NOVATEUR PUBLICATIONS
International Journal of Research Publications in Engineering and Technology [IJRPET]
ISSN: 2454-7875
VOLUME 3, ISSUE 10, Oct. -2017

THE EFFECT OF FERROCHROME SLAG AS PARTIAL REPLACEMENT OF CEMENT IN CONCRETE

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ABSTRACT:

Concrete is the second mostused material in the world after water. In 21st century, world is progressing at a breath-taking pace and rapid construction helps us to cope up with the pace. Cost of concrete and its environmental impact both depends on the constituent materials. It has become a key concern to make concrete more and more environment friendly by replacing conventional materials. Ferrochrome slag is a waste material obtained from the manufacturing of high carbon ferrochromium alloy. This slag is formed as a liquid at 1700 °C and its main components are SiO_2, Al_2O_3 and MgO. Additionally, it consists of chrome, ferrous/ferric oxides and CaO. Ferrochrome slag has many ill effects on environments such as reduced growth of trees and animals, less reproductive capacity in mammals and also some carcinogenic diseases like Cancer. The ill effects of Ferrochrome slag can be controlled by using it in construction industry. There have been many theories proving the benefits of ferrochrome used as partial or complete replacement of Aggregates. This project aims towards the use of Ferrochrome slag (powder form) as partial cement replacement in concrete to study its effect on Compression, Tensile and Flexural Strength of Concrete.

KEY WORDS: Concrete. Ferrochrome slag.

I. INTRODUCTION:

Slags are the unit vital wastes and by-products of metallurgic trade that are treated, recycled and utilization of the varied slags from metallic element and non-ferrous metal production, in addition as waste combustion, and use of salt fluxes in secondary metal production. The metallurgic compound slags have stone-like properties and, thus their major applications area unit in applied science field worldwide. The slags ought to be recycled, changed and processed in an exceedingly correct means, by taking the environmental impact into thought.

Ferrochrome slag is the by-product of waste generated from the ferrochrome steel plant. Globally, generation of Ferrochrome slag is 6.5 to 9.5 million tons and increased by 2.8 to 3 % per annum. It contains 13-39% of SiO_2, 10-29% of MgO, 16-43% of Al_2O_3, 1-6% of CaO, 6-18% of Chromium, 3-11% of Iron and other minerals. The raw materials used in the ferrochrome production are upgraded lumpy ore and fine concentrate from the Kemi mine. Fine concentrate is first ground and made into pellets in the sintering plant. The pellets are then sintered in the sintering furnace at a temperature of 1400°C. The charge of the smelting furnaces consists of pellets, upgraded lumpy ore, reducing metallurgical coke and fluxing quartzite. Before smelting the material is preheated up to 500–800°C by burning carbon monoxide gas in a shaft preheater

II METHODOLOGY:

Test specimens are prepared by doing tests on cement and aggregate according to IS specification

Sr. No.	Compound	Percentage
01	Chromium Oxide (Cr_2O_3)	7.98 %
02	Silicon Di-oxide (SiO_2)	1.68 %
03	Aluminium Oxide (Al_2O_3)	66.87%
04	Carbon (C)	0.0006%
05	Phosphorous (P)	0.011%
06	Sulphur (S)	0.005%

CASTING OF TEST SPECIMEN:

The project consists of Compression test on Cubes, Split Cylinder test on Cylinders and Flexural Strength on Beams Standard specimens are selected as per IS: 516-1959 as follows.

Sr. No.	Test of concrete	Test specimen
01	Compression Test on cube	Length = 150 mm
		Width = 150 mm
		Height = 150 mm
02	Tensile Test on cylinder	Diameter = 150 mm
		Height = 300 mm
03	Flexural Strength on beams	Length = 500 mm
		Width = 100 mm
		Height = 100 mm

III COST CALCULATION

Description	Quantity	Unit	Rate	Per Unit	Cost
0 % Ferrochrome					
Ferrochrome	0	m^3	0	m^3	0
Cement	8	Bags	300	Bags	2400
Sand	0.42	m^3	700	m^3	294
Aggregate	0.84	m3	500	m3	420
			Total cost		3114 Rs
			% Savings in cost		0 %
5 % Ferrochrome					
Ferrochrome	0.014	m^3	0	m^3	0
Cement	7.6	Bags	300	Bags	2280
Sand	0.42	m3	700	m3	294
Aggregate	0.84	m^3	500	m^3	420
			Total cost		2994 Rs
			% Savings in cost		3.85 %
10 % Ferrochrome					
Ferrochrome	0.028	m3	0	m3	0
Cement	7.2	Bags	300	Bags	2160
Sand	0.42	m^3	700	m^3	294
Aggregate	0.84	m^3	500	m^3	420
			Total cost		2874 Rs
			% Savings in cost		7.71 %
15 % Ferrochrome					
Ferrochrome	0.042	m3	0	m3	0
Cement	6.8	Bags	300	Bags	2040
Sand	0.42	m^3	700	m^3	294
Aggregate	0.84	m^3	500	m^3	420
			Total cost		2754 Rs
			% Savings in cost		11.56 %

IV RESULTS:

While conducting the experiments, precautions were taken to take the readings of dial gauges at particular load intervals. During load application attention was paid to crack formation in specimens. The results of the tests on various Specimens are explained below:

The average compressive strength of control sample (0% Ferrochrome) is 22.963 N/mm² while with the ferrochrome replacement CB10 has yielded a highest average compressive strength as 21.219 N/mm². The average tensile strength of control sample (0% Ferrochrome) is 3.655 N/mm² while with the ferrochrome replacement CL10 has yielded a highest average tensile strength as 3.285 N/mm². The average rupture strength of control sample (0% Ferrochrome) is 3.678N/mm² while with the ferrochrome replacement BM10 has yielded highest average rupture strength as 3.649N/mm².

CONCLUSION:

Partial cement replacement has been studied. The experimental studies have resulted in following conclusion:

The results from Compressive test shows that the 28-day compressive strength of concrete is maximum at 10% ferrochrome slag, whereas the percentage replacement of 5% and 15% ferrochrome slag leads to decrease in compressive strength. The results from Split Cylinder test is also optimum with 10% ferrochrome slag as compared to 5% and 15% ferrochrome slag. Flexural Strength of the sample with 10% ferrochrome slag specimen is more than control sample (0% Ferrochrome slag). The replacement of ferrochrome slag partially to the cement in concrete will not only conserve the cement but also reduces the environmental impacts of it. The replacement of ferrochrome slag partially to the cement in concrete minimizes total cost of concrete

FUTURE SCOPE:

The project was carried out with partial replacement of cement using Ferrochrome Slag. However, the study can be further continued with addition of fly ash with ferrochrome slag. And also, instead of cement replacement, ferrochrome slag can be used to replace fine aggregate in varying percentages.

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