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EXPERIMENTAL ANALYSIS ON EFFECTIVE UTILIZATION OF INDUSTRIAL WASTE MATERIALS OF EGG SHELL, GGBS AND SAW DUST ASH

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ABSTRACT

The aim of the work is to study the suitability of egg-shell powder, Ground Granulated Blast Furnace slag and sawdust ash as a partial replacement of cement. The chemical compositions of these Industrial wastes taken under study are almost similar to that of Ordinary Portland cement. In this experimental work, egg shell plays a major role, as it is used in all the combination of the concrete cubes. The industrial wastes are grounded to the fineness of cement, and the properties of cement such as initial setting time, final setting time, fineness test, soundness of cement, water absorption, etc. are conducted on the replaced sample. The tests revealed encouraging results for the study. The sample of blended cement consists of 20% of egg shell powder, 50% of GGBS and 10% of Sawdust ash. The proportion of the mineral admixtures is applied in testing cubes for their compressive strength. The compression test is conducted for finding the strength of the concrete in 7 days and 28 days strength. Using the results from the compression test, the optimum percentage of the mineral admixtures is finalized and it is used for casting beam specimens. The beams are cured normally for 28 days in normal potable water, and tested for their flexural strength. Usage of these industrial wastes reduces the production of cement, which in-turn reduces the environmental pollution.

KEYWORDS: Egg Shell Powder, Industrial Waste, GGBS, Sawdust Ash, Cementitious Material

INTRODUCTION

Even though India is still developing, India is not having a wide spread of the materials needed for construction. For example, cement is not available widely throughout India, because the availability of raw materials is a major problem. Hence, engineers started thinking of the alternate materials for construction. Nowadays, the availability of river sand has been a mirage for everyone dreaming of a house.

Today, the usage of fibers, GGBS, fly ash, etc. is some of the materials, which are taken as a wide substitute for construction materials. Engineers are checking for the suitability and the amount of suitability of the locally available materials to be used for construction.

In this project, Ground granulated blast furnace slag, sawdust ash and egg shell powder are checked for its suitability for using as a alternate Cementitious material.

Blast furnace slag cements are in use for a reasonably long period due to the overall economy in their production as well as their improved performance characteristics in aggressive environments. Also, the use of pozzolanas as additives to cement, and more recently to concrete, is well accepted in practice. Ground granulated blast furnace slag (GGBS) is one such pozzolanic material (termed by a few as a supplementary or complimentary cementitious material) which can be used as a cementitious ingredient in either cements or concrete composites. Research work to date suggests that these supplementary cementitious materials improve many of the performance characteristics of the concrete, such as strength, workability, permeability, and durability and corrosion resistance. To assess the effectiveness of GGBS in cementitious

composites, some of the parameters like chemical composition, hydraulic reactivity, and fineness have been carefully examined by many earlier.

During the last decades it has been recognized with growing sawdust ash waste are of large volume and that this is increasing year by year in the household Mills and factory's. Now a day's even in rice mills they are using sawdust for burning due to shortage of rice husk.

EXPERIMENTAL

Materials Used

Cement

Ordinary Portland cement of (53 grade cement) confirming to IS: 8112-1989 is used. Table 1 shows the properties of cement, ESP, GGBS and SDA.

Fine Aggregate

Natural River Sand of size below 4.75mm confirming to zone II of IS 383-1970 is used as fine aggregate.

Coarse Aggregate

Coarse aggregate used in this study consist of crushed stone of size 12mm and below.

The specific gravity of fine and coarse aggregates is 2.64 and 2.63 respectively. Water absorption of fine and coarse aggregates is 0.5% and 0.1% respectively.

Egg Shell Powder *(*ESP)

The egg shell powder used for this study was collected from SKM egg products in Tamil Nadu as egg shell mash the egg shell powder was ground to very fine powder using special grinder and made to pass through 90micron sieve.

Figure 1: Egg Shell Powder

Ground Granulated Blast Furnace Slag (GGBS)

GGBS is added to concrete by addition at the concrete mixer, along with ordinary cement, aggregate and water. The normal ratios and proportions of aggregates and water to cementitious material in the mix remain unchanged. GGBS is used as a direct replacement for ordinary cement, and replacement rates for GGBS vary from 30% to up to 85%. Typically 50% is used in most instances.

Figure 2: GGBS

Saw Dust Ash (SDA)

Saw Dust was openly heated to about the temperature of 600ºc the ash was then grounded after cooling and graded in accordance with BS 812(1967). Some properties of concrete with sawdust ash (SDA) as a replacement for ordinary Portland cement (OPC) are investigated. The maximum replacement of SDA is 10%.

Figure 3: SDA

Water

Water used for the preparation of concrete and curing as per IS: 456–2000.

Table 1: Physical Properties

Materials	Specific Gravity
OPC	3.15
ESP	1.12
GGBS	2.98
SDA	2.51

Table 2: Chemical Properties

	CEMENT	ESP	GGBS	SDA
$Si0_2$	21.3	0.11	34.70	50.2
CaO	63.14	50.7	39.18	5.45
Fe_20_3	3.77	0.02	2.02	14.23
Al_20_3	5.41	0.03	14.95	1.02
MgO	1.2	0.01	10.45	0.09

The mix proportion used for casting is as follows: 1:1.993:2.52

OPC 394 kg/m^3

Fine aggregates - 785 kg/m^3

Coarse aggregates - 992 kg/m^3

Water–cement ratio - 0.47

Combination of Materials

- Cement + Egg Shell Powder + GGBS
- Cement + Egg Shell Powder + Sawdust ash

Casting of Specimens

Cube Size

150*150*150mm

Beam Size

1200*150*100mm

Casting of Specimen

The specimens were casted in the laboratory. Steel molds were used for casting. Reinforcement cage was made and placed inside the molds during casting. Required quantities of cement, fine aggregate, coarse aggregate, ESP, GGBS & SDA is weighed and mix is prepared according to the mix proportions. The mix is poured into the mold and compacted by using vibrator. The specimen is kept for 24 hours and curing is done for 28 days.

EXPERIMENTAL PROGRAMM

Table: 3

% of Replacement	No of Cubes			
	ESP & GGBS (50:50)		ESP & SDA (50:50)	
	7 Days	28 Days	7 Days	28 Days
0	3	3	3	3
5	3	3	3	3
10	3	3	3	3
15	3	3	3	3
20	3	3	3	3
25	3	3	3	3

Reinforcement Details of Beam

At bottom 3 no's of 10 mm dia bars are used. At top 2 no's of 10mm dia bars are used. To arrest shear reinforcement are provided 8 mm stirrups are used at 100mm spacing.

Dimension – 100 x 150 x 1200mm

Main bar dia – 10mm

Stirrups – 7# 8ϕ @ 150mm c/c

Figure 4: Reinforcement of Beam

Figure 5: Mixing

Figure 6: Casting

Figure 7: Curing

TESTING OF SPECIMENS

- Compression Strength Test
- Flexural Strength Test

Compression Strength Test

The compression test is used to determine the hardness of cubical and cylindrical specimens of concrete. The strength of a concrete specimen depends upon cement, aggregate, bond, w/c ratio, curing temperature, and age and size of specimen. Mix design is the major factor controlling the strength of concrete.

Figure 8: Compression Testing of Cube

Flexural Strength Test

It is the resistance of concrete to tension under flexural loading. The tensile strength of concrete is primarily made to estimate the load under which cracking develops.

LOADING SET UP

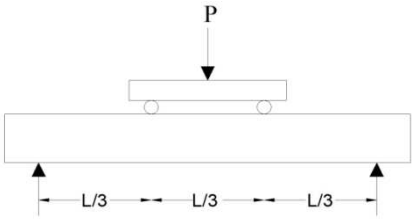

Figure 9: Two Point Loading Set Up

RESULTS

Compression Strength on Cube

Table: 4

% of Replacement	Avg. Compressive Strength (N/Mm^2)			
	ESP & GGBS (50:50)		ESP & SDA (50:50)	
	7 days	28 days	7 days	28 days
0	24.71	36.67	24.71	36.67
5	23.33	37.12	26.25	38.20
10	25.80	39.61	23.11	35.12
15	24.10	35.40	24.30	32.19
20	22.17	30.70	20.70	29.51
25	18.54	27.00	18.21	26.30

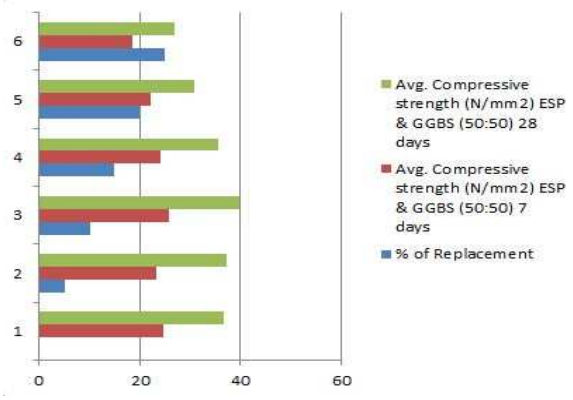

Chart 1: Replacement of ESP & GGBS

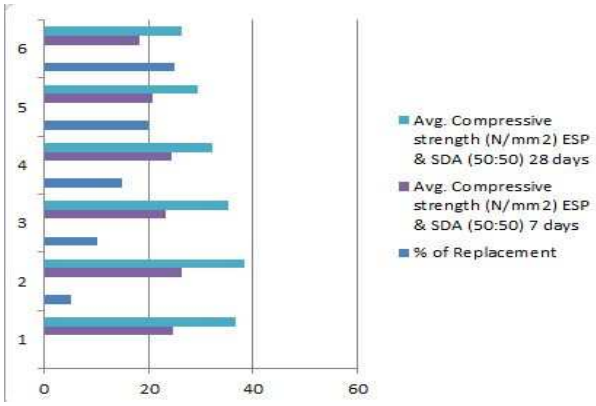

Chart 2: Replacement of ESP & SDA

CONCLUSIONS

Now days, the environmental pollution is one of the most important worldwide issue. The industrial mineral admixtures wastes such as egg shell powder, GGBS and SDA has been affecting one of the environmental pollution. The use of industrial mineral admixtures in construction is one of the solutions to reduce the environmental pollution. The results of the works can be concluded that egg shell powder, GGBS and SDA mixed concrete cubes had maximum strength at 5%, 10% replacement. The 28-days compressive strengths of the ESP & GGBS mix concrete cubes shows maximum strength at 10% replacement with cement.

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