UTILIZATION OF EGG SHELL POWDER & GGBS IN CONCRETE

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ABSTRACT

During the manufacturing of cement carbon- di- oxide is released and it causes environmental pollution and global warming. To reduce the impact of carbon - di - oxide in environment, waste by products are used as admixture in this study, so that environmental pollution and natural resources consumption is reduced. Eggshell is generally thrown away as a waste. It can used as a partially replacement of cement. It contains calcium carbonate. Its usage increases the strength. Approximately 900 Kg of carbon dioxide is emitted from 1000 kg of cement manufacturing process. To reduce the impact of cement production on the atmosphere, waste byproducts were used as a blend in this study to reduce environmental pollution and resource consumption. In this study, egg shell powder is 30% (5, 10, 15, 20, 25 and 30) and GGBS is fixed at 25%. These two wastes are used in M25 grade concrete as a partial substitute for cement and determine various properties such as workability, compressive strength and Durability test.

Keyword: - *Eggshell powder, GGBS, compressive strength, durability of result*.

1. INTRODUCTION

India is the world's second largest producer of eggs every year. Treating garbage eggshells is a big deal. If you send it to the landfill, it will harm the human body and cause problems related to human health and environment. Egg shells are generally rich in calcium and have almost the same limestone composition. The use of egg shell waste rather than regular lime as a cementitious material can have the same benefits as preserving natural lime and using waste. The objective of the current review is to determine the potential availability of these reckless materials as a building material for cement. GGBS is also a waste of the steel industry. GGBFS cement has been reasonably utilized because its performance properties under strong conditions have been improved and extended during the generation due to the general economy. In addition, the use of pozzolanas as additives in cement and the use of cement in the latter days are highly recognized every day. GGBS is one of those pozzolanic materials that can be used as a cement-based fixture in cement or concrete composites. By inquiring about work up to date, we suggest that these supplemental cement materials can improve the performance properties of concrete, such as work capacity, strength, permeability, durability and resistance to corrosion. The advantages of using these byproducts construction are (1) it reduces the amount of construction and demolition waste entering landfill sites; and (2) it reduces the use of natural resources.

1.1 EGGSHELL POWDER

The chemical composition of Eggshell powder and cement was found to be similar. The main ingredient of egg shell was calcium carbonate (about 51%). Eggshell waste has evolved from poultry farms, restaurants and hotels. These wastes are used in animal feed and are disposed of in many countries. These wastes are collected and implemented in our projects.

Processing of egg shell powder is performed in the following order: (1) material collection, (2) crushing and powdering of egg shells, (3) egg shell powder sieving, and (4) mixing of cement and shell powder. The constitution of Eggshell powder is made on a 75 micron sieve. The retained residues were supplied to the fertilizer and animal feed industries.

Table:- 1 Physical Properties

NAME	PHYSICAL PROPERTIES
Specific graviety	2.89
Moisture content	1.18
Bulk density (g/m^3)	0.8
Particle density (g/m^3)	1.012
Porosity (%)	22.4BET
Surface area m^2/g	21.2

Table:- 2 Chemical Properties

COMPOSITION	CEMENT	ESP
CaO	63.8%	47.49%
SiO_2	21.4%	0.11%
Al_2O_3	5.1%	Nil
Fe_2O_3	2.6%	Traces
MgO	0.36%	Nil
SO_3	3.38%	0.38%
K_2O	1.88%	Nil
Na_2O	0.14%	0.14%

1.2 GGBS (GGBFS)

The pulverized blast furnace slag consists essentially of a silicate of calcium and an alumina silicate. Portland cement is a good catalyst for slag activation because it contains three main chemical components that activate slag, such as lime, calcium sulphate and alkali. The material has a glass structure. And the ground is less than 45 microns. The surface area is about 350 - 450 m2 / kg Blaine. Crushed slag, usually sulphate and alkaline water, supplied with common port land cement and with active agent, react chemically with GGBS and hydrates and chemicals in a similar way to Portland cement.

Table:- 3 Chemical Properties

TABLE 1:
CHEMICAL COMPOSITION OF GGBFS

CONTENTS	MASS (%)
SiO_2	30-36
Al_2O_3	18-25
Fe_2O_3	0.8-3
CaO	30-34
MgO	6-10

2. MIX DESIGN AND MIX PROPORTIONS

Mix Proportion: Our project is proposed of M25 grade of concrete and the mix design was based on IS 10262-1982 and IS 383 -1970 codal provisions. The mix proportion arrived was 1:1.2:2.25 (cement: fine aggregate: coarse aggregate).

Table:- 4 Mix Proportions

	M1	M2	M3	M4	M5	M6	M7
Density (kg/m^3)	2509	2509	2509	2509	2509	2509	2509
C.A (kg/m^3)	732	732	732	732	732	732	732
F.A (kg/m^3)	389	389	389	389	389	389	389
CEMENT	325	232	219	207	195	183	171
GGBS(%)	0	25	25	25	25	25	25
ESP (%)	0	5	10	15	20	25	30
GGBS (kg)	0	81	81	81	81	81	81
ESP (kg)	0	12	24	37	49	61	73
NATURAL SAND	905	905	905	905	905	905	905
WATER	159	159	159	159	159	159	159
Ratio Of Mix Proportion (Source Material: F.A: C.A)	1:1.2:2.25	1:1.2:2.25	1:1.2:2.25	1:1.2:2.25	1:1.2:2.25	1:1.2:2.25	1:1.2:2.25

3. EXPERIMENTAL WORK AND TEST RESULTS

3.1 Slump Test:

The mold for the slump test is a truncated cone with a height of 300 mm. The bottom is 200mm and the top is 100mm in diameter. The bottom is placed on a smooth surface and the container is filled with concrete with three layers tested for workability. Each layer was turned a standard 1 mm diameter steel bar 23 times. When the mold is filled with concrete. The cone will slowly and carefully drop the unreinforced concrete vertically. Slump when the height of the concrete center decreases, it is called slump. The decrease in concrete height against mold is measured on a scale.

Table:- 5 Slump Result

Proportion	Slump(mm)
OPC(M25)	85
5A25	80
10A25	70
15A25	60
20A25	70
25A25	60
30A25	60

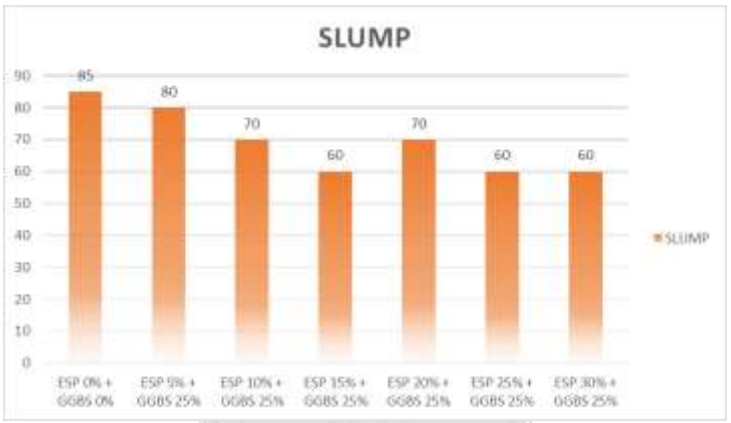

Fig. 1 Slump Result

3.2 Compressive Strength Test:

We are preparing M25 mix designs using the characteristics of materials. Then we have up to 30% egg shells. At each rate we are building a cube. After testing the cube on the 7th, 14th, and 28th, all weights are applied before testing the cube. Compressive strengths were calculated for all ratios of cube using the compressive strength formula using,

Volume of cube = a3
=150x150x150 = 3.375x106 mm3
Volume of cylinder = 2 x pi x r2 x h
= 2 x 3.14 x 75 x 150 = 0.70 x 106 mm3

For all concrete mixes, the compressive strength is determined in 150 × 150 × 150 mm cubes at 7 days, 14 days and 28 days of hardening. The following table shows the results of compressive strength tests applied to concrete at constant intervals of 5, 10, 15, 20, 25 and 30% of egg shell powder and 25% of GGBS at each interval. The test results of the cube compressive strength are shown in the figure below.

Table : 6 Compression Test Result (Cube)

Proportion	CUBE		
	7 day	14 day	28 day
OPC(M25)	16.29	18.88	31.33
ESP 5% + GGBS 25%	19.00	24.66	35.92
ESP 10% + GGBS 25%	20.32	27.47	38.81
ESP 15% + GGBS 25%	21.77	29.40	41.85
ESP 20% + GGBS 25%	20.87	27.36	42.08
ESP 25% + GGBS 25%	19.36	25.77	38.29
ESP 30% + GGBS 25%	18.43	23.77	37.10

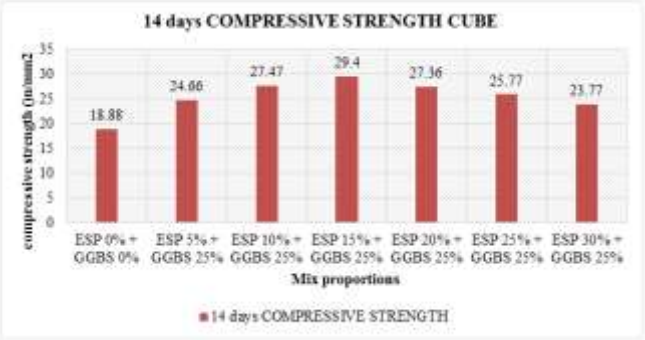

Fig. 2 (14 days compressive strength)

Fig.3 (7 days compressive strength)

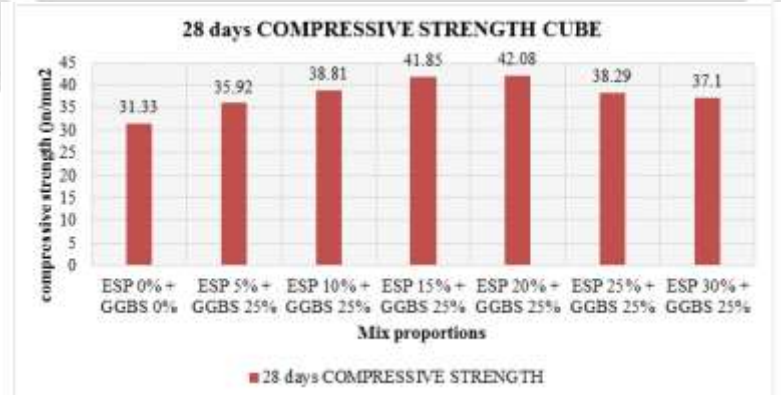

Fig.4 (28 days compressive strength)

Table: 7 Compression Test Result (Cylinder)

Proportion	CYLINDER		
	7 day	14 day	28 day
OPC(M25)	15.37	17.91	22.35
ESP 5% + GGBS 25%	18.19	21.97	26.12
ESP 10% + GGBS 25%	24.22	25.48	30.28
ESP 15% + GGBS 25%	25.23	30.46	35.83
ESP 20% + GGBS 25%	27.72	34.23	40.45
ESP 25% + GGBS 25%	28.00	36.87	45.07
ESP 30% + GGBS 25%	30.46	36.95	48.09

Fig.5 (7 days compressive strength)

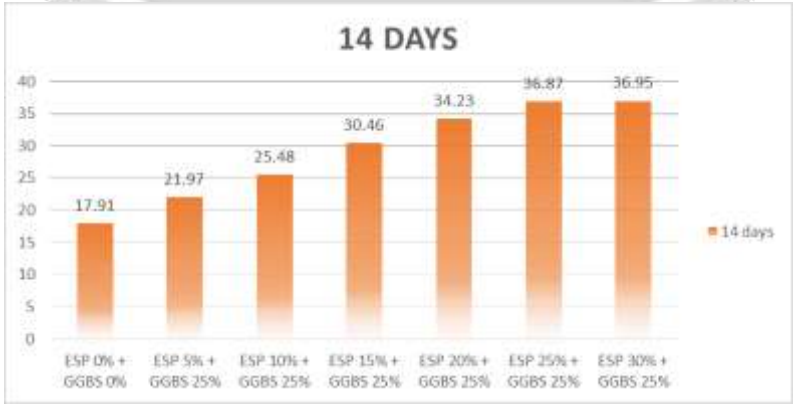

Fig.6 (14 days compressive strength)

Fig.7 (28 days compressive strength)

In this work mineral admixture are used to enhance the Compressive strength of concrete made with Egg Shell Powder and GGBS. The compressive strength of partially cement replaced concrete made with 5, 10, 15, 20, 25 and 30% Egg Shell Powder and 25% of GGBS ranges from 16.29 to 18.43 MPa at 7 days and 31.33 to 37.10 at 28 days From the Experimental Results it is clears that the compressive strength of concrete made with 15% ESP and 25% GGBS shows higher compressive strength value than natural aggregate concrete mix. From the results it is concluded that the ESP & GGBS can lightly improve the Compressive strength of concrete. Hence it is viable to use ESP up to15% replacement and GGBS up to 25% replacement without affecting the required strength.

3.3 Water permeability Test:

The durability of concrete depends on the permeability of the concrete, which is defined as the property of controlling the rate at which the fluid flows into a porous solid. This test was performed in accordance with IS: 3085 (Part 7) -1965. The permeability test setup is shown in Figure 6.5. A standard 150 mm cube was cast and cured for 28 days, and four sides of the cube were painted to prevent water from penetrating from the sides.

The upper surface was effectively sealed to achieve water tightness. Pressure was applied to the water pressure. The amount of water passing through the cube was collected at the bottom of the vial through a funnel. The operating pressure, the amount of water collected and the observation time were recorded. The permeability coefficient was calculated using the given formula.

Table: 8 Max Depth Of Water Penetration Result (mm)

Proportion	Max. Depth Of Water Penetration(mm)
OPC	7
S1	9
S2	15
S3	17
S4	19
S5	20
S6	21

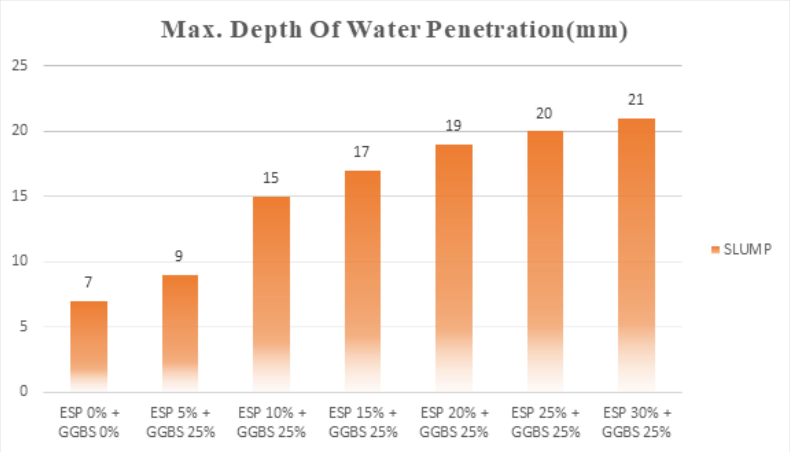

Fig.8 Max. Depth of Water Penetration

K=QL/ATH
K = Co-efficient of permeability in cm/sec.
Q = Quantity of water percolating over the entire period of test.
A = Effective area of specimen in cm2.
T = Time in seconds over which 'Q' is measured.
H = Pressure head in cm.
L = length of specimen in cm

3.3 Chloride attack:

A 5% sodium chloride (NaCl) solution was used as the standard exposure solution for all tests. The specimens were immersed in a solution of sodium chloride in a plastic container and the volume ratio of the sulfate solution to the specimen was maintained at 4: 1. Changes in mass and compressive strength were observed at regular intervals.

Table: 9 Weight After 90 Days Immersed In Chloride Acid Result

Proportions	ESP & GGBS	Initial Weight	Weight After 90 Days Immersed In Acid
M1(OPC)	0A0	8.23	8.10
M2	5A25	8.34	8.20
M3	10A25	8.40	8.35
M4	15A25	8.43	8.40
M5	20A25	8.49	8.42
M6	25A25	8.53	8.49
M7	30A25	8.55	8.50

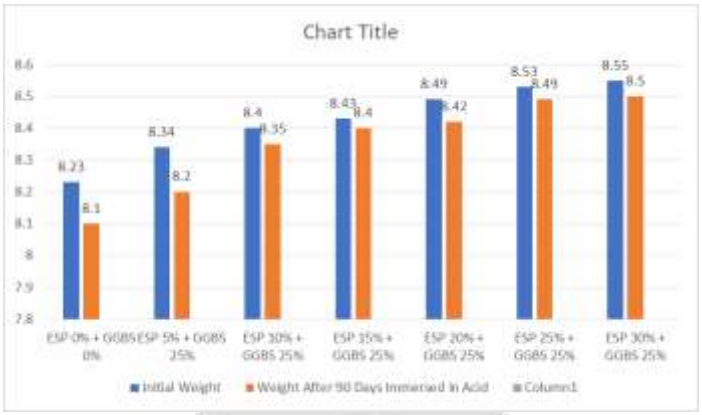

Fig.9 Weight Loss After 90 Days Immersed In Chloride Acid

3.4 Suphate attack:

The resistance of concrete to sulfate attack was studied by determining the loss of compressive strength or compressive strength of a concrete cube submerged with 5% sodium sulfate (Na2SO4) and 5% magnesium sulfate (MgSO4) And sulpHates not immersed in water. After 28 days of hydration hardening, the concrete cube with a size of 150 mm, which was dried for 28 days, was immersed in 5% Na2SO4 and 5% MgSO4 for 90 days. The concentration of sulfate was maintained during this period. After 90 days of immersion, the concrete cubes were taken out of the sulphate water and wiped off the water and soil from the cube surface tested for compressive strength according to the procedure specified in IS: 516-1959, and this type of fin acceleration test ding out the loss of compressive strength for assessing sulphate resistance of concrete.

Table: 10 Weight After 90 Days Immersed In Suphate Acid Result

Proportions	ESP & GGBS	Initial Weight	Weight After 90 Days Immersed In Acid
M1(OPC)	0A0	8.23	7.90
M2	5A25	8.34	8.01
M3	10A25	8.40	8.06
M4	15A25	8.43	8.08
M5	20A25	8.49	8.10
M6	25A25	8.53	8.12
M7	30A25	8.55	8.15

Fig. 10 Weight Loss After 90 Days Immersed In Sulphate Acid

4. CONCLUSIONS

The compressive strength (cube) of conventional concrete is 16.29 Mpa at 7 days, whereas compressive strength 0f partially replaced cement by an amount of 15% ESP and 25% of GGBS at 7 days found to be 29.40 Mpa. Also it is found that the compressive strength of partially replaced concrete have 33 % higher strength than the conventional concrete respectively.

The Compressive strength (cube) of conventional concrete is 31.33Mpa at 28 days, whereas compressive strength of partially replaced cement by an amount of 15% ESP and 25% of GGBS at 28 days found to be 42.08 Mpa. Also it, is found that the compressive strength of partially replaced concrete have 35% higher strength than the conventional concrete respectively.

The compressive strength (cylinder) of conventional concrete is 15.37 Mpa at 7 days, whereas compressive strength 0f partially replaced cement by an amount of 30% ESP and 25% of GGBS at 7 days found to be 30.46 Mpa. Also it is found that the compressive strength of partially replaced concrete have 33 % higher strength than the conventional concrete respectively.

The Compressive strength (cylinder) of conventional concrete is 22.35 Mpa at 28 days, whereas compressive strength of partially replaced cement by an amount of 30% ESP and 25% of GGBS at 28 days found to be 48.09 Mpa. Also it, is found that the compressive strength of partially replaced concrete have 35% higher strength than the conventional concrete respectively.

The durability test result shows that the initial weight of the cube is more and when it is immersed in acid after 28 days of curing for 90 days in acid its weight decreases. It is observed from the results the maximum percentage loss in weight and percentage reduction due to sulphate Acids for M25 grade concrete are 1.25% at 15% ESP & of 25% GGBS replacement. There is considerable variation in loss of weight with ESP and GGBS replacement. And in chloride acid there is 1.45% loss in weight when 15% ESP and 25% GGBS is replaced with cement.

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