ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Vol 3, Issue 3, March 2018

Experimental Analysis of Concrete by Replacing Aggregate with Steel Slag

[1]Sonali Gadpalliwar, [2]Shraddha Kathalkar, [3]Nikhil Agrawal
[1][2][3] Assistant Professor CIVIL Department, Shri Ramdeobaba College of Engineering and Management, Nagpur, India

Abstract: **The study presents the evaluation of steel slag in concrete compared to natural aggregate in concrete. Steel slag is obtained glass like product left over after the desired material has been smelted from its raw ore. It is the mixture of metal oxides and silicon di-oxides. Steel slag was selected due its characteristics which are almost similar to conventional aggregates. There are many grades of steel that can be produced, and the properties of the steel slag can change significantly with each grade. Grades of steel can be classified as high, medium, and low, depending on the carbon content of the steel. The compressive strength results obtained for specimen with steel slag was almost same as that of normal concrete specimen. Since the Steel slag is the by-product of steel industries, thus it is easily available and cheap. The main purpose of using steel slag was to save the natural aggregate and hence using the so called waste product and recycling it instead of dumping it in the environment. The study done is on M40 grade concrete with 25%, 50%, 75% and 100% replacement of conventional aggregates with steel slag and the maximum compressive strength is achieved.**

Index Terms— Cement, Fine aggregate, Coarse Aggregate, Steel Slag.

1. INTRODUCTION

Concrete is the most widely used construction material in civil engineering industry because of its high structural strength and stability. Concrete has a key role in development of infrastructure and housing. The cement concrete is a mixture of cement, sand, gravel or crushed rock and water when placed in skeleton of form and allowed to cure, becomes hard like a stone. Since concrete has some special properties like it has high compressive strength, free from corrosion and there is no appreciable effect of atmospheric agents on it. It hardens with age and the process of hardening continues for a long time after the concrete has attained sufficient strength. Concrete binds rapidly with steel as it is weak in tension; the steel reinforcement is placed in cement concrete at suitable places to take up the tensile stresses. This is termed as RCC. Concrete is prepared by using the natural resources. These resources can be saved if we use the waste products. This will recycle the waste and waste production will be low. In this study we have used steel slag which is a waste product of steel and produced in abundant amount. The steel slag has no other better use and generally used for dumping purposes. In this study we have replaced natural aggregates with steel slag. The use of steel slag reduces the need of natural rock as constructional material, hence preserving our natural rock resources, maximum utilization and recycling of by-products and recovered waste materials for economic and environmental reasons has led to rapid development of slag utilization. In this study, it is proposed to utilize steel slag as full replacement of coarse aggregate in the production of concrete. Tests for compressive strength, and water absorption were conducted. Cost analysis for M40 grade concrete and replaced aggregate concrete were compared.

II. OBJECTIVES

Following are the objectives of translucent concrete:

•To find the optimum percentage of replacement of Coarse Aggregate with Steel Slag at which maximum strength is obtained.
•To provide economical construction material.
•Provide safeguard to the environment and society by utilizing waste properly.
•Comparison of optimum percentage of replacement of coarse aggregate with steel slag with ready-mix concrete.

III. MATERIALS USED

The materials used in experimental investigation include:

a. CEMENT

Pozzolona Portland cement of 53-grade was used in this study conforming to IS:8112-1989 which has
Specific gravity 3.15, Normal consistency 31%.

b. GROUND GRANULATED BLAST FURNACE SLAG (GGBS)

The GGBS used in research is obtained from Bhilai Steel Plant (Bhilai, Chattisgarh). Ground

ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Vol 3, Issue 3, March 2018

granulated blast-furnace slag is the granular material formed when molten iron blast furnace slag is rapidly chilled by immersion in water. It is a granular product with very limited crystal formation, is highly cementitious in nature and, ground to cement fineness, and hydrates like port land cement. The specific gravity of GGBS is 2.86.

c. STEEL SLAG

Steel Slag is a by-product of steel is produced during the separation of molten steel from impurities in steel making furnaces. The slag occurs as a molten liquid melt and a complex solution of silicates and oxides that solidifies upon cooling. The steel slag was obtained from JAYASWAL NECO Industries ltd., Nagpur.

The fineness modulus of steel slag was found to be 4.3 and its specific gravity was 3.1.

d. AGGREGATE

Good quality river sand was used as a fine aggregate conforming to Zone- II of IS: 383- 1970 have Fineness modulus of 2.735, specific gravity of 2.5 and water absorption 0.98%. Quarry sand from sidheshwar quarry plant Pachgaon, Nagpur, conforming to Zone- II of IS: 383- 1970 have fineness modulus of 2.85, specific gravity of 3 and water absorption 1%. The coarse aggregate passing through 20 mm and retained on 10 mm sieve was used in research. Its specific gravity is 2.85 and water absorption 1.41%.

e. WATER

In this research potable water free from organic substance was used for mixing as well as curing of concrete.

f. SUPERPLASTICIZER

AC-PLAST-BV M4 PLASTICIZER as a high range water reducing admixture for obtaining a workable mix was used in research, Strength increased 0.20 and Specific gravity 1.14.

IV. FIGURES AND TABLES

4.1 MIXTURE PROPORTIONING

The M40 mix proportioning is designed as per guidelines, according to the Indian Standard Recommended Method IS 10262- 2009. The total binder content was 400 kg/m³, fine aggregate is taken 613.92 kg/m³ , coarse aggregate is taken 1235.37 kg/m³. The super plasticizer content was varied to maintain a slump of 60 mm for all mixtures. This research is carried out in four phase, in first phase mix of M40 grade concrete with replacement of 0%,25%,50%,75% and 100% of coarse aggregate with steel slag is carried out to determine the optimum percentage of replacement at which maximum compressive strength is achieved Cube moulds were used for casting. The total mixing time was 5 minutes; Compaction of concrete in three layers with 25 strokes of 16mm rod was carried out for each layer is done. T he concrete was left in the mould and allowed to set for 24 hrs before the cubes were demoulded and placed in curing tank until the day of testing. The four specimens of each set was prepared and left for curing in the curing tank for 7, 14 and 28days.

Table 4.1.1 Sieve Analysis for Fine and Coarse Aggregate and steel slag

Sieve Size	Percentage Passing		
mm	Coarse Aggregate	Sand	Steel Slag
40	100	100	100
20	100	100	100
10	75	100	74
4.75	19.81	96.5	20.21
2.36	0.6	90.5	0.65
1.18	0	75.5	0
0.6	-	55.5	-
0.3	-	27.6	-
0.15	-	3.0	-
Fineness Modulus Of sand	4.96	2.59	4.3
Sand Conforming to Zone		Zone II	

Table 4.1.2: Different Mixed Proportion:

TYPE OF CONCRETE MIX	CEMENT	COARSE AGGREGATE	FINE AGGREGATE	STEEL SLAG
A	100%	100%	100%	0%
A1	100%	75%	100%	25%
A2	100%	50%	100%	50%
A3	100%	25%	100%	75%
A4	100%	0%	100%	100%
B (RMC)	100%	100%	100%	0%
B1 (RMC)	100%	75%	100%	25%

ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Vol 3, Issue 3, March 2018

Table 4.1.3: Material for Different proportion in Kg/m^3:-

TYPE OF CONCRETE MIX	CEMENT	COARSE AGGREGATE	FINE AGGREGATE	STEEL SLAG	WATER
A	400	1235.57	613.92	0	158
A1	400	883.76	613.92	346.15	160.42
A2	400	617.68	613.92	725.7	163.42
A3	400	294.58	613.92	1048.21	155.06
A4	400	0	613.92	1451.4	168.2

V. RESULTS AND DISCUSSION

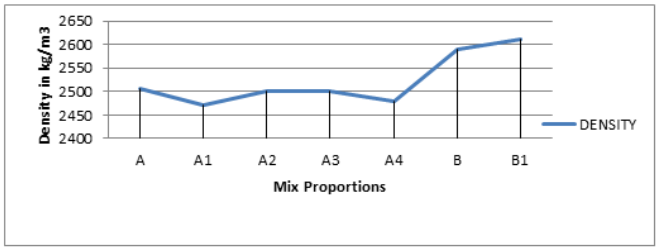
4.1. Testing methods

The three specimens of each set was prepared and left for curing in the curing tank for 7, 14 and28 days. Specimens were cube with dimensions of 150 x 150x 150 mm for compressive strength. Testing is done as per as per IS: 516 – 1959.

4.2. Density

Table 4.2.1: Various percentage and their Densities for M40 grade of concrete.

Sr. No	Coarse Aggregate	Fine Aggregate	Steel Slag	M40 Density Kg/m3
A	100	100	0	2506.67
A1	75	100	25	2471.11
A2	50	100	50	2499.55
A3	25	100	75	2500.74
A4	0	100	100	2478.22
B	100	100	0	2590.0
B1	25	100	75	2610.0

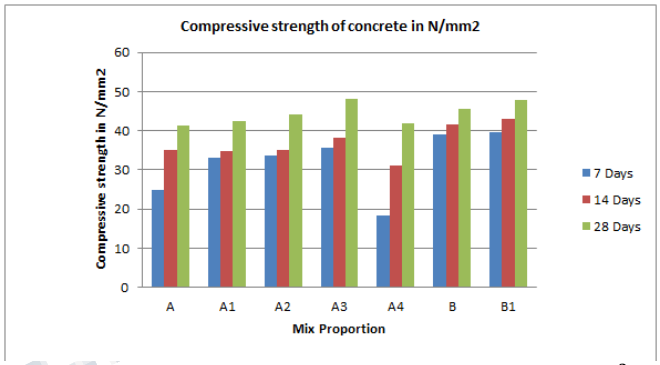


Graph 1: Density of Concrete (In Kg/m^3)

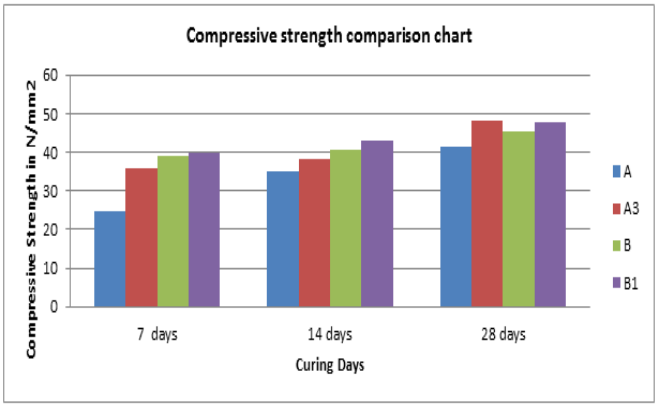
4.2.2 Compressive Test on Cube as per IS 516-1959: (Size: 150 X 150 X 150)

Table 4.2.3 Average Compressive Strength of Cubes of different proportions

TYPE OF MIX	COMPRESSIVE STRENGTH IN N/mm^2 ON (DAY)		
	7 DAYS	14 DAYS	28 DAYS
A	24.76	34.94	41.32
A1	33.06	34.87	42.55
A2	33.64	35.1	44.12
A3	35.77	38.196	48.12
A4	18.37	31.21	41.75
B	39.02	40.56	45.45
B1	39.75	43.16	47.72



Graph 2: Compressive Strength of concrete In (N/mm^2)
Remark: The compressive strength achieves high at 75% replacement of coarse aggregate with steel slag.



Graph 3: Average Compressive Strength (In N/mm^2)
Remark: The compressive strength achieves high with steel slag as compared to conventional concrete.

ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Vol 3, Issue 3, March 2018

VI. CONCLUSION

With reference to previous discussions on replacement of coarse aggregate with Steel Slag in Concrete, Compressive Strength, and effectiveness of cost the following conclusions can be made.

A. Conclusions Regarding Density of Concrete

As per comparison densities of conventional concrete with steel slag concrete was almost same.

B. Conclusions Regarding Compressive Strength

As per discussion in result analysis it is concluded that for same design of M 40, compressive strength of steel slag concrete is more than the normal concrete. Compressive strength of concrete is more in 75% replacement of coarse aggregate with steel slag. As per comparison of conventional concrete and steel slag concrete, the strength of the steel slag concrete is nearly same as conventional concrete.

REFERENCES

[1] P.S.Kothai and Dr.R.Malathy, Utilization of Steel Slag in Concrete as a Partial Replacement Material for Fine Aggregates, Volume-3 Issue-4(18), April 2014.

[2] Netinger, M. Jelčić, Rukavina & D. Bjegović Mladenovič, Concrete containing steel slag Aggregate: Performance after high temperature exposure, Volume-2, Issue -3 (5), Jan-Feb 2010.

[3] Mr. Nikhil, A. Gadge, Prof. S. S. Vidhale, Mix Design of Fibre Reinforced Concrete (FRC) Using Slag & Steel Fiber, Volume- 3 , Issue -6 (4),November-December 2013.

[4] Dr.K.Chinnaraju, V.R.Ramkumar, K.Lineesh, S.Nithya, V.Sathish, Study on concrete using steel slag as coarse aggregate replacement and eco sand as fine aggregate replacement, Volume-1 , Issue – 3(12) , June-July 2013.

[5] Magdi M. E. Zumrawi, Faiza O. A. Khalill, Experimental Study of Steel Slag Used as Aggregate in Asphalt Mixture, Volume - 9 no. 6(1), 2015.

[6] Sonali K. Gadpalliwar, R. S. Deotale, Abhijeet R. Narde, To Study the Partial Replacement of Cement by GGBS & RHA and Natural Sand by Quarry Sand in Concrete (14)

[7] D. S. Rajendra Prasad, Effect Of Rha And Crp As Replacement Materials And Effect Of Co2 Curing Of Concrete (2)

[8] Manguria, Partial Replacement of natural river sand with crushed rock sand in concrete production(2)

[9] Dr. A.D. Pofale, Effective Utilization of Crusher Dust in Concrete Using Portland Pozzolana Cement (13)

[10] Pazhani.K., and Jeyaraj.R “Study on durability of high performance concrete with industrial wastes”[40]

[11] IS 456 -2000 “Code of Practice for Plain and Reinforced Concrete”, Bureau of Indian Standards, New Delhi [39]

[12] Shetty M. S. "Concrete Technology" S. Chand & Co.Ltd, 1997[28]

[13] IS 516 -1959 “Methods of Tests for strength of concrete”, Bureau of Indian Standards, New Delhi [202]

[14] IS 10262-2009 “IS Method of Mix Design”, Bureau of Indian Standards, New Delhi [21]

[15]IS 383: 1970 “Specification for coarse and fine aggregates from natural source for concrete”