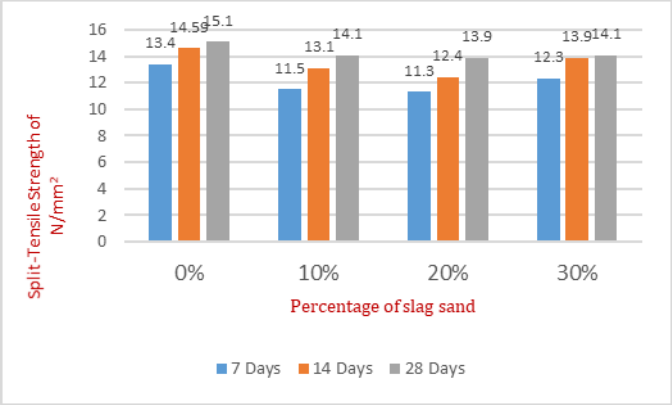
Table 7: Split-Tensile Strength of 10% Slag sand

SPLIT TENSILE STRENGTH of 20% Slag sand(N/mm²)			
Sl no	7 Days	14 Days	28 Days
1	11.46	10.82	13.36
2	12.09	12.98	14.26
3	10.18	13.36	14
Average	11.3	12.4	13.9

Table 8: Split-Tensile Strength of 20% Slag sand

SPLIT TENSILE STRENGTH of 30% Slag sand (N/mm²)			
Sl no	7 Days	14 Days	28 Days
1	13.36	13.36	13.75
2	10.63	15.78	13.11
3	12.73	12.47	15.27
Average	12.3	13.9	14.1

Table 9: Split-Tensile Strength of 30% Slag sand



Graph 3: Split-Tensile Comparison

- The Split Tensile strength of RS or 0% slag sand was found to be increasing 11.25% from 7 days to 28 days.
- The Split Tensile strength of 10%,20%&30% slag sand was found to be highest for both 10% and 30% and almost the same value for 20% but RS has got the highest value.

4.3 FLEXURAL STRENGTH

Flexural test evaluates the tensile strength of concrete indirectly. It tests the ability of unreinforced concrete beam to withstand failure in bending the results of flexural test on concrete expressed as modulus of rupture which denotes as MPa or psi

Standard size of specimen is 100mm width, 100mm depth and span of 5000mm

Test is done immediately after taken out from curing using flexural testing machine

The following expression is used for estimation of modulus of rupture

MR = $3PL/2bd^2$(1/3 break) and PL/bd^2 (Half break)

1. MR= modulus of rupture

P= ultimate applied load indicated by testing machine

L= span length

b= average width of the specimen at the fracture

d= average depth of the specimen at the fracture

FLEXURAL STRENGTH of 0% Slag sand (N/mm²)			
Sl no	7 Days	14 Days	28 Days
1	2.9	3.24	4
2	2.87	3.5	3.88
3	3.04	3.65	3.91
Average	2.93	3.46	3.93

Table 10: flexural strength of 0% Slag Sand

FLEXURAL STRENGTH of 10% Slag sand (N/mm²)			
Sl no	7 Days	14 Days	28 Days
1	3.41	3.68	4.54
2	3.37	3.74	3.86
3	3.54	3.62	3.92
Average	3.44	3.68	4.1

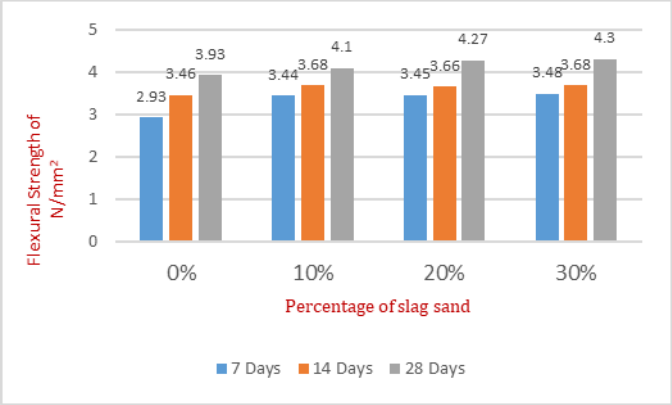
Table 11: flexural strength of 10% Slag sand

FLEXURAL STRENGTH of 20% Slag sand (N/mm²)			
Sl no	7 Days	14 Days	28 Days
1	3.32	3.5	3.97
2	3.59	3.8	4.2
3	3.43	3.68	4.64
Average	3.45	3.66	4.27

Table 12: Flexural Strength of 20% Slag sand

FLEXURAL STRENGTH of 30% Slag sand (N/mm²)			
Sl no	7 Days	14 Days	28 Days
1	3.51	3.64	4.32
2	3.4	3.78	3.94
3	3.49	3.61	4.65
Average	3.48	3.68	4.30

Table 13: Flexural Strength of 30% Slag sand



Graph 4: Flexural Strength Comparision

- The Flexural strength of RS or 0% slag sand was found to be increasing 25.44% from 7 days to 28 days.
- The Flexural strength of 10%,20%&30% slag sand was found to be increasing.

5. CONCLUSIONS

1. The results obtained after partially replacing RS with 10%,20% and 30%slag sand shows increase in compressive and flexural strength and almost nearby value for split-tensile strength.
2. As referred from journal [3] the partial replacement of SS will help to increase strength up to 40% replacement after which it will tend to decrease.
3. Iron ore slag sand is an eco-friendly alternative building material that can be used for construction replacing some percentages of river sand.

REFERENCES

[1]. Nandini reddy and P. Gopal, 'REPLACEMENT OF RIVER SAND BY IRON SLAG' International Journal of Innovative Research in Advanced Engineering (IJIRAE) ISSN: 2349-2163 Issue 04, Volume 4 (April 2017).

[2]. Chetan Khajuria, 'USE OF IRON SLAG AS PARTIAL REPLACEMENT OF IRON SLAG 'International Journal of Science, Engineering and Technology Research (IJSETR), Volume 3, Issue 6, June 2014.

[3]. Jyoti R. Mali, Piyush Bagul, Yogesh Biyani, Pradip Pandhare, Hemant Bafna and Mandar Joshi, 'PARTIAL REPLACEMENT OF FINE AGGREGTES WITH GGBS' International Journal of Advance Research, Ideas and Innovations in Technology.

[4]. Sindhu.A. E and Karthikeyan.N, 'EFFECT OF RELACING SAND WITH CAST IRON SLAG ON COMPRESSIVE STRENGTH OF CONCRETE' International Journal of Science and Engineering Research (IJ0SER).

[5]. M. SOUNDAR RAJAN, 'STUDY ON STRENGTH PROPERTIES OF CONCRETE BY PARTIAL REPLACEMENT OF SAND BY STEEL SLAG' International Journal On Engineering Technology and Sciences – IJETS™, ISSN (P): 2349-3968, ISSN (O): 2349-3976.

BIOGRAPHIES

Sagar Gotur, Student @ Rajiv Gandhi institute of technology, B.E. civil engineering, Bangalore, Karnataka, India.

Madhan M B, Student @ Rajiv Gandhi institute of technology, B.E. civil engineering, Bangalore, Karnataka, India.

Sethupathy G, Student @ Rajiv Gandhi institute of technology, B.E. civil engineering, Bangalore, Karnataka, India.

Arun A, Student @ Rajiv Gandhi institute of technology, B.E. civil engineering, Bangalore, Karnataka, India.

Divya Nair, Assistant Professor, Dept. of Civil Engineering, RGIT, Bangalore, Karnataka, India.