ISSN: 2278-0181
CONFCALL - 2019 Conference Proceedings

Behaviour of Concrete by using Weldibg Slagas a Partial Replacement of Sand

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Abstract:- **In India, natural river sand (fine aggregate) is traditionally used in concrete. However, growing environmental restrictions to the exploitation of sand from riverbeds leads to the research for utilization of an alternative material (industrial waste) for fine aggregates in the construction industry. This project investigates about using welding slag as a fine aggregate replacement material, was tested as an alternative to traditional concrete. The fine aggregate has been replaced by welding slag consequently in the range of 10%, 20%, 30%, 40%, and 50% by weight for M30 grade concrete. In this project, materials were collected and tested for determination and comparison of material properties of fine aggregates and welding slag. Concrete mixtures were produced, tested and compared in terms of workability and strength with the conventional concrete. These tests were carried out to evaluate the mechanical properties for 7 and 28 days. As a result, the compressive strength increased up to 10% addition of used welding slag. Then from 20% to 50% addition of welding slag in concrete has reduced the compressive strength. This research work is concerned with experimental investigation on strength of concrete and optimum percentage of partial replacement by replacing fine aggregates from 10% to 50%. The present study investigated 10% replacement of welding slag provides better strength than the conventional concrete.**

Keywords—Fine aggregate, welding slag, compressive strength , workability.

INTRODUCTION

Construction aggregate or simply aggregate is a broad category of coarse particulate material used in construction, including sand, gravel, crushed stone, slag 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 sand, researchers have identified some alternatives for sand, namely scale and steel chips, waste iron, crushed granite fine, slag, etc. the welding slag were obtained from local arc welding industries. And this is used replace the fine aggregate partially in the production of concrete. The physical and chemical characteristics of welding slag were determined in the laboratory as per standard methods. The consumption of slag in concrete not only helps in reducing the green house gases. Welding slag is a by-product from submerged arc welding process. Submerged arc welding is a versatile welding process in which coalescence is produced by heating the Meta. The flux is converted into slag during welding which is treated as waste and discarded. with an arc maintained between a bare metal electrode and the Work piece the welding slag which is collected from the submerged arc welding was crushed using a crusher. Crushed m ass then sieved so that the grains of the slag should confirm to the practical size of the original flux. it has to be disposed-off. Land fill space is required to dump the slag waste. It is non bio-degradable and will not decay with time. So the industrial waste like welding slag can be reused in construction as a partial replacement of fine aggregates. The physical characteristics of Welding slag used in the present study is given in table. The specific gravity of welding slag is greater than that of coarse aggregate and fine aggregate. But the fineness modulus of welding slag is less compared to coarse aggregates and fine aggregates. the welding slag contains higher amount of Fe, Al, and Ca. these metals are hi present experimental work explores the possibility of using welding slag as a replacement of natural sand in concrete in this work fine aggregate replaced by welding slag in various percentages 10, 20, 30, 40, 50 with constant W/C ratio of 0.4. And the compressive strength for 7 and 28 days has been investigated

TABLE 1: PHYSICAL CHARACTERISTICS OF WELDING SLAG MATERIALS

Sample number	Properties	Welding slag
1	Specific gravity	2.95
2.	Fineness modulus	2.12

A.CEMENT

Portland cement (often referred to as Ordinary Portland Cement or OPC) is the most common type of cement in general use around the world. According to The Bureau of Indian Standards (BIS) OPC has been classified as follows:

1. 33 grade OPC, IS 269:1989
2. 43 grade OPC, IS 8112:1989
3. 53 grade OPC, IS 12269:1987

In the present investigation, we have adopted 43 grade OPC, IS 8112:1989. The following tables will explain about the physical and chemical properties of Ordinary Portland Cement (43 grade).

A.FINE AGGREGATE

- Fine aggregates generally consist of natural sand or crushed stone with particle size smaller than about 5mm (materials passing through 4.75mm IS sieve).aggregates must be clean, hard, strong and durable. Grading or particle size distribution of aggregate is a major factor determining the workability ,segregation, bleeding, placing, and finishing characteristics of concrete.

B.COARSE AGGREGATE

The coarse aggregate is the strongest and least porous component of concrete .it consists of one or a combination of gravels or crushed stone with particle size larger than5mm (usually between 10mm and 40mm).To get water tight concrete the aggregate must contain a large proportion of very fine particles.

A.WATER

Water plays an important role in workability, strength, and durability of concrete. Too much water reduces the concrete strength, whereas too little will make the concrete unworkable. The water used for mixing and curing should be clean and free from injurious amount of oils, acids, alkalis, salts, sugars, or organic materials, which may affect the concrete or steel. The pH value of water used for mixing should be greater than six. In the present investigation drinking water was used both mixing and curing of concrete specimens

METHODOLOGY

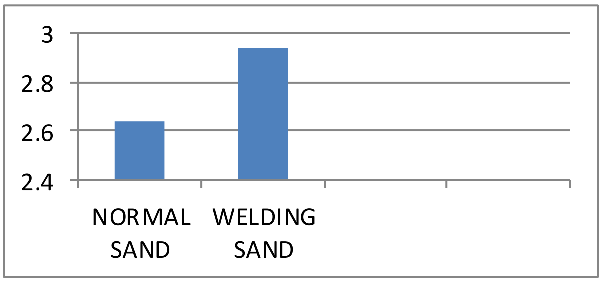
SPECIFIC GRAVITY OF WELDING SLAG

Determine and record the weight of the empty clean and dry pycnometer, WP.Place 10g of a dry soil sample (passed through the sieve No.10) in the pycnometer. Determine and record the weight of the pycnometer containing the dry soil, WPS.Add distilled water to fill about half to three-fourth of the pycnometer. Soak the sample for 10 minutes.Apply a partial vacuum to the contents for 10 minutes, to remove the entrapped air.stop the vaccum and carefully remove the vacuum linr from pycnometer.fill the pycnometer with distilled (water to the mark),clean the exterior surface of the pycnometer with a clean, dry cloth. Determine the weight of the pycnometer and contents, WB. Empty the pycnometer and clean it. Then fill it with distilled water only (to mark). Clean the exterior surface of the pycnometer with a clean, dry cloth. Determine the weight of the pycnometer and distilled water, WA`. Empty the pycnometer and clean it.

Formula:

$$\text{Specific gravity} = \frac{\text{Weight of dry sample}}{\text{Weight of equal volume of water}}$$

$$\text{Specific gravity} = \frac{W_2 - W_1}{(W_4 - W_1) - (W_3 - W_2)}$$



PARTICLE SIZE DISTRIBUTION

Take a suitable quantity of oven-dried aggregate. The mass of aggregate sample required or each test depends on the maximum size of material. Clean the sieves to be used, and record the weight of each sieve and the bottom pan. Arrange the sieves to have the largest mesh size at the top of the stack. Pour carefully the aggregate sample into the top sieve and place lid over it. Place the sieve stack on the mechanical shaker, screw down the lid, and vibrate the aggregate sample for 10 minutes. Remove the stack and re-weigh each sieve and the bottom pan with the aggregate sample fraction retained on it. Obtain the mass of aggregate retained on each sieve. The sum of the retained masses should be approximately equal to the initial mass of the aggregates sample. Calculate the percent retained on each sieve by dividing the mass retained on the sieve with the total initial mass of the aggregate. Calculate the cumulative percent retained by adding percent retained on each sieve as a cumulative procedure. Calculate the percent finer by subtracting the cumulative percent retained from 100 percent. Mark a grain size distribution curve by plotting sieve size a log scale and percent finer on ordinary scale.

FINENESS MODULUS

Take a suitable quantity of oven-dried aggregate. The mass of aggregate sample required or each test depends on the maximum size of material. Clean the sieves to be used, and record the weight of each sieve and the bottom pan. Arrange the sieves to have the largest mesh size at the top of the stack. Pour carefully the aggregate sample into the top sieve and place lid over it. Place the sieve stack on the mechanical shaker, screw down the lid, and vibrate the aggregate sample for 10 minutes. Remove the stack and re-weigh each sieve and the bottom pan with the aggregate sample fraction retained on it. Obtain the mass of aggregate retained on each sieve. The sum of the retained masses should be approximately equal to the initial mass of the aggregates sample. Calculate the percent retained on each sieve by dividing the mass retained on the sieve with the total initial mass of the aggregates. Calculate the cumulative percent retained by adding percent retained on each sieve as a cumulative procedure. Calculate the percent finer by subtracting the cumulative percent retained from 100 percent. Mark a grain size distribution curve by plotting sieve size a log scale and percent finer on ordinary scale.

COMPACTION FACTOR

Pour concrete in moulds oiled with medium viscosity oil. Fill the cylinder mould in four layers each of approximately 75mm and ram each layer more than 35 times with evenly distributed strokes. Remove the surplus concrete from the top of the moulds with the help of the trowel. Cover the moulds with wet mats and put the identification mark after about 3 to 4 hours. Remove the specimens from the mould after 24 hours and immerse them in water for the final curing. The test are usually conducted at the age of 7 -28 days. The time age shall be calculated from the time of addition of water to the dry ingredients. Test at least three specimen for each age of test as follows: Draw diameter lines on two ends of the specimen so that they are in the same axial plane. Determine the diameter of specimen to the nearest 0.2mm by averaging the diameters of the specimen lying in the plane of remarked line measured near the ends and the middle of the specimen. The length of specimen also shall be taken be nearest 0.2 mm by averaging the two lengths measured in the plane containing pre marked lines. Centre one of the plywood strips along the centre of the lower platen. Place the specimen on the plywood strip and align it so that the lines marked on the end of the specimen are vertical and centered over the plywood strip. The second plywood strip is placed length wise on the cylinder centre on the lines marked on the lines marked on the ends of the cylinder. The assembly is positioned to ensure that lines marked on the end of specimen are vertical and the projection of the plane passing through these two lines interest the center of the platen. Apply the load without shock and increase it continuously at the rate to produce a split tensile stress of approximately 1.4 to 2.1 N/mm2/min, unit no greater load can be sustained. Record the maximum load applied to specimen. Note the appearance of
concrete and any unusual feature in the type of failure. Compute the split tensile strength of the specimen to the nearest 0.25N/mm2

OBSERVATIONS:

Area of cylinder = 1776mm^2
Diameter of the mould = 150 mm
Length of the mould = 300 mm

BATCHING, MIXING AND CASTING OF SPECIMEN

The procedure which was adopted in the batching, mixing and casting operation is under standards and specifications. The fine aggregates were weighed first with an accuracy of 0.5 grams. The mixture was prepared by hand mixing on a water tight platform.OPC having 43 grades was used in casting. Various proportions of fine aggregates are replaced with welding slag and thoroughly mixed. Then water was added carefully so that no water was lost during mixing. Sixteen clean and oiled moulds for each category were then placed on the vibrating table respectively for the cubical samples for compression strength testing. Vibrations were stopped as soon as cement slurry appeared on the top surface of the mould.

SLUMP CONE

The internal surface of the mould is thoroughly cleaned and freed from superfluous moisture and adherence of any old set concrete before commencing the test. The mould is placed on a smooth, horizontal rigid and non−absorbent surface. The mould is then filled in four layers each approximately ¼ of the height of the mould. The mould is removed from the concrete immediately by raising it slowly and carefully in vertical direction. This allows the concrete to subside. This subside is referred as slump of concrete. The difference in level between the height of the mould and that of the highest point of the subsided concrete is measured. This difference in height in mm is taken as slump of concrete. The pattern of slump indicates the characteristics of concrete in addition to the slump value. If the concrete slumps evenly it is called true slump. If one half of the cone slides down, it is called shear slump. In case of shear slump, the slump value is measured as the difference in height between the height of the mould and average value of subsidence.

RESULT AND DISCUSSION

Compressive strength and split tensile strength of Ordinary Portland Cement Concrete for 7days and 28 days curing. The present investigation is based on the IS method of conventional concrete. Trial mix proportions have been obtained for M30 grade conventional concrete from the mix design investigation compression test, split tensile strength test are carried out on the concrete cubes and cylinders.

TABLE 2- 7 days Result – Compressive Strength of 10%

SI.No	Size of Specimen (mm^3)	Ultimate load (kN)	Cross-sectional Area (mm^2)	Ultimate compressive strength (N/mm^2)
1	150X150X150	480	22500	21.33
Average Compressive Strength				21.77

WELDING SLAG IN CONCRETE SPECIMENS

1	150X150X150	305	22500	13.55
2	150X150X150	315	22500	14
Average Compressive Strength				13.77

TABLE 3 - 7 DAYS RESULT – COMPRESSIVE STRENGTH OF 20% WELDING SLAG IN CONCRETE SPECIMEN

SI.No	Size of Specimen (mm^3)	Ultimate load (kN)	Cross-sectional Area (mm^2)	Ultimate compressive strength (N/mm^2)
1	150X150X150	345	22500	15.33

ISSN: 2278-0181
CONFCALL - 2019 Conference Proceedings

TABLE 4.5 - 7 DAYS RESULT – COMPRESSIVE STRENGTH OF 50% WELDING SLAG IN CONCRETE SPECIMEN

SI.No	Size of Specimen (mm^3)	Ultimate load (kN)	Cross-sectional Area (mm^2)	Ultimate compressive strength (N/mm^2)
1	150X150X150	210	22500	9.33
2	150X150X150	240	22500	10.66
Average Compressive Strength				10

TABLE 4.6 - 28 DAYS RESULT – COMPRESSIVE STRENGTH OF 10% WELDING SLAG IN CONCRETE SPECIMEN

SI.No	Size of Specimen (mm^3)	Ultimate load (kN)	Cross-sectional Area (mm^2)	Ultimate compressive strength (N/mm^2)
1	150X150X150	727	22500	32.3
2	150X150X150	747	22500	33.2
Average Compressive Strength				32.78

SI.No	Size of Specimen (mm^3)	Ultimate load (kN)	Cross-sectional Area (mm^2)	Ultimate compressive strength (N/mm^2)
1	150X150X150	320	22500	14.22
2	150X150X150	500	22500	22.22
Average Compressive Strength				18.22

CONCLUSION

FROM THIS TEST, REPLACEMENT OF FINE AGGREGATE WITH THIS WELDING SLAG MATERIAL PROVIDES MAXIMUM COMPRESSIVE STRENGTH AT 10% REPLACEMENT. SPLIT TENSILE STRENGTH IS ALSO DECREASE ON INCREASE IN PERCENTAGE OF WELDING SLAG. USE OF WELDING SLAG AS A REPLACEMENT MATERIAL FOR FINE AGGREGATE WILL PRODUCE LOW COST CONCRETE AND ALSO HELPFUL IN INDUSTRIAL WASTE MANAGEMENT. APPLICATION OF THIS STUDY LEADS TO DEVELOP IN CONSTRUCTION SECTOR AND INNOVATIVE BUILDING MATERIAL.