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"THE STUDY OF VARIOUS PARAMETERS OF ECO-FRIENDLY CONCRETE USING WELDING SLAG"

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Abstract : This project represents the experimental results of replacement of fine aggregate with that of welding slag and evaluates the effect of various properties of concrete. The basic objective of the study is to identify an alternative source of fine aggregate because the natural sources of aggregates are depleting very fast due to the fast pace of construction activities in India. In place of fine aggregate welding slag is produced as a byproduct off some arc welding processes, most specifically shielded metal arc welding (also known as stick welding), submerged arc welding, and flux-cored arc welding. Slag is formed when flux, the solid shielding material used in the welding process, melts in or on top of the weld zone. Slag is the solidified remaining flux after the weld area cools. In this study concrete of M25 grade were considered with a W/C ratio of 0.45 for the replacement of 5%, 10%, and 15% of course aggregate by slag. In this investigation the improvement in compressive strength and durability properties. Based on the overall observations, it could be recommended that the welding slag could be utilized as fine aggregate in the various applications of concrete. This study investigates the performance of concrete mixtures containing welding slag at various percentage and compressive strength, at 7 and 28 days. Result shows that concrete with welding slag had higher compressive strength and durability.

Key words : Welding slag, Compressive strength and carbonation test.

Introduction

Concrete is a very important material and widely used in construction industry. It offers stability and design flexibility for the residential marketplace and environmental advantages through every stage of the construction and use the characteristic compressive strength is usually measured by 150 mm x 150 mm cubes according to BS approach. Concrete is a construction material which is a mixture of cement (commonly Portland cement) as well as other cementation material such as fly ash and slag cement, aggregate water and chemical add mixtures are widely used in construction industry. Now days there are many filler material used in construction industries. In cement based products such as concrete and mortars, a balance between the particle sizes of component must be kept in order to obtain the required material properties such as workability, strength and durability of concrete. The worldwide consumption of sand as fine aggregate (FA) in concrete production is very high, and several developing countries have encountered some strain in the supply of natural sand in order to meet the increasing needs of infrastructural development in recent years . So, there is large demand for alternative materials for fine aggregates in construction industry. To overcome the stress and demand for river

Paper ID: UGC 48846-931

sand, researchers have identified some alternatives for sand, namely scale and steel chips , waste iron , crushed granite fine , etc. Environmental management in developing countries is a complex issue because environmental problems are linked with social and economic aspects, which must be considered in the development of any environmental program or regulation .The problem of waste accumulation exists worldwide, specifically in the densely populated areas. Scale, granulated slag, and steel chips are industrial wastes in the iron and steel industry and cause a nuisance both to the health and environment when not properly disposed. Reuse of industrial solid waste as a partial replacement of aggregate in construction activities not only saves landfill space but also reduces the demand for extraction of natural raw materials.

Materials

The Materials used for this experimental work are cement, sand, water, steel slag.

A. Sand

The fine aggregate used for all the specimens were Narmada River sand complying the requirements of IS383:1970. The specific gravity of the fine aggregate is 2.74. The fractions from 4.75mm to 150 micron are termed as fine aggregate.

B. Water

Portable water was used for experimentation.

C. Cement

Ordinary Portland cement of 43 grade. It was used in this experimentation confirming to IS-12269-1987.

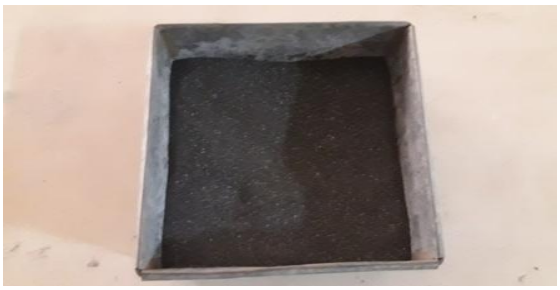
D. Coarse aggregate

Crushed granite coarse aggregates of 20-mm maximum size were used

E. Welding slag

The welding slag was obtained from local fabrication industries, and they are used to replace fine aggregate partially in the production of concrete. The nature and the physical structure of the welding slag used for the investigation. The physical and chemical characteristics of the welding slag were determined in the laboratory as per standard methods.

Welding slag



Paper ID: UGC 48846-931

Table 1
Typical Composition Of Ordinary Portland Cement

Chemical	Weight
Tri- calcium silicate-C3S	55%
Di -calcium silicate-C2S	18%
Tri- calcium-aluminate-C3A	10%
Tetra- calcium alumino ferrite –C4AF	8%
Calcium sulphate dehydrate-CSH2	6%

Table 2
Physical Characteristic Of
Welding Slag

1) Specific gravity 2.64
2) Fineness Modulus 2.53

Table 3
Chemical Characteristics Of Welding Slag
Metals Concentration (mg/L)

Metals	Acid soluble	Water soluble
Fe	26.03	2.11
Mg	6.16	2.03
Zn	0.62	0.05
Al	63.9	5.49
Cu	0.13	0.02
Ca	50.9	22.28
Pb	0.12	0.04
Cr	0.28	0.04
K	2	0.68

Experinmental Work

The research is completely based on IS-456-2000. The three set of mixture Mix A, Mix B & Mix C was prepared by using M-25 grade and the proportions are 1:1:2. The steel Slag is used to replacement of aggregates of saving natural resources. Two tests are conducted on prepared concrete cube that is carbonation depth, and compression strength test.

FOR Mix A1

0 % of welding slag and 100 % fine aggregates by weight.

FOR Mix A2

5 % of welding slag and 95 % fine aggregates by weight.

FOR Mix A3

10% of welding slag and 90% fine aggregates by weight.

FOR Mix A4

Paper ID: UGC 48846-931

15% of welding slag and 85% of fine aggregates by weight.

Afterwards the fresh mixes were filled into steel moulds with internal dimension of 150X150X150 mm. Steel mould was filled with material to about half height and the layer was compacted by tamping it with tamping rod in a uniform manner over mortar surface in such a way to produce full compaction of the mortar with neither segregation nor excessive laitance. The moulds were then be completely filled and the upper layer of the mortar compacted in a similar manner, after which the mould were kept on the vibrating table.

Compression strength = Ultimate load / Bearing area

Finally the relation between carbonation depth and compressive strength is found out. The specimen was tested an interval 7 and 28 days. The test is made three types of test specimen of M-25 grade of concrete.

- **Testing Method**

A. Compression Strength
B. Carbonation depth of concrete

Result And Discussion

In this research, welding slag was used as a partial replacement of fine aggregate. The ordinary Portland cement, sand and aggregate mixing proportion is 1:1:2. Fig 1 and 2 shows the result of the compressive strength depending upon the changes in the mixing percentage of the welding slag. After the test process the Mix-A2 and Mix-A3 has high strength than the other two mixes. In the M 25 grade of concrete compressive strength of Mix-A2 and Mix-A3 is increased by 60.41% and 56.72% with respect to normal mix A1 for 28 days. For 7 days compressive strength of Mix-A2 and Mix-A3 is increased by 13.33% and 3.61% respectively. The carbonation depth is assessed using a solution of phenolphthalein indicator of 1% and ethyl alcohol of 70 %. Carbonation of concrete is caused due to the carbon-dioxide in atmosphere. The indicator solution is sprayed on freshly exposed surface of the concrete. The color of concrete is turned to pinkish color after sprayed. The carbonation depth of the concrete M25 grade Mix-A2 and Mix-A3 is 1.30 cm and 1.1 cm at the age of 28 days and 2.14 cm and 1.75 cm at 7 days respectively.

Test Results of Compressive Strength Depending Upon Various Percentage of Mixing Welding Slag.

S.no	%	Strength 7 days N/mm²	Strength 28days N/mm²
1	0	15.75	24.1
1	5	17.85	38.66
2	10	16.32	37.77
3	15	17.2	31.11

Paper ID: UGC 48846-931

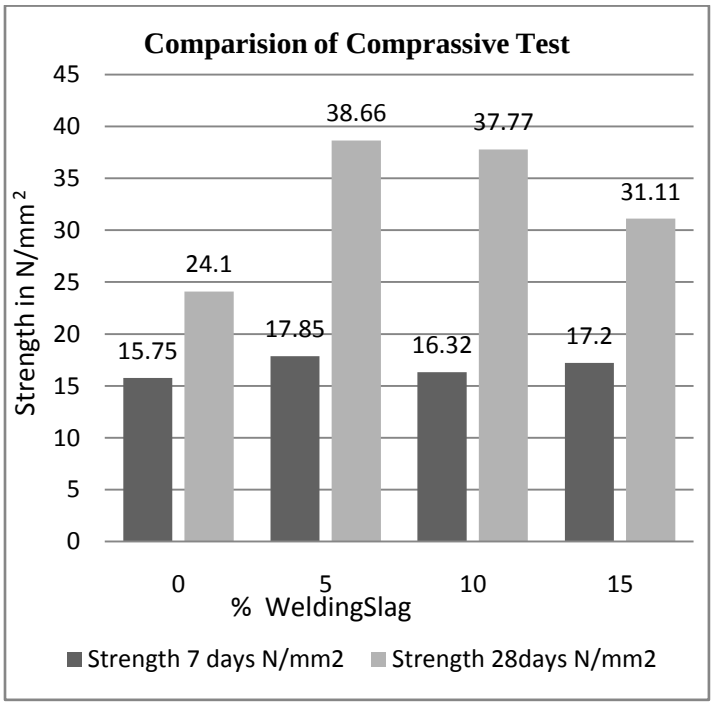


Fig1. Relation between compressive strength of M25 concrete at various percentage of steel slag.

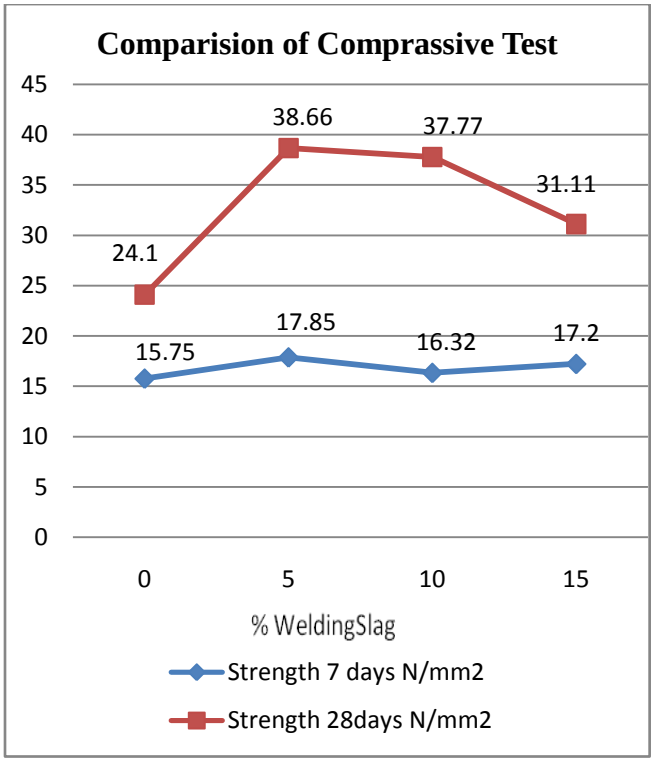


Fig2. Relation between compressive strength of M25 concrete at various percentage of Welding slag.

Paper ID: UGC 48846-931

Table 3
Test Results of Compressive Strength And Carbonation Depth Depending Upon Various Percentage Of Mixing Welding Slag.

S.no	%Welding slag	Carbonation depth Cm	Strength 7 days N/mm²
1	0	3.20	15.75
1	5	1.30	17.85
2	10	1.1	16.32
3	15	10.5	17.2

Table 4
Test Results of Compressive Strength and Carbonation Depth Depending Upon Various Percentage of Mixing Welding Slag

S.no	% Welding slag	Carbonation depth Cm	Strength 28days N/mm²
1	0	3.80	24.1
1	5	2.14	38.66
2	10	1.75	37.77
3	15	6.30	31.11

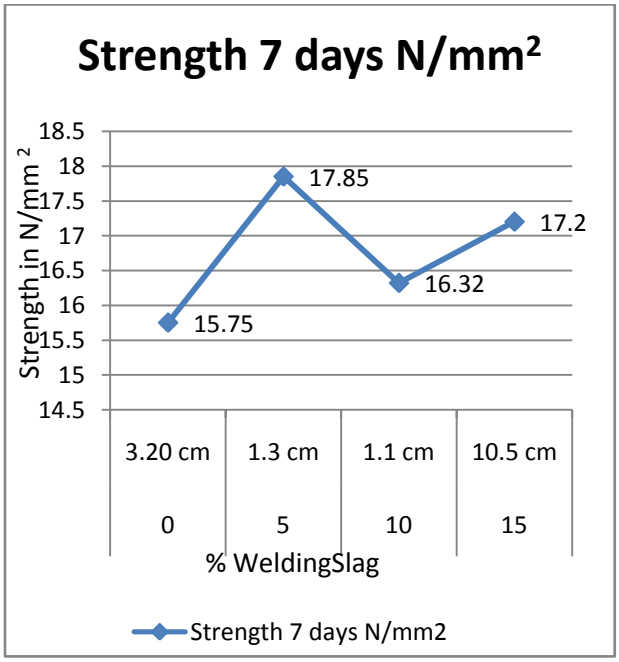


Fig 3. Relation between compressive strength and Carbonation depth of M 25 concrete at various percentage of Welding slag.

Paper ID: UGC 48846-931

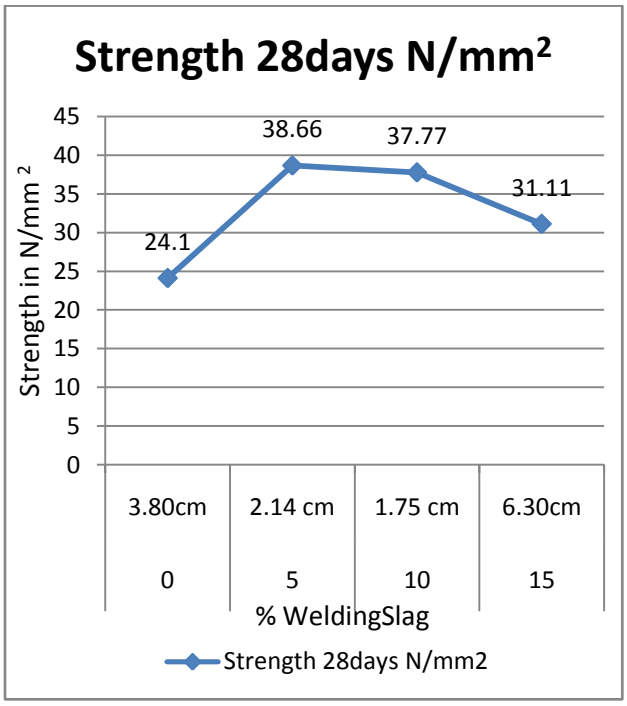


Fig 4. Relation between compressive strength and Carbonation depth of M 25 concrete at various percentage of Welding slag.

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