ISSN: 2319-9490

Available online at http://www.ijcrls.com

International Journal of Current Research in Life Sciences
Vol. 07, No. 04, pp.1658-1661, April, 2018

RESEARCH ARTICLE

EXPERIMENTAL STUDY ON STRENGTH PROPERTIES OF M30 CONCRETE WITH ENERGY OPTIMIZED FURNACE STEEL SLAG AS REPLACEMENT FOR AGGREGATES

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Received 24th February, 2018; Accepted 17th March, 2018; Published 15th April, 2018

ABSTRACT

Environmental and economic factors encourage the use of industrial by-products. The main objective of this study was to identify an alternative for natural aggregates which are becoming scarce. Steel slag is an industrial by product obtained from the steel manufacturing industry. It is a non-metallic ceramic material formed from the reaction of flux such as calcium oxide with the inorganic non-metallic components present in the steel scrap. Most of the volume of concrete comprises of aggregates. Therefore, replacing either fully or partially with steel slag will lead to environmental benefits and waste reduction of industrial by-products and also contribute to sustainable development. In this study, it is proposed to utilize the steel slag as full replacement of conventional coarse aggregate and partially as fine aggregate in the varying percentage of 0% to 50%. For this investigation, M30 grade of concrete was designed and specimens were cast and tested at 7 days and 28 days for compressive strength, tensile strength and flexural strength. From the test results, the optimum mix was obtained in which fine aggregate was replaced with 10% steel slag and coarse aggregate with 100% steel slag which showed better compressive strength, split tensile strength and flexural strength.

Key words: EOF steel slag, compressive strength, split tensile strength, flexural strength.

Citation: Priscil Nidhu, S., K. Ranjit, V., Sasetharan, K., Surendar and Thanigai Velan, R. 2018. "Experimental study on strength properties of m30 concrete with energy optimized furnace steel slag as replacement for aggregates" *International Journal of Current Research in Life Sciences*, 7, (04), 1658-1661.

INTRODUCTION

Concrete is a complex material composed mainly of water, aggregate and cement. Usually there are additives and reinforcements included in achieving the desired physical properties of the finished material. When these ingredients are mixed to gether, they form a fluid mass that is easily moulded into shape. Over time, the cement forms a hard matrix which binds the rest of the ingredients together into a durable stone – like material with manyuses. Concrete is the widely used man-made building material in the world, owing to its versatility and relatively low cost. Aggregate is the main constituent of concrete, occupying more than 70% of the concrete matrix. In many countries, there is a scarcity of natural aggregates that is suitable for construction, whereas in other countries the consumption of aggregates has increased in recent years, due to increase in the construction industry. In order to reduce depletion of naturalaggregate, artificially manufactured aggregates and some industrial waste materials can be used as alternatives. New by-products and waste materials are being generated by various industries for many years, by-products such as fly ash, silica fume and steel slag such as energyoptimized furnace slag are considered as waste materials. Concrete prepared with such materials showed improvement in workability compared to normal concrete and has been used in the construction of chemical plants and under-waterstructures. Over recent decades, intensive research studies have been carried to explore all possible reuse methods. Construction waste, blast furnace, steel slag, coal fly ash and bottom ash have been accepted in many places as alternative aggregates in embankments, roads, pavements, foundation and building construction. Currently, the production of industrial waste and sub graded by-products has been increased and it causes huge environmental hazards. For example the current production of steel slag (generally a mixture of lime, silicate and metallic) is estimated around 41 million tons per annum in India, but only 20% of steel slag is used as road base course. From the literature review it was observed that, the steel slag aggregate improves the mechanical performance of concrete with respect to increase in the replacement level with natural coarse aggregate.

Need for steel slag

The increase in demand for the ingredients of concrete is overcome by partially replacing the building materials by the waste materials obtained from various industries. Since there is

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an increasing demand for fine aggregates nowadays, it is time to find alternatives which can be replaced for both fine and coarse aggregates. An alternative source of sand is attributed by waste by products from industries like steel slag, flyash, metakaolin. In India slag production capacity is about 41 million tons per annum and this is projected to reach 90 million tons by 2020.This can be used in various ways like making cement or sand or coarse aggregate. The slag is produced after the material is treated at about 1500 degree Celsius. At this temperature, all the chemical ingredients become inert and is safe to use.

MATERIALS AND METHODS

Cement

The cement used was Ordinary Portland Cement of grade53 conforming IS:8112-1989 and similar to ASTM type III (C150-95) from Bharathi cements.

Aggregate

M sand conforming to the code IS 383-1970 and steel slag obtained from JSW steel Ltd. was used. Crushed coarse aggregates of 20mm size were used and steel slag passing through 25mm sieve and retained on 4.75mm sieve was obtained from JSW steel Ltd.

EOF steel slag

Energy Optimizing Furnace (EOF) steel slag as coarse aggregate and fine aggregate replacement in concrete. Concrete prepared with such material showed improvement in workability compared to normal concrete.

Table 1. Physical properties of materials

Paramater	EOF Steel Slag	Cement
Loss on Ignition(LOI)	1.54 %	1.19 %
Silica (SiO_2)	40.14 %	20.44 %
Calcium Oxide (CaO)	22.56 %	63.21 %
Magnesium (MgO)	2.9 %	1.78 %
Iron Oxide (Fe_2O_3)	20.63 %	0.69 %
Aluminium Oxide (Al_2O_3	6.61 %	4.14 %

RESULTS AND DISCUSSION

Compressive strength

Concrete cubes of size 150 mm x 150 mm x 150 mm were cast, cured and tested for compressive strength on 7th day and 28th day

Inference

The Compressive strength of concrete increases upto 10% replacement of fine aggregate with steel slag and 100% of coarse aggregate with steel slag which is 20% higher than the conventional concrete. Further increase in percentage of steel slag as fine aggregate decreases the strength as shown in figure 1.

Split tensile strength

Concrete cylinders of diameter 150 mm and height 300 mm were cast and the specimens were cured, and tested for split tensile on 28th day.

Inference

It was observed that the split tensile strength of concrete showed similar behavior as that of compressive strength. The value increased upto 10% replacement of fine aggregate with steel slag and 100% of coarse aggregate with steel slag which is 13% higher than the conventional concrete. Further increase in percentage of steel slag as fine aggregate decreases the split tensile strength as shown in figure 2.

Flexural strength

Concrete beams of size 100 mm x 100 mm x 500 mm were cast and the specimens were cured, and tested for flexural strength in UTM on 28th day.

Up to 10% replacement of fine aggregate with steel slag increases the flexural strength of concrete. The maximum flexural strength obtained was 6.94 N/mm^2 which is 19% higher than the conventional concrete.

Table 2. Chemical Composition of materials

Description	Fine Aggregate (M Sand)	Coarse Aggregate	EOF Steel Slag as Fine Aggregate	EOF Steel Slag as Coarse Aggregate
Specific Gravity	2.47	2.80	2.72	3.1
Fineness Modulus	3.087 (zone II)	7.2	3.92	7.7
Water Absorption	1.57%	1.8%	2.01%	2.78%
Bulk Density	1950 kg/m^3	2886 kg/m^3	3020 kg/m^3	3186 kg/m^3

Table 3. Mix Ratio

Types	Fine Aggregate		Coarse Aggregate	
	% of EOF slag as fine aggregate	Fine aggregate	% of EOF slag as coarse aggregate	Coarse aggregate
M1	-	100%	-	100%
M2	0%	100%	100%	-
M3	10%	90%	100%	-
M4	20%	80%	100%	-
M5	30%	70%	100%	-
M6	40%	60%	100%	-
M7	50%	50%	100%	-

Further addition of steel slag as fine aggregate decreases the strength as shown in figure 3.

Table 4. compressive strength after 28 days

Type	Compressive Strength (N/mm^2)
M1	36.6
M2	38.95
M3	42.14
M4	32.94
M5	31.75
M6	29.20
M7	28.40

Table 5. Split tensile strength after 28 days

Type	Split tensile strength (N/mm^2)
M1	3.83
M2	3.95
M3	4.32
M4	3.63
M5	3.57
M6	3.42
M7	3.37

Table 6. Flexural strength after 28 days

Type	Flexural strength (N/mm2)
M1	5.85
M2	6.11
M3	6.94
M4	5.43
M5	5.29
M6	4.99
M7	4.88

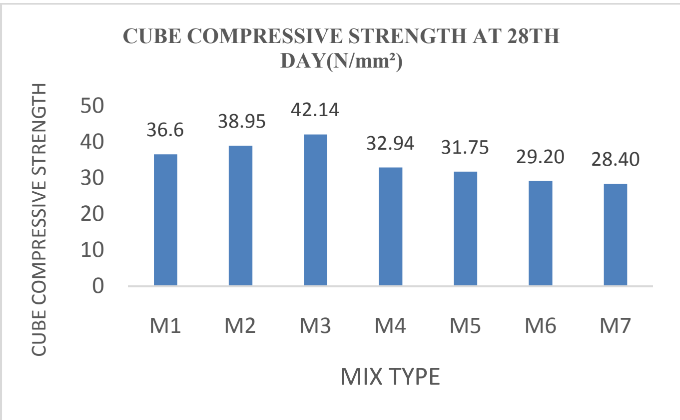

Fig. 1. Bar diagram showing compressive strength of concrete at 28th day

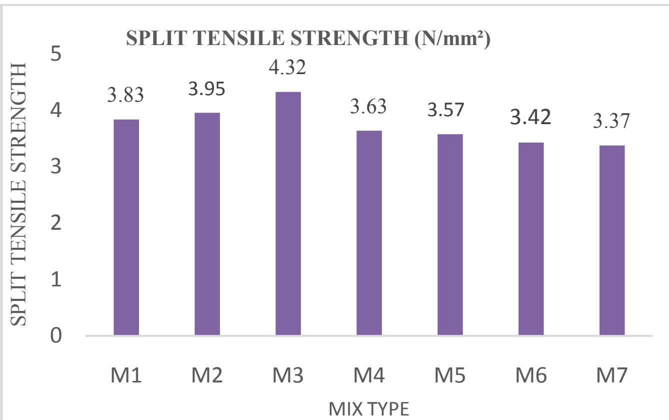

Fig. 2. Bar diagram showing split tensile strength of concrete at 28th day

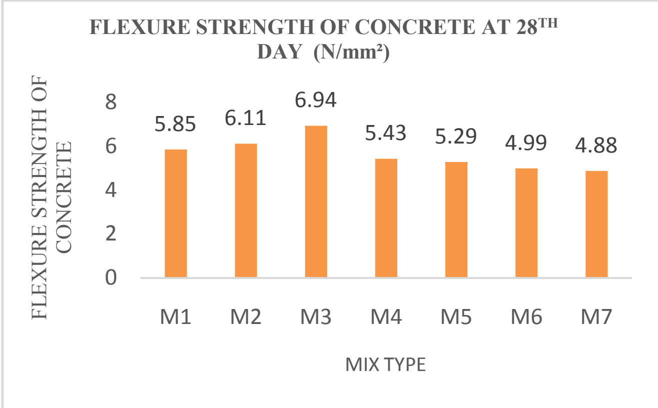

Fig. 3. Bar diagram showing flexural strength of concrete at 28th day

Conclusion

From the above results the following conclusions are made, in this study steel slag is replaced as Fine aggregate in increasing percentages of 10 and the conventional coarse aggregate is completely replaced with steel slag aggregates. The present experimental results show that there is increase in strength upto 10% replacement after which the value decreases. Hence it is concluded that steel slag can be replaced up to 10% as Fine aggregate and 100% as Coarse aggregate which is considered as optimal mix in this investigation. This study relates the use of steel slag as Fine aggregate and Coarse aggregate in M_{30}grade of concrete and recommends the use in concrete.

- The partial replacement of steel slag as Fine aggregate in varying percentage gains increase in Compressive strength, Split tensile strength, Flexural strength.
- It aids in environmental and economical benefits and also mass utilisation of waste industrial by products.

REFERENCE

Anil, Mukesh Kumar, Pankaj and Pradeep Kumar, 2017. "Effect of steel slag as partial replacement of fine aggregate in M35 grade of concrete" *Imperial Journal of Interdisciplinary Research* (IJIR) vol-3, Issue-9, ISSN:2454-1362.

Arivoli, M. and Malathy, R. 2017. "Study on mechanical properties of concrete replacing EOF steel slag as coarse aggregate" ISSN 2321-807X volume 13 number5 *Journal of advanced in chemistry*,

Gozde Inan Sezer and Mert Gulderen 2015. "Usage of steel slag in concrete as fine and/or coarse aggregate" *Indian Journal of Engineering and Material science*"vol-22,June pp 339-344.

Krishna Prasanna, P. and Venkata Kiranmayi, K. 2014. "Steel slag as a substitute for fine aggregate in high strength concrete" *International Journal of Engineering Research,* and Technology (IJERT) ISSN:2278-0181, vol-3, Issue 10.

Padmapriya, R., Bupesh Raja, V.K., Ganesh Kumar, V. and Baalamurugan, J. 2015. "Study on replacement of coarse aggregate by steel slag and fine aggregate by manufacturing sand in concrete" *International Journal of ChemTech Research,* ISSN:0974-4290 vol.8, No.4 pp 1721-1729,

Ravikumar, H. Dr. Dattatreya, J.K. and Dr. Shivananda, K.P. 2015. "Experimental Investigation on replacement of steel slag as coarse aggregate in concrete" Journal of Civil Engineering and Environmental Technology ISSN:2349-8404; vol.2,No.11; April-June, pp 5863.

Ritesh Mall, R.D. 2014. Patel "Comparitive Strength analysis of concrete by using steel slag as an alternative to normal aggregates (coarse) in concrete" International Journal of Computer and Mathematical Science" IJCMS ISSN 2347-8527 vol-3, Issue 5,

Sabapathy, Y.K., Balasubramanian, V.B., Shiva Shankari, N. and Yeshwant Kumar, A. 2016. "Experimental investigation of surface modified EOF steel slag as coarse aggregate in concrete" accepted 19 July.

Saravanan, J. and Suganaya, N. "Mechanical Properties of Concrete Using Steel Slag Aggregate" *International Journal of Engineering Inventions,* e-ISSN:2278-7461,Volume 4, Issue 9 (May 2015) pp:07-16.

Vidhya, J. and Dhilipkumar, R. 2016. "Study on strength properties of concrete by partially replacing fine aggregate as steel slag" IJIRT vol-2, Issue-8 ISSN:2349-6002.

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