Experimental Study on Replacement of Coarse Aggregate by Weld Slag in Concrete

[1]Manoranjan. S A, [2]Rashika. R,
[1 & 2] UG Students
Department of Civil Engineering
M.A.M. College of Engineering and Technology,
Tiruchirappalli 621105

[3]Parthiban. S
[3]Assistant Professor
Department of Civil Engineering
M.A..M.. College of Engineering and
Technology, Tiruchirappalli 621105

Abstract*— An alternate effort has been planned to prepare a concrete mixture with the usage of industrial waste. Particularly, experimental usage of Weld Slag to some extent along with coarse aggregate has been investigated in this paper. Weld Slag is a waste material produced in the Fabrication Industries. So for, the weld slag is not reused in any of the industries. Since the weld slag property by appearance and the specific gravity is found to be similar to that of the coarse aggregate. The present paper is focused to investigate the mechanical property of concrete with weld slag as a replacement material for coarse aggregate. By utilizing the waste as a replacement material becomes a better contribution towards waste management, environmental safety and economically cost-less for making of coarse aggregate. The main objective of the paper includes utilization of weld slag as a partial replacement for coarse aggregate. The investigation comprises of various percentage of replacements such as 10%, 20% and 30% of weld slag and are denoted as WS1, WS2 and WS3 respectively. The IS method has been followed for arriving the mix design for M20 grade concrete and the *Determined for various percentage of slag replacement.

Keywords: Weld Slag, Mix design, Compressive Strength

1 INTRODUCTION

The waste management in India is one of the major challenges for clean environment and economy. Our construction industry is playing a major role in addressing this problem. Due to industrial development a numerous waste products are emerging out which are environmentally create many problems. Also the storage of waste products is an additional problem in the industries. In steel fabrication industry, a large volume of slags are generated while carrying out the welding process. The weld slag is a solid form of by product and final waste product after completion of welding process. Though the slag is a waste product primarily consists of silicates and carbonates. Since the weld slag is being a sizable solid waste it can be used in concrete making as a replacement to some extent. Conventionally small gravels have been using in coarse aggregate. The coarse aggregate is taking place 75% of concrete preparation. As an alternate effort the weld slag may be used in certain percentage along with coarse aggregate to explore the possibility of making concrete utilizing the waste product.

Reviews of literature survey are presented as below,
[1] studied to reduce a fine aggregate by the replacement of weld slag 5%, 10% and 15%. The optimum compressive strength of the concrete is 41 N/mm^2 for 5% WS and 39.7N/mm^2 for 10% replacement. [2] carried out the study to replace the aggregates (coarse and fine) with the industrial slag (Crystallized and granular).The compressive strength of concrete improved by 5 – 7%. [3] studied the effect of Chromite and red mud in concrete mix in the level of 5%, 10% and 15%.The experimental result indicated that the mixture of 5% chromite waste and 5% red mud substituted with Portland cement gave good compressive strength performance.[4] study of using blast furnace slag as replacement for Portland cement concrete. The replacement mixture at the percentage of 0, 15, 30 and 45% was studied in the duration of 7, 28 and 91 days. The study reveals that 0% use of slag is 60.8 N/mm^2 in 91 days and 45% use of slag is 61.9 N/mm^2. [5] investigated the waste steel scrap to increase the strength of concrete in their study for the partial replacement of 5% CNC waste with the natural aggregate. The result was found after 28 days for 3 different types of cases are 30.31 N/mm^2, 38.36 N/mm^2 and 28.0 N/mm^2 respectively. The compressive strength of concrete increased gradually due to the replacement of natural aggregate with the waste steel scrap.

3. METHODOLOGY

3.1 MATERIALS

Raw materials required for the concreting operation of present work are cement, fine aggregate, coarse aggregate, weld slag and water.

3.1.1. Cement (C)

The cement used in this project is Portland pozzolana cement. The grade of cement is 43 and the Specific gravity is 3.1.

3.1.2. Coarse Aggregate (CA):

The crushed granite coarse aggregate maximum of size 20 mm is used. Specific gravity of aggregate is found to be 2.71.

3.1.3. Fine Aggregate (FA):

Locally available river sand is used for concrete making. Specific gravity of fine aggregate is found to be 2.61.

3.1.4. Weld slag (WS):

The weld slag is obtained from the steel fabrication industries and they are used to replace coarse aggregate partially in the making of concrete. Specific gravity of the slag is determined to be 3.0. The sample of weld slag is as shown in Figure 1.

Figure 1 Weld Slag

The various material properties of the mix is presented in Table 1.

Table 1 Physical properties of materials

S. No	Materials	Specific Gravity
1	Cement	3.15
2	FA	2.65
3	CA	2.7
4	WS	3

The chemical composition of weld slag [1] is given in Table 2

Table 2 Chemical Composition of Weld Slag [1]

METALS	CONCENTRATION(mg)	
	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	50.82	22.28
Pb	0.12	0.04
Cr	0.28	0.04
K	2	0.68

4. MIX DESIGN

The mix design is made for a control mix for M_{20} grade of concrete for w/c ratio is 0.45 respectively.

4.1 Mix Ratio

Mix ratio for control concrete is obtained as 1: 1.28: 2.69. The mix proportion for various percentage of replacements such as 10, 20 and 30 % are presented in Table 3

Concrete Mix	Cement	FA	CA	WS
C.C	1	1.28	2.69	0
WS1	1	1.28	2.42	0.27
WS2	1	1.28	2.15	0.54
WS3	1	1.28	1.88	0.81

Table 3 Mix Proportion

5. EXPERIMENTAL INVESTIGATION

The 6 cubes (150mm x 150mm x 150mm cubes set of 3) each are casted for compressive strength (7 days of curing). After casting the specimens as per the mix proportion, all the test specimens are finished with a trowel and the mechanical compactor is used for compaction for removing the air voids. All the cubes are demoulded after 24 hours and put into the water tank for curing.

5.1 WATER ABSORPTION TEST

Water absorption test has been carried out for 7th day saturated cube specimen and oven dried specimen for specimens with and without weld slag.

5.2 COMPRESSIVE STRENGTH

This test is done to determine the cube strength of concrete mix prepared. The test is conducted on the 7th day and its observations are listed below in the form of graph. Compressive strength values with various replacements for coarse aggregates by weld slag such as WS1, WS2 and WS3 are presented. The typical testing of the specimens are as shown in Figure 2.

Figure 2 Compressive Strength Test for Concrete Cube in CTM

6. RESULT AND DISCUSSION

The compressive strength of the cubes for various percentage of replacement and the control concrete is given in Table 4 and the pictorial variation is as shown in Figure 3.

The compressive strength of concrete for 7 days of curing decreases gradually as the percentage of replacement increases. However, replacement by 10%, 20% and 30% is found to be more than the conventional concrete.

Table 4 Compressive Strength for 7th Day Curing

S.No	% Replacement Of Weld Slag	Compressive Strength (N/mm²)
1	C.C	18
2	WS1	23.98
3	WS2	23.27
4	WS3	23.45

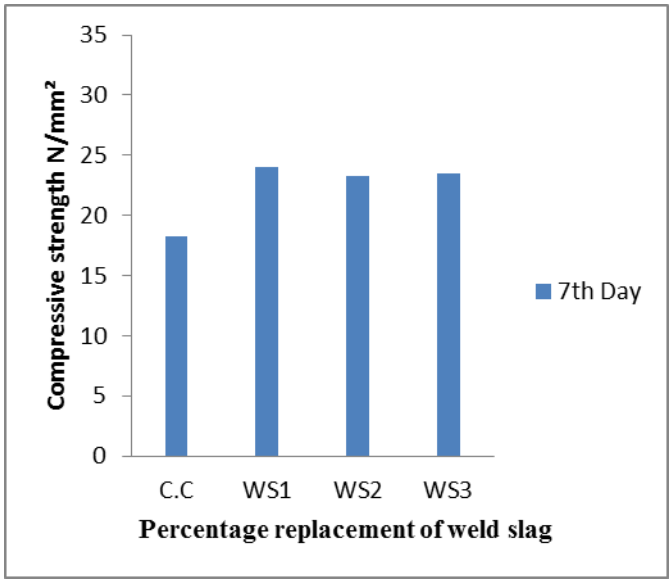

Figure 3 Variation of Compressive Strength with Percentage Replacement

7. CONCLUSION

This paper studied the replacement of the coarse aggregate partially by weld slag with WS1, WS2 and WS3 respectively to increase the strength of concrete. As expected the strength is more than the conventional concrete for WS1, WS2 and WS3 by replacement of weld slag. Though there is a meager variation in the increased strength of WS2 and WS3 as per the proportional mix of weld slag but the compressive strength is gradually increased. So it is observed that the replacement of coarse aggregate by industrial weld slag is very much suitable for construction purpose. Also it is an effective alternate for using the weld slag in construction industry.

REFERENCE

[1] Sreekrishnaperumal Thanga Ramesh (2013) "Use of furnace slag and weld slag as replacement for sand in concrete" ijeee vol 4:3
[2] Mohamed Nadim (2012) on "Utilization of Industrial waste slag as aggregate in concrete" open journal vol 2
[3] Basak Mesei (2011) "Use of selected industrial waste in concrete".
[4] Gulden Cagin (2011) "Sustainability for blast furnace slag by using construction waste".
[5] Abishek Manloy and Dr. K.K. Pathak (2010)"Utilization of waste steel scrap to increase the strength of concrete".
[6] IS 456-2000 Specifications for plain and reinforced concrete.
[7] IS 10262-2009 Recommended guidelines for concrete mix Design, BIS. New Delhi, India, 2009.
[8] IS 383-1970, Specification for Coarse and Fine Aggregates from natural sources for concrete (Second revision).
[9] IS 2386-1963, Methods of Test for Aggregates for Concrete Part I Particle Size and Shape.