Effect of Silica Fume on Steel Slag Concrete

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***Abstract*—Concrete is a widely used construction material. It must be designed to withstand severe environment before taking most of the inspirational forms. The Engineers are now-a-days try to improve the its capacity with different ideas. Like adding various admixtures and supplementary cementitious materials (SCM). The main objective of the SCM is capacity which that replace the cement and provides cementitious property then it decreases the price of the Portland cement. The material which can be used as supplementary cementitious material such as fly ash, GGBS, steel slag, silica fume. In these modern days most of concrete produced from these materials. To optimize concrete mixtures the properties of the materials compared with each other. The silica fume is a mostly used supplementary cementitious material, which increase the durability and for the design of high strength concrete. From steel manufacturing industries steel slag byproducts are produced[3]. The steel slag which is used as aggregate in concrete for hot mix surface application purpose. The workability industrial byproduct there is a need of extra work for the replacement of fine and coarse aggregate with steel slag for purpose of the considerable benefits[5]. The presence of free lime and Magnesium oxides in steel slag has a property of expanding nature, because this phenomenon steel slag is not used as aggregate in manufacturing of the concrete. Suitable treatments of weathering and usage of Pozzolanic materials like silica fume with steel slag is decrease the expansion of the concrete. Some small faults in material hence it is achieved by proper combination of materials each other, then it can be produce a good product with increases the total quality of the material and enhance the various properties.**

***Index Terms*— Steel slag, Fly ash, Silica fume, Slag cement, Fly ash cement, Fine aggregate, Coarse aggregate, GGBS, GGBFS, Lime, Cement .**

I. INTRODUCTION

Concrete is a combination of cement, sand ,coarse aggregate and water .Its achievements in its adaptable as can be designed to withstand severe environments while taking on the most inspirational forms. Engineers and scientist are additionally trying to increase its limits with the help of creative chemical admixtures and various supplementary cementitious materials. Initial supplementary cementitious materials the engineering marvels like Roman aqueducts, in this example of this technique is used by Greeks and Romans. Supplementary cementitious materials controls environmental pollution strictly and have manufactured on increase in the industrial wastes and sub graded byproducts which can be used as supplementary cementitious materials such as fly ash, silica fume, ground granulated blast furnace slag The supplementary can be separate in 2 categories depend on their type of reaction i.e. hydraulic, pozzolanic .Ground granulated blast furnace slag is SCM [1].

It is used for many years as an additional cementitious material in Portland cement, either as a component of mixture cement. *Granulated blast furnace slag commonly replaces 35%-65% Portland cement in concrete.* It can be improves strength and durability of concrete and increasing the service life of concrete structure. It has great proportion of the concrete structure. Fly ash is the pozzolanic equivalent generated in the burning of coal. It is taken from the chimneys of coal fired power plants. The fly ash includes silica dioxide and Calcium oxide.

The replacement of Portland cement with fly ash consider to decrease the Greenhouse gas "Footprint" of concrete as the generation of one ton of Portland cement greater approximately one ton of co2 as constract to zero co2 being produced using existing fly ash .Since the worldwide generate of Portland cement is expected to reach nearly 2 billion tons by 2010.Replacement of this Portland cement with large proportion of fly ash could decrease carbon emission associated with construction.

2. EXPERIMENTAL INVESTIGATION

The experimental program consisted of determination of the compressive strength of steel slag concrete by

using M20 mix proportion using with fly ash cement or slag cement or combination of both fly ash and slag Cements + binder mix as silica fume, fine aggregate as sand, coarse aggregate as steel slag [2]. *The binder mix is used for the different mixture of slag cement and fly ash cement and their proportion were 1:0, 0:1, 1:1 from this totally three combinations were made. 0%, 10%, 20% of binder mix is added further to silica fume.*

Here with 1:3 proportions of one part of binder mix and 3 parts of sand were prepared as mortar in 12 sets. Six specimens for each variation were cast and tested after 7 and 28 days curing [4].

2.1 Materials: Fly ash is obtained from Palvoncha thermal power station Bhadradri kothagudem district INDIA. Silica fume is obtained from Aadhithya minerals & chemicals private limited Hyderabad Telangana in India.

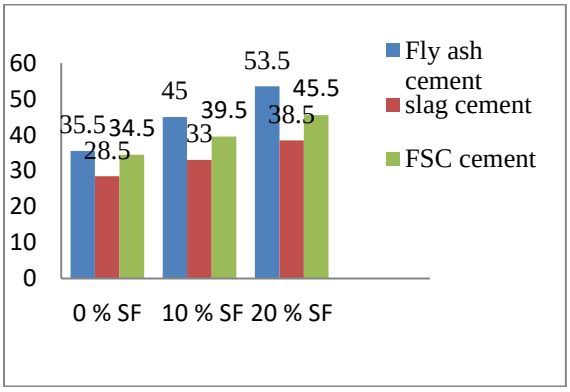
Sand is obtained from Godavari River Badrachalam Telangana. Steel slag is obtained from Surat in Gujarat .Slag cement is obtained from Dalmia Bharath in Andhra Pradesh The specific gravities of fly ash, silica fume, sand; steel slag and slag cements are 3, 2.27, 2.65, 3.35 and 2.95 respectively. Chemical composition of steel slag, silica fume, sand, fly ash, slag cement is shown in table-1. Natural river sand confirming to grading Zone -2 of IS 383:1970 was used.

Silica fume is consists of fine particles with surface area of 215280 ft²/IB. It is 1/ 100 range of cement. Steel slag By BOP 50 million tons produced. Fly ash is largely made of silicon dioxide. Slag cement as SC10 & SC20 with 10% & 20% with silica fume replacement. Experimental study on mortar: In this we prepared mortar of 1:3 ratio of different types of cement + silica fume replacement as binder mix and sand is taken as fine aggregate .Normal consistency of different binder mixes was determined by using the following procedure referring to IS 4031: part 4(1988) i.e. 250 grams of sample which is coarser than 150 microns some quantity of water is added to the sample mix it properly for 2 to 3minutes, this paste placed in Vicat's mould water requirement for different binder mixes are founded

Mix	Description	Cement (grams)	Silicafume (grams)	Consistency %
FC0	FC	250	00	35.5
FC10	FC with10% of SF	225	25	45
FC20	FC with 20% of SF	200	50	53.5
SC0	SC	250	00	28.5
SC10	SC with 10% of SF	225	25	33
SC20	SC with 20% of SF	200	50	38.5
FSC0	FC:SC(1:1)	125 each	00	34.5
FSC10	FC:SC(1:1) with 10% of SF	112.5 each	25	39.5
FSC20	FC:SC(1:1)with 10% of SF	100 each	50	45.5

Table-1

SC,SC,FC,SF,SFC,SC0 ,SC10 are slag cement , fly ash cement ,silica fume , slag and fly ash cement Slag cement with 0% silica fume replacement , Slag cement with 10%silica fume replacement. From the above table we concludes that water requirement increases with respect to increase in the percentage of replacement of silica fume in the binder mix and also concludes that the fly ash cement is requires more water for proper mixing because of its fineness.



% SF Replaced on X – axis

% Consistency on Y – axis

Normal consistency of different binder mixes

3.RESULTS AND DISCUSSIONS

For each type of cement six standard cubes with different mortars were casted to determine the compressive strength in 7-days, 28 days and also nine numbers of cubes were casted to know the compressive strength of concrete. The size of the cube is taken as per the IS 10086 – 1982.

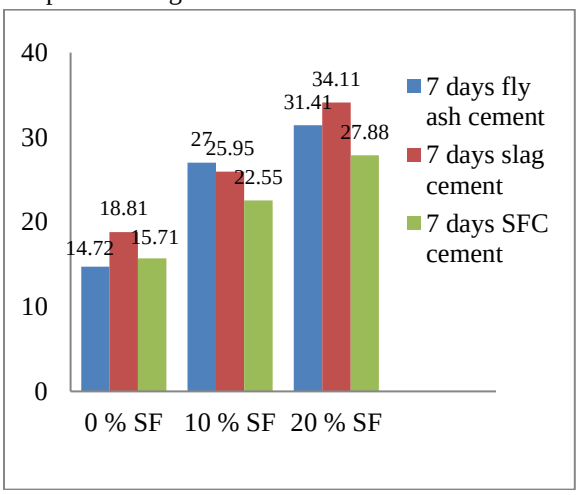
Compressive strength of mortar:

Type of cement	%of silica fume replaced	Compressive strength	
		7 days	28 days
Fly ash cement	0	14.72	26.54
	10	27	31.72
	20	31.41	37.22

Slag cement	0	18.81	29.42
	10	25.95	35
	20	34.11	42.10
Slag and Fly ash cement	0	15.71	32.55
	10	22.55	37.66
	20	27.88	40.10

Table-2

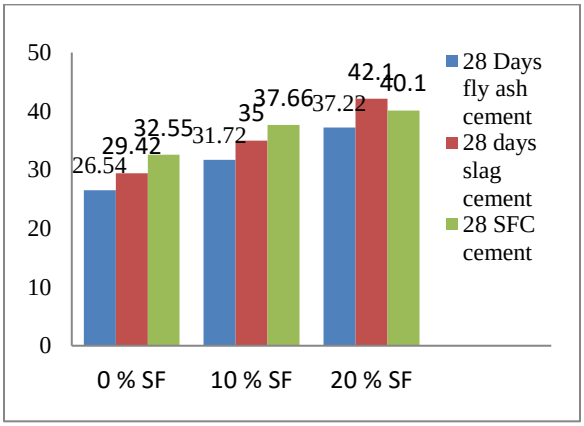
By performing the compression test for different motors, concludes that the strength in 7 days 28 days increases with increase in the dosage of silica fume in different types of mortars .The rate of reaction is faster in fly ash cement because of finer nature of fly ash compared to slag cement .



% SF Replaced on X – Axis

% Consistency on Y – Axis

(a).Compressive strength for mortar for 7 day



% SF Replaced on X - Axis

% Consistency on Y – Axis

(b). Compressive strength for mortar for 28 days

CONCLUSIONS

1.Silica fume is used for denser the binder mix and enhance the strength of the binder mix and the intrusion of silica fume increases the age of strength of the slag and accelerate the strength of the fly ash cement .

2. At any stage the equal combination of the slag and fly ash cement improves the strength development. The silica fume particles reacts with the lime then if hydrates and crystalline composition, which makes binder mix denser and decreases the capillary absorption and porosity and increases the dose up to 20%**.**

3**.** The disadvantage of silica fume with steel slag at any stage it decreases the strength of concrete. Because of voids present in it this is overcame by use of vibratory needle. The effect of alkalis Na2O, k2O in the steel slag which is used as coarse aggregate make concrete more alkaline then silica fume reacts with the alkaline reduces this effect of alkaline.

4. The mixture of silica fume with steel slag shows large number of voids then the combination of fly ash and silica fume increases strength makes concrete denser and cohesive and higher capillary absorption. Fly ash cement with steel slag produce the high strength of concrete.

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