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EXPERIMENTAL STUDY ON THE USE OF LOW CARBON SILICO MANGANESE INDUSTRY WASTE AS COARSE AGGREGATE IN CONCRETE

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Abstract—Concrete is one of the prime materials for construction and it is the most broadly utilized for different applications everywhere throughout the world. Aggregate makes 70% of its volume is the principal component material in concrete production and consumes globally 8– 12million tonne of natural aggregate annually. The accumulated waste generated from industries severely affects environmental conditions. The reuse of industrial waste materials and by – products also decreases the need to produce new raw materials. The scarcity of raw materials required for construction is increasing day by day due to globalization. The main challenge for researchers and engineers is preventing the exhaustion of natural resources and increasing the usage of waste materials. The fact that materials that consider as waste from different industries are expanding and Increasing to cover the huge demand of construction materials and existing structure restoration, as the Engineers especially civil engineers has left a big impression throughout the history that consider an Ecological move via using new waste materials in the construction and development. Due to its mechanical strength, porosity, wear resistance and water absorption, steel slag is already being used as a fine and coarse aggregate for asphalt road mixes, as well as a raw material for clinker, as ballast for railways, and as a filling material in various excavations. successful incorporation of steel slag as aggregates in construction products requires the consideration of certain issues. Firstly, as steel slag is an industrial by product until recently disposed in landfills, the question is whether it is suitable for use in construction. Then the technical characteristics of the material are examined because due to its physicochemical properties steel slag requires special care, but can also provide maximum value if used for specific applications. The utilization of a by-product in suitable applications mainly where it is advantageous compared to traditional materials, but also where it is most economical can give a higher added value to the product. Finally, there are a number of economy-related parameters that allow for a new product to enter the construction market like the situation of the local aggregate market or the need to communicate the efficiency of a new product through demonstration projects. This study aims to analyze the viability of the use of waste products (silico manganese slag) from low carbon silico manganese industry as coarse aggregate in concrete.

I. INTRODUCTION

Global warming and environmental degradation have become the one of the major issues in recent years. The scarcity of raw materials required for construction is increasing day by day due to globalization. The main challenge for the researchers and engineers is preventing the exhaustion of natural resources and increasing the usage of waste materials. The major by product from industry is slag. The metallurgical steel slag from industries creates great concern to the environment. These steel slags may be used as substitution of natural aggregate in the field of construction. The paper aims to study experimentally, the effect of replacement of coarse aggregate by silico manganese slag on mechanical properties and durability properties of concrete.

A. INTRODUCTION TO SILICO MANGANESE SLAG

Steel making slag may be a product resulting from the economic process distributed to supply first Fe and second steel silicomanganese slag is generated in the steel making processes resulting from the transformation of Fe to liquid steel.

1) Advantages Of Silico Manganese Slag

- Greater hardness: Slag incorporates a greater resistance to wear. This can be a result of its mineral composition. The results are less wear, longer road lifetimes. Roads constructed using silico manganese slag demonstrates reduced rutting(potholes).

- Better adhesion: Silico manganese slag has micro pores and thus, it retains its own adhesiveness wear. In contrast, natural rock becomes smooth with wear its surface becomes polished and slippery. As a result, tires can grip better on surfaces constructed using silico manganese slag and this is often particularly important highways and in curves.

- Wear resistance: Silico manganese slag is hard and internally bound. Natural gravel doesn't have some stability and load bearing capacity. As slag is difficult and more compact than natural rock. Roads lasts longer. As there's less wear,

particulate pollution is reduced. but this, slag is effectively employed in preparation of Asphalt

B. OBJECTIVES OF THE STUDY

• To check the workability of concrete with the use of manganese slag as coarse aggregate.

• To review the compressive strength of concrete with the use of manganese slag as coarse aggregate.

• To review the flexural strength of concrete with the use of manganese slag as coarse aggregate.

• To review the durability of concrete with the use of manganese slag as coarse aggregate

II. MATERIAL PROPERTIES

The samples for the experiments are collected from INDSIL Hydro Power and Manganese Ltd (Palakkad, Kerala, India). The waste deposition at industry is as shown below.

FIG 1. WASTE DEPOSITION AT INDUSTRY

TABLE.1 PHYSICAL PROPERTIES OF LOW CARBON SILICO MANGANESE SLAG

PROPERTY	VALUE
Specific gravity	3.4
Water absorption	0.65%
Crushing value	29%
Impact value	17.3%
Bulk density	1999 Kg / cum
Abrasion value	28%
Volume of voids	0.245 %

TABLE.2 CHEMICAL COMPOSITION OF LOW CARBON SILICO MANGANESE SLAG

CONSTITUENTS	COMPOSITION
Aluminium oxide	1-4 %
Calcium oxide	40-57%
Magnesium oxide	10-14%
Manganese oxide	5-10%
Silica	20-35%

TABLE.3 PROPERTIES OF CEMENT

PROPERTIES	TEST RESULTS
Normal consistency	30%
Specific gravity	3.08
Initial setting time	30
Final setting time	240
Fineness of cement	4.44%

TABLE.4 PROPERTIES OF FINE AGGREGATE

PROPERTIES	TEST
Fineness modulus	2.89
Specific gravity	2.6
Bulk density	1.7

III. CONCRETE MIX DESIGN

Concrete mix design is done as per IS 10262:2009. Chosen M30 grade concrete.

w/c ratio	Cement	FA	CA	Water
0.4	350 kg/cu	850kg/cum	1415 kg/cum	140kg/ cum

TABLE. PROPORTIONS OF VARIOUS MATERIALS

IV. CONCRETE LABORATORY TESTS AND RESULTS

A. WORKABILITY TEST

Generally, Slump values for M20 to M30 can be as low as 25 and as high as 75. Slump values for M30 to M40 can be as low as 50 and as high as 100.The slump value obtained is 5 cm. The slump is true slump.

B. COMPRESSIVE STRENGTH OF CONCRETE

The M30 grade of concrete means the concrete mix which attains 28-day strength (characteristics) minimum as 30 MPa or 30 N/mm2.The compressive strength test on the specimens shows good results. An average compressive strength value on 7th day, 14th day and 28th day are 28.18 N/mm,33.80 N/mm² and 35.02 N/mm² respectively.

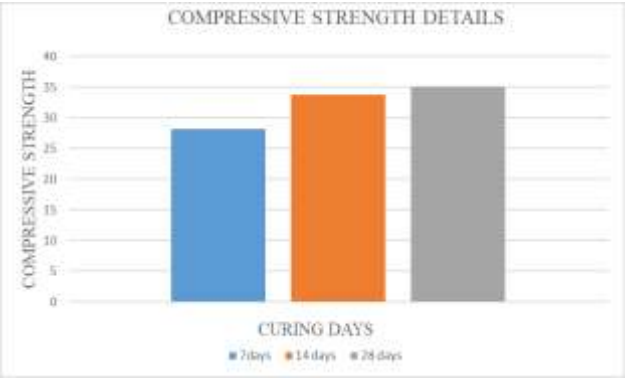

FIG 2. COMPRESSIVE STRENGTH RESULTS

C. SPLITTING TENSILE STRENGTH OF CONCRETE CYLINDER

The split tensile strength test on the specimens shows good results. An average split tensile strength value on 7th day, 14th day and 28th day are 3.79 N/mm²,3.81 N/mm² and 4.05 N/mm² respectively.

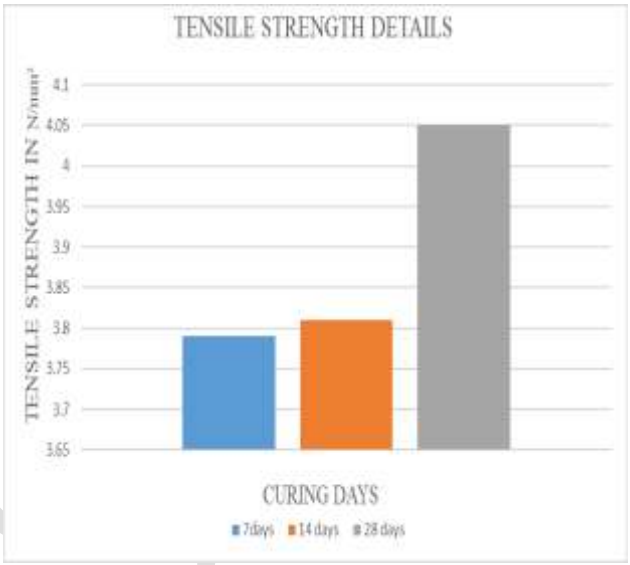

FIG 3. TENSILE STRENGTH DETAILS

V. CONCLUSION

The paper study experimentally, the effect of replacement of coarse aggregate by silico manganese slag on mechanical properties and durability properties of concrete. From the Physical properties and chemical composition of low carbon silico manganese slag it is very suitable to replace coarse aggregate in concrete. Hardness, better adhesion and wear resistance are the added advantages of slag.

The designed mix is also resulting to a true slump suitable for structural members. Compressive strength of an average 35.02 N/mm² is available after 28 days of curing and an average split tensile strength of 4.05 is resulting after 28 days of curing.

When comparing with the normal concrete with natural coarse aggregate the results obtained from workability test, compression test and split tensile strength are good acceptable.

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