Effect of partial replacement of fine aggregate by steel slag and its impact on compressive strength of concrete

Mr. Pruthviraj L. Kadam, Anuj P. Shete, Ajit R. Ahir, Jay S.Pawar, Prathmesh S. Kadam, Vishal A. Patil, Mr Bajirao V. Mane (B.E. civil) Nanasaheb Mahadik Polytechnic Institute Peth. (MH)
Tal. – Walwa, Dist. – Sangli (415407)
Email ID – Nmpicivilboys@Gmail.com
Email ID – bajimane9090@Gmail.com

Abstract: As constructions are increasing at faster rate conspumtion of naturally available sand is more. The Fine Aggregate which we use for construction is available from natural rivers and streams. Use of large amount of fine aggregate affects the environment. Here Steel Slag which is waste material available from Sawing and Shaping of Steel and residue remains while producing steel products or working on steel in steel manufacturing industries. This research aims to study the effect of Steel Slag as partial replacement of Fine Aggregate with 0%, 10%, 20%, 30%, and 40%. The Specimen cubes having size (150mm X 150mm X 150mm) are tested after 14 and 28 days water curing. The result grah shows that variations in compressive strength for Fine aggregate replaced by Steel slag for 14 and 28 days water curing. The 30% and 40% replacements are desirable replacements of fine aggregate by steel slag.

Index Terms— Fine Aggregate, environmental affect, Steel slag and compressive Strength of Concrete.

1 INTRODUCTION

STeel Industries are growing widely nowadays. The extract of steel means steel slag is harmful, which increases pollution, and impossible for easy disposal. So main object of this research is waste management and use of steel slag in making low cost concrete. Nowadays there are many steel industries which produce steel products, and we know as there is production there will be waste generation. Steel Slag is generated at very large amount in Industrial areas. This steel slag damages and affects the environment and it is also difficult for disposal. So this waste or steel slag is used for making Steel Slag Concrete. For the study of Steel Slag oncrete we used M_{30} grade concrete. The concrete cubes as specimens of size (150mm X 150mm X 150mm) are cast for Partial replacement of steel slag with 0%, 10%, 20%, 30%, and 40%. ?Then these cubes were cured in normal potable water for 14 and 28 days. The graph obtained are studied with respect to controlled specimen. This shows variations in compressive strength for partial replacement of Fine aggregate by Steel slag. The results shows 30% replacement is desirable percentage replacement of fine aggregate by steel slag. Compressive strength goes on increasing upto 30% of replacement and more than 30% it goes on decreasing.

2 OBJECTIVES :

The objective of reseach paper is to study behavior of steel slag concrete. Also to study comparison of compressive strength of steel slag concrete for 0%, 10%, 20%, 30%, and 40% replacement of fine aggregate by steel slag. The concrete specimen cubes are cured in normal potable water for 14 and 28 days. Then tests will give us results of variations in compressive strength and these variations can be effectively shown by graphs below.

3 ADMIXTURES

STEEL SLAG

In this study the collection of steel slag is done from Shiroli MIDC, Kolhapur. Steel products are widely used nowadays everywhere. Steel is durable and strong. Steel has greater demand everywhere in industrial areas. This large amount of mass of waste means steel slag is today one of the environmental problem around the word. Proper disposal of steel slag is not possible.

Property	**Value of Steel Slag**
Specific Gravity	3.2 – 3.6
Unit Weight, kg/m^3 (lb/ft^3)	1600 – 1920 (100 – 120)
Absorption	up to 3%
Constituent	**Composition (%)**
CaO	40 – 52
SiO_2	10 – 19
FeO	10 - 40 (70 - 80% FeO, 20 - 30% Fe2O3)

MnO	5 – 8
MgO	5 – 10
Al_2O_3	1 – 3
P_2O_5	0.5 – 1
S	< 0.1
Metallic Fe	0.5 – 10

4 NECISSITY OF USE OF STEEL SLAG:

In steel industries generation of waste is in very large quantity. There are several reuses and recycling solutions for the Industrial byproduct in practical applications.

5 APPLICATIONS OF STEEL SLAG:

Today steel slag is used in many fields where its unique characterstics can be put to effective use.

1. Road base course material.
2. Coarse Aggregate for concrete.
3. Calcium Silicate Fertilizer.
4. Blending Material for Portland Cement.
5. Fertilizer and soil improvement.

6 ADVANTAGES OF STEEL SLAG:

6.1 Figures and Tables

The Application of steel slag includes its use in Granular base, Embankments, Engineered fill, highway shoulders, and hot mix asphalt pavement.

1. Greater Hardness
2. Better Adhesion.
3. Greater stability and reduced wear.

7 DISADVANTAGES OF STEEL SLAG:

1. More amount of steel slag affects environment
2. Difficult for disposal.

8 MIX PROPORTION

In this reseach paper, M_{30} mix proportion is designed as per guidelines of Indian Standard recommende method IS 10262:2009. We used 53 grade cement, also zone 2 is taken into consideration from IS 383(1970). The coarse aggregate is selected passing through 20mm and retained on 10mm Sieve.

We with our guide finnaly designed the mix proportion as follows.

Cement (kg/m^3)	Water (kg/m^3)	Fine aggregate	Coarse aggregate (kg/m^3)
1	0.4	1.58	2.27

The mix proportion of M_{30} Grade concrete with varying percentage of steel slag is determined by following table.

For 0% replacement:

Cement (kg/m^3)	Water (kg/m^3)	Fine aggregate+ steel slag (kg/m^3)	Coarse aggregate (kg/m^3)
492.5	197	782.87+00.00	1119.56
1	0.4	1.58	2.27

For 10% replacement:

Cement (kg/m^3)	Water (kg/m^3)	Fine aggregate+ steel slag (kg/m^3)	Coarse aggregate (kg/m^3)
492.5	197	704.59+78.28	1119.56
1	0.4	1.58	2.273

For 20% replacement :

Cement (kg/m^3)	Water (kg/m^3)	Fine aggregate+ steel slag (kg/m^3)	Coarse aggregate (kg/m^3)
492.5	197	626.3 + 156.57	1119.56
1	0.4	1.58	2.273

For 30% Replacement:

Cement (kg/m^3)	Water (kg/m^3)	Fine aggregate+ steel slag (kg/m^3)	Coarse aggregate (kg/m^3)
492.5	197	548.01 + 234.861	1119.56
1	0.43	1.62	2.86

For 40% Replacement:

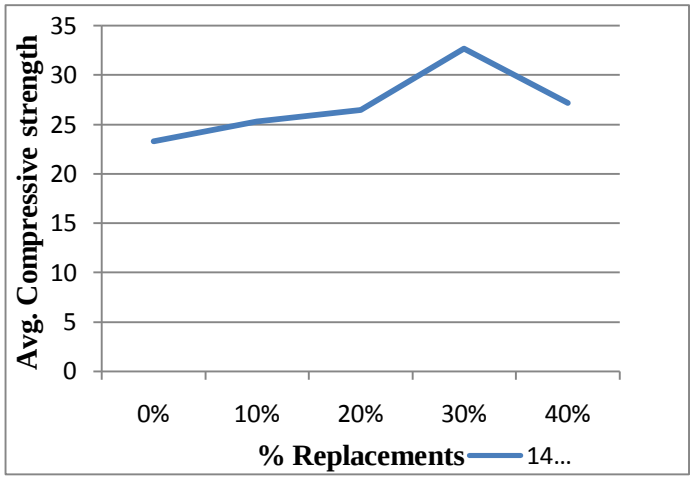
Cement (kg/m³)	Water (kg/m³)	Fine aggregate+ steel slag (kg/m³)	Coarse aggregate (kg/m³)
492.5	197	469.72 + 313.148	1119.56
1	0.45	1.72	3.04

9 RESULT AND DISCUSSION

The Compressive test are carried out on UTM after curing with water for 14 and 28 days. The compressive strength goes on increasing for 10%, 20%, 30% and 40%. But goes on decreasing for 40% compare to 30%. The result shows that 30% replacement gives better compressive strength for water curing to the 14 and 28 days. Also 40% replacement gives better compressive strength. But 30 % replacement is desirable and economical replacement of steel slag as compare to fine aggregate. Also 10% and 20% replacement increases the strength as compare to 0% or no replacement.

Test result after 14 days curing:

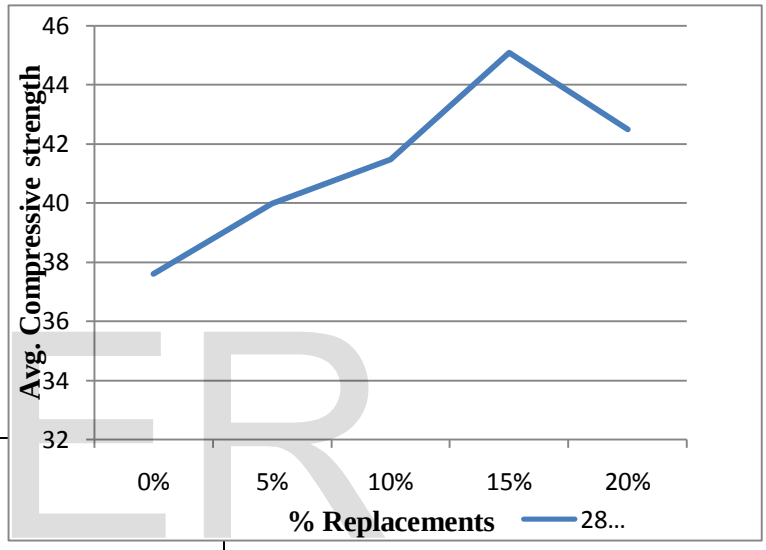
Sr. No.	% Replacement of Fine Aggregate by Steel Slag.	Average Compressive Strength (N/mm²)	
1	0%	**23.32**	
2	10%	**25.34**	
3	20%	**26.51**	
4	30%	**32.72**	
5	40%	**27.22**	



Graph 1: For 0%, 5%, 10%, 15% & 20% replacement of Fine Aggregate by Steel Slag.

Test result after 28 days curing:

Sr. No.	% Replacement of Fine Aggregate by Steel Slag.	Average Compressive Strength (N/mm²)
1	0%	**37.60**
2	10%	**39.98**
3	20%	**41.48**
4	30%	**45.10**
5	40%	**42.50**



10 CONCLUSION:

After completion of this project it is concluded that, for 10%, 20%, 30%, and 40% Replacement the strenghth increases as compare to 0% replacement. As the replacement goes on increasing greater then 30% the strength decreases. And as Steel Slag has low cost compare to naturally available fine aggregate 30% replacement is desirable replacement. And also helps in reducing pollution of environment.

11 REFERENCES:

1. Study on behavior of concrete mix replacing fine aggregate with steel slag at different properties. International Journal of Engineering and Research and Application. ISSN : 2348 – 9622. Vol. 05. ISSUE 11, [Part 04] PP 3946. P. Sateesh Kumar1, VVS. Sarma, N. Vidya Sagar Lal. (2015)[1].

2. Compressive strength of steel slag aggregate and artificial sand in concrete Prof Mrs. A. I. Tamboli. ISSN 0976 – 6316. Volume 6, Issue 2, February (2015)[2].

3. Performance of steel slag as fine aggregate in structural concrete. NIJETECH Vol. 34 No. 03, PP 452 – 458 Copyright 02 Faculty of Civil Engineering. University of Nigeria. NSUKKA ISSN:

0331 – 8443. K. A. Olonade1, M. B. Kadiri and P. O. Aderemi. (2015)[3].

4. Study on mechanical properties of ecofriendly Economic concrete. IJSTM – ISSN : 2394 – 1537 Vol. No. 04. Issue No. 02, Y.Boopathi1, Dr. K. Nirmal Kumar. (2015)[4].

5. . Study on strength properties of concrete by partially replacement of sand by steel slag. IJETS ISSN [P] : 2349 – 3948, ISSN [O] : 2349 – 3976. Vol. 01. Issue 06. M. Sounder rajan. October (2014)[5].

6. Steel slag as a substitute for fine aggregate in high strength concrete. IJERT ISSN : 2278 – 0181. Vol. 03 Issue 10, Krishna Prasanna P Venkata Kiranmayi K. October (2014)[6].

7. Utilization of steel slag in concrete as a partial replacement material for fine aggregates. IJIRSET, ISSN: 2319 – 8763 An ISO 3291 – 2007Certified Organization Vol. 03 Issue 04,. P.S.Kothai, Dr.R.Malathy. April (2014)[7].

8. Effect of using steel slag aggregate on mechanical properties of concrete. ISSN: 1546 – 9239 American Journal Of Applied Science. 11 [p]: 700 – 706. Sultan A. Tarawneh, Emhaidy S. Gharaibeh and Falah M. Saraireh. (2014)[8].

9. Study on compressive strength of cement mortar with partial replacement of fine aggregate by steel slag for Ferro cement laminates. ISSN 0974 – 5904, Vol. 04 No. 06. PP: 1139 – 1144. J. SRIDHAR and R. MALATHY. (2011)[9].

10. I.S.456:2000.

11. I.S. 10262:2009.

12. Concrete technology by M. S. Shetty.