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Performance of Stainless Steel Slag in Concrete Structures

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ABSTRACT

This work present the results of experimental investigations carried out to evaluate effects of replacing aggregate (coarse and Fine) and Cement with that of Stainless Steel Slag on various proportions in Concrete (25% 50% 75% 100%). The basic objective of this study was to identify alternative source of aggregates and cement and to produce new type of concrete made of stainless steel slag as a green concrete. And to control the manufacturing and usage of conventional building materials these creates pollution to the environment. Alternate source of material is necessary because of very fast pace of construction activities and because of that increase of demand and cost of conventional building materials in India and all over the world and to solve the disposal problem of waste by products in effective manner. By using these waste materials in concrete we can control cost of materials used in construction. Stainless steel slag is the waste industrial by product from stainless steel production. It provides great opportunity to utilize it as an alternative to normally available aggregates (coarse and Fine) and cement. In this study, concrete of M30 grade were considered for a W/C ratio of 0.45 for the replacements of various percentage of coarse aggregate fine aggregate and cement by stainless steel slag. The investigation revealed improvement in compressive strength. Based on the overall observations, it could be recommended that stainless steel slag could be utilized as coarse aggregate fine aggregate cement in the following ratios respectively 100%, and 25% for all the concrete applications. This study investigates the performance of concrete mixtures containing stainless steel slag in terms of Compressive strength, at 7, 14 and 28 days. Results show that concrete incorporating stainless steel slag had higher compressive strength of concretes.

Keywords-- Stainless steel slag

I. INTRODUCTION

Concrete is the most widely used building material in construction industry. Concrete is usually made from a mixture of broken stone or gravel, sand, cement, and water, which can be spread or poured into moulds and forms a stone-like mass on hardening. And the construction activities are increased more worldwide, due to that increase of demand of materials used in concrete. Due to increase in demand the cost of building materials are now a day's increasing more and more. For producing a concrete with good quality and strength with less cost more research have been done by scientist as well as by the civil engineers and is still ongoing. Now a days we are preferring a blended materials such as fly ash, silica fume, GGBS, rice husk ash, and other materials which possessing a good cementicious properties for replacing cement, and other waste by products and materials in fine and coarse aggregate replacement to produce a good quality concrete with less cost. These can also be used to produce a high performance concrete. However the material selection should be proper and the physical and chemical properties need to be satisfied for material replacements. The main objective of this work is to find compressive and split tensile strength for replacement of cement with stain less steel and lime respectively and in combined form, replacement of aggregate for steel slag for 25, 50, 75 and 100% respectively

II. LITERATURE REVIEW

Thangaselvi et al (2015) Researched on Strength and Durability of Concrete Using Steel Slag as a Partial Replacement of Coarse Aggregate in Concrete Global warming and environment destruction have become the major issue in recent years. Emission of green house gases from industries has impact on climate change. In this study, the replacement was done with coarse aggregate by steel slag for different proportions of 0%, 20%, 40%, 60%, and 80% and M40 grade of concrete is used for water cement ratio of 0.40. Experiment on compressive strength, split tensile strength, flexural strength at 7 days and 28 days are conducted on specimens. The optimum strength is obtained on 60% replacement of coarse aggregate by steel slag.

N. Manoj et al (2014) Researched on Experimental Investigation of Fiber Reinforced Concrete with Partial Replacement of Coarse Aggregate by Steel

Slag. Fiber-reinforced concrete (FRC) is concrete containing fibrous material which increases its structural integrity. It contains short discrete fibers. They are evenly distributed and randomly oriented. In addition, the character of fiber-reinforced concrete changes with varying concretes, fiber materials, geometries, distribution, orientation, and densities.

M. Soundar rajan et al (2014) Researched on Study on strength properties of concrete by partially replacement of sand by steel slag**.** Natural aggregates are becoming scarce widely along with their production and shipment becoming more difficult. The primary aim of this research was to evaluate the strength of concrete made with steel slag as replacement for fine aggregates. In this work steel slag will be made for varying percentages such as 10%, 20%, 30%, 40%, and 50% by weight of sand. Studies on compressive strength, tensile strength, flexural strength was studied optimum percentage were 30% of steel slag replacement.

A.I. Tamboli et al (2015) Researched on compressive strength of steel slag aggregate and artificial sand in concrete. Steel slag is a by product of steel making processes of steel industry. It's also one of the biggest industrial wastes which are being produced worldwide in a huge quantity. This research deals with substantial replacement of natural aggregates and natural sand used in concrete. In this study coarse aggregate were partially replaced with steel slag aggregate with different replacement percentage in concrete i.e. 0%, 10%, 20%, and 30%. Compressive strength of concrete with various percentage of steel slag aggregate was found. Significant increase in compressive strength was found at 20% aggregate replacement.

III. EXPERIMENTAL INVESTIGATION

MATERIAL USED AND PROPERTIES

CEMENT

In this work Portland Pozzolana Cement conforming to IS 1489 (PART 1) -1991 was used. Specific gravity was found to be 3.15

FINE AGGREGATE

The fine aggregate used for all the specimens were Natural River sand complying the requirements of IS383:1970. The specific gravity of the fine aggregate was found to be 2.65

COARSE AGGREGATE

Crushed granite or crushed slate as coarse aggregates of nominal size 20mm were used. The specific gravity was 2.7

WATER

Portable tap water available in the laboratory with pH value of 7.0±1 and confirming to the requirements of IS: 456- 2000 was used for mixing concrete and also for curing the specimens.

STAINLESS STEEL SLAG

The stainless steel slag which is obtained from steel plant, Salem, Tamilnadu, India. Specific gravity of stainless steel slag was found to be 3.2

IV. RESULTS AND DISCUSSION

In this work stainless steel slag is used as replacement of conventional building materials such as cement fine aggregate and coarse aggregate in partial in various proportions and also in fully to its quantity. The Replacements are done for a ratio of 25% 50% 75% and 100%. The concrete tested for compressive strength. The grade of concrete mixed is M30 grade with a water cement ratio of 0.45 the grade chosen as per IS 456-2000 for an exposure condition of severe for reinforced concrete. The mix was prepared is Non pumping mix with ratio of 1: 1.814: 2.84. The optimum strength obtained at a replacement of 25% of stainless steel slag by cement and 25% of stainless steel slag by fine aggregate and 100% of coarse aggregate. The stainless steel slag concrete made with the optimum strength gained replacements. The strength of the stainless steel slag concrete at an age of 7 days 14 days and 28 days are more than the conventional concrete.

COMPRESSIVE STRENGTH OF CONCRETE in N/mm^2

Cube specimen of size 15cm X 15cm X 15 cm were made with M30 grade of concrete, concrete mixed and cured and tested with reference to Indian standard code specification IS 516 – 1959.Results are tabulated in table 1 to 6

Table 1 Compressive strength of Conventional concrete (N/mm^2)

DAYS	**7 days**	**14 days**	**28 days**
Characteristic compressive strength of concrete (f**ck)**	19	30.8	37.54

Table 2 Compressive strength of concrete for Replacement of coarse aggregate (N/mm^2)

% of replacement	**7 days**	**14 days**	**28 days**
25%	21.4	31.67	37.41

50%	22.9	32.43	38.69
75%	25.80	35.23	39.00
100%	26.76	36.88	40.14

Table 3 Compressive strength of concrete for Replacement of fine aggregate (N/mm^2)

% of replacement	**7 days**	**14 days**	**28 days**
25%	12.82	22.09	38.96
50%	13.74	23.17	38.56
75%	14.24	24.76	35.47
100%	15.67	25.98	32.70

Table 4 Compressive strength of concrete for Replacement of cement by stainless steel slag (N/mm^2)

% of replacement	**7 days**	**14 days**	**28 days**
25%	18.47	25.66	36.35
50%	17.28	22.18	33.29
75%	14.55	17.60	26.42
100%	9.82	12.24	18.92

Table 5 Compressive strength of concrete for Replacement of cement by lime and stainless steel slag (N/mm^2)

% of replacement	**7 days**	**14 days**	**28 days**
25% L + S	3.15	9.12	13.29
50% L + S	3.67	14.69	14.55
75% L + S	2.92	14.23	21.16
100% L + S	1.79	9.23	22.87
100% OF S (SSS)	2.21	9.11	20.71

Table 6 COMPRESSIVE STRENGTH OF STAINLESS STEEL SLAG CONCRETE (N/mm^2)

DAYS	**7 days**	**14 days**	**28 days**
Characteristic compressive strength of concrete (f**ck)**	22.12	32.88	39.19

V. CONCLUSION

From the above experiments use of stainless steel slag as part of conventional building materials can help in reduction in disposal problem, we can produce a cost effective concrete, and by controlling usage of conventional building materials, the increase in cost can be controlled , Environmental pollution caused by manufacturing of building materials can be controlled. By the test results of replacement in cement, fine

aggregate & coarse aggregate, we have analyzed that the stainless steel slag can be effectively replaced for 25% of cement and 25% of fine aggregate and 100% of coarse aggregate, hence the optimum percentage of strength achieved for these percentages. All the percentage of replacement from 25 to 100% were found to be good in case of compressive strength

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