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USE OF STEEL SLAG AS AGGREGATE IN CEMENT CONCRETE: EXPERIMENTAL STUDY

Umesh Kumar Kori[1], Prof. Afzal Khan[2]

[1,2]MIT, Bhopal, India.

ABSTRACT

An effects on concrete by replacement of sand and coarse aggregate as steel slag on properties such as compressive strength, split tensile strength, flexural strength, are studied. The natural sand was replaced with steel slag by 0%, 10%, 20%, 30%, 40%, and 50% by weight and coarse aggregate was replaced with steel slag by 0%, 20%, 40%, 60%, 80%, and 100% by weight at fixed water-cement ratio 0.48.

Keywords: Coarse Aggregate, Design Mix, Plastisizer, Steel Slag, Sand, Slump value, workability etc

1. INTRODUCTION

The building industry is the biggest user of natural materials and also a large amount of wastes resulted from the demolition of constructions. The construction process is responsible for 40% to 50% of the greenhouse gas generated. The bi-products from industries are slag, rice husk ash, bagasse, fly ash, cement dust, brick dusk, blast furnace slag, sludge, glass, tires, sandpaper, silica fume, etc. The above-listed waste materials represent a major problem for the environment because the dust and fine particles spread in the atmosphere which causes air pollution and leaching toxic chemicals like lead, cobalt, etc. also when they are dumped in landfills, quarries, rivers or oceans they cause a serious damage on the water in which animals and humans can consume it and lead to a health problem.

As the demand for coarse aggregate in the making of cement concrete is increasing day by day the search for alternative material has become a crying need. Stone chip is the most widely used coarse aggregate in India and the continuous spreading of the brick industries are hampering the environment to a great extent. Moreover the price of brick aggregate is also going higher as its demand gets higher. Stone can be used as a replacement of brick aggregate but it has low availability and higher price. In this existing condition the waste materials such as steel slag can be considered as a possibility which can be used instead of conventional coarse aggregates.

Steel slag is a byproduct obtained either from conversion of iron to steel in a Basic Oxygen Furnace (BOF), or by the melting of scrap to make steel in the Electric Arc Furnace (EAF). The molten liquid is a complex solution of silicates and oxides that solidifies on cooling and forms steel slag. Steel slag is defined by the American Society for Testing and Materials (ASTM) as ìa non-metallic product, consisting essentially of calcium silicates and ferrites combined with fused oxides of iron, aluminum, manganese, calcium and magnesium that are developed simultaneously with steel in basic oxygen, electric arc, or open hearth furnacesî.

Figure 1: Steel Slag Sample

2. OBJECTIVES OF THE STUDY

The various objectives of the study is to study the fresh and hardened properties of concrete made with steel slag as partial replacement of coarse aggregate, to find out mechanical properties of concrete by partially replacing fine aggregate with steel slag, to compare mechanical properties of concrete made with conventional aggregate and steel slag aggregate and to find out the possibility of utilization of Steel slag in concrete as partial replacement.

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3. METHODOLOGY

In this study, Steel Slag obtained from Bhilai Steel Plant, Durg, Chhattisgarh, a part of National SAIL, located in Chhattisgarh state, India is used. It is very famous for steel in India with a capacity of 2600 MW. The natural sand was replaced with steel slag by 0%, 10%, 20%, 30%, 40%, and 50% by weight and coarse aggregate was replaced with steel slag by 0%, 20%, 40%, 60%, 80%, and 100% by weight at fixed water-cement ratio 0.48.

Effects on concrete by replacement of sand and coarse aggregate as steel slag on properties such as compressive strength, split tensile strength, flexural strength, are studied. In this slump was kept constant 100 ± 10 mm respectively and achieve the required slump Plastizer were used as directed by the manufacturer.

RESULTS

Results of the various experimental investigations are reported and discussed. Mix design of M25 grade of concrete is given and mix proportioning of different concrete mixes is fixed.

Table -1: Compressive strength of sample containing Steel Slag as Fine aggregate

Steel Slag %	0	10	20	30	40	50
Compressive strength MPa after 7 days	20.12	22.15	22.45	19.45	18.56	16.02
Compressive strength MPa after 14 days	31.59	32.30	32.50	28.02	24.36	20.10
Compressive strength MPa after 28 days	33.05	34.45	34.56	32.25	26.36	24.30

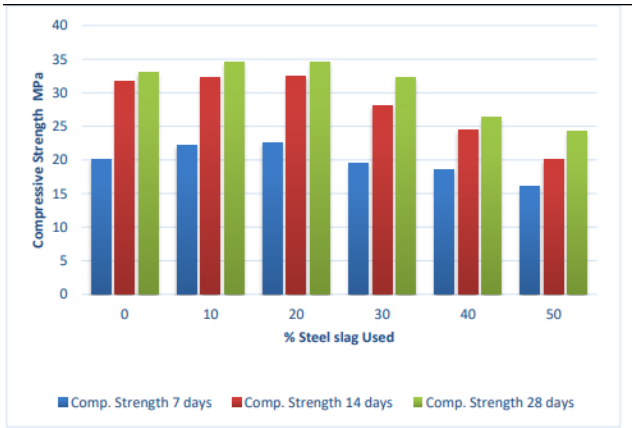

Chart -1: Compressive strength of sample containing Steel Slag as Fine aggregate

Table -2: Compressive strength of sample containing Steel Slag as coarse aggregate

Steel Slag %	0	20	40	60	80	100
Compressive strength MPa after 7 days	20.12	20.15	21.00	19.75	17.50	16.25
Compressive strength MPa after 14 days	31.59	31.50	32.05	27.45	23.23	19.45
Compressive strength MPa after 28 days	33.05	33.15	33.50	31.23	27.25	23.60

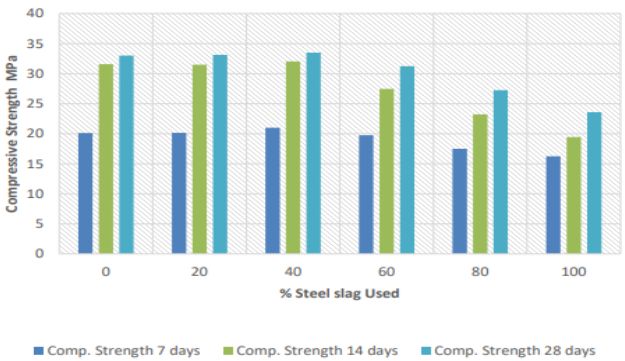

Chart -2: Compressive strength of sample containing Steel Slag as Coarse aggregate

Here 0% to 50% of steel slag was replaced with sand and optimum percentage of replacement was found at 20% replacement of steel slag with sand. For controlled concrete the compressive strength was found for 7, 28 days. It was observed that for 20% sand replacement the compressive strength was increased as compared with controlled concrete. Then after that compressive strength were decreased from 30% to 50% replacement. The steel slag concrete gains strength at a slower rate in the initial period and acquires strength at faster rate.

4. CONCLUSION

In this report experimental results are presented to evaluate the possibility of utilizing of slag as sand in concrete with compressive strength of 25 MPa.

After the review of all properties of steel slag it can be concluded that steel slag has properties similar to Indian standard sand and coarse aggregate hence it can be used as fine aggregate and coarse aggregate in construction. While replacing fine aggregate with steel slag The compressive strength for 7,14 & 28days was increased up to 20% replacement and after that compressive strengths were decreased from 30% to 50% replacement. Replacing coarse aggregate with steel slag The compressive strength for 7,14 & 28days was increased up to 40% replacement and after that compressive strengths were decreased from 50% to 100% replacement.

Therefore, the conclusions of all these tests suggest that the mixture containing 40% steel slag may be used as a suitable replacement for coarse aggregate and 20% steel slag may be used as a suitable replacement for fine aggregate in concrete in moderate environments without compromising the strength.

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