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EXPERIMENTAL STUDIES ON CONCRETE FOR THE PARTIAL REPLACEMENT OF CEMENT BY EGG SHELL POWDER AND GGBS

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Abstract - The major problem the world is facing today is the environmental pollution. In the construction industry mainly the production of Portland cement will causes the emission of pollutants results in environmental pollution. The carbon dioxide produced by cement industries causes environmental pollution and global warming. In 1000Kg of cement manufacturing processes approximately 900Kg of CO2 is emitted. In order to reduce the impact of cement production on atmosphere, wastes by products are used as admixture in this study, so that environmental pollution and natural resources consumption is reduced., in the present study, Egg shell powder are varied up to 12.5Percentage (7.5, 10 and 12.5) and GGBS is added to optimum egg shell powder content cement concrete from 20% to 35 Percentage (20, 25, 30 and 35). These two wastes are used as a partial replacement of cement and various properties like workability, compressive strength, and split tensile strength and shear strength were determined.

Key Words: Egg Shell Powder, GGBS Concrete aggregates, Compressive strength, Split Tensile strength, shear strength test, Fineness modulus, Shear strength.

1. INTRODUCTION

India ranks second in the world with annual egg production. Garbage Disposal of these egg shells is a big job in case if they are sending to landfills it attracts vermin and causes problems related to human health and surround. Egg shell is generally rich in calcium and has nearly same composition of limestone. The utilization of eggshell waste rather than regular lime as cementaceous material can have benefits like conserving natural lime and utilizing waste material. The target of the present review is to decide the potential utilization of these thriftless as an establishing material for cement. And also the GGBS is a waste product from the iron manufacturing industry. GGBFS cements were utilized reasonably for a long stretch because of their enhanced execution attributes in forceful situations and the general economy in their creation. Additionally, the utilization of pozzolanas as added substances in cement and all the more as of late in cement likewise it is very much acknowledged day by day. GGBS is one of such pozzolanic material this can be utilized as a cementaceous fixing either in cement or in concrete composites. Inquire about work till date proposes that these supplementary cementations materials enhance a number of the execution attributes of the concrete, for example, work ability, strength, penetrability, durability, and resistance to corrosion. The advantages of using these by-products construction are (1) it reduces the amount of construction and demolition waste entering landfill sites; and (2) it reduces the use of natural resources.

Materials and Methodology

1.1 .1 Cement

Ordinary Portland Cement (OPC) of 43 grade with brand name Ultra-Tech confirming to (IS 8112-1989) standards were used to cast the specimens. To know the quality of selected cement, few tests have been conducted in the Laboratory.

Table 1: Test results on cement

Sl. No	Name	Experimental value	IS 8112-1989 specified limits
1	Fineness of cement (Sieving method)	5.67%	!> 10%
2	Normal Consistency	29%	--
3	Initial Setting Time	58 mins	!< 30mins
4	Final Setting Time	270 mins	!>600mins
6	Specific Gravity	3.12	3.1 to 3.25
7	CompressiveStrength 3days strength 7days strength 28days strength	 28.23MPa 37.23MPa 46.93MPa	 Minimum 16MPa 22MPa 43MPa

1.1.2 Fine Aggregate (FA)

Nearby available sand from Tungabhadra River confirming to a zone II from Table 4 of IS code 383-1970 has been used as FA. The tests conducted are specific gravity, water

absorption and fineness modulus tests. The test results on fine aggregate and sieve analysis values are placed in the Table 2

Table 2: Test results of Fine Aggregate

Sl .No.	Test	Value
1	Specific Gravity	2.62
2	Water Absorption	0.8%
3	Fineness Modulus	2.92

1.1.3 Coarse Aggregate (FA)

Crushed natural-granite aggregate from local crusher has been used and which has maximum size of 20mm. The tests for natural granite aggregate are conducted as per IS 383-1970 procedure and the obtained results are presented in Table 3, from sieve analysis test.

Table 3: Test results of Natural Coarse Aggregate

Sl. No.	Test	Experimental Value
2	Specific gravity	2.65
3	FM	5.85
4	Water absorption	0.6%

1.1.4 Egg Shell Powder (ESP)

The broken egg shells were gathered from the nearby bodies. These shells are cleaned in ordinary water and air dried for a time of five days around at a temperature scope of 25 – 300 C. At that point these dried shells hand squashed, granulated and sieved through 90µm sieves. Material gone through 90µm sieve is utilized for cement substitution in concrete and the specific gravity of Egg Shell Powder is 2.01

1.1.5 Water

Clean fresh water is used for mixing and curing the specimens.

1.1.5 GGBS (GGBFS)

Ground Granulated Blast furnace Slag consist essentially silicates & alumina silicates of calcium. Portland cement is a good catalyst for activation of slag because it contains the three main chemical components that activate slag: lime, calcium sulphate and alkalis. The material has glassy structure. and is ground to < than 45 microns. The surface area is about 350 - 450 m2 / kg Blaine. The ground slag in presence of water and an activator which are commonly sulphates & alkalis which are supplied by ordinary Port land Cement react chemically with GGBS and hydrates and sets in a manner similar to Portland cement.

1.1.6 Conplast SP-430

To obtain better workability Conplast SP-430, superplasticising admixture used in the work. It is a brown solution which disperses in water instantly. It reduces water to higher levels thus increasing the strength. The specific gravity of this admixture is 1.2. For the present experimental design work the dosage is varied from 0.7 to 0.8% by weight of cement to achieve the slump value (100mm).

1.1.7 Casting

The cubes of inner dimensions 150X150X150mm were cast to find out the compression strength of mixes. To evaluate the split tensile strength, cylinders of 150mm diameter with 300mm height were cast and to evaluate shear strength 150x60x90mm moulds are used. The proportions for various mixes were evaluated for 100 mm slump. The mixes are designed for M30 grade concrete as per IS Codes. All materials are weighed, . as in mix design separately. The cement, sand, natural-coarse aggregate and recycled-coarse aggregate were dry mixed in pan mixer thoroughly till uniform mix is achieved. Required a quantity of water is added to the dry-mix along with super plasticizer. The fresh concrete was placed in the mould and the compaction was adopted by mechanical vibrator. The specimens were removed from moulds after 24 hours & placed in water pound for 28 days curing. After a period of 28 days the specimens were taken out & allowed to dry under shade, later the specimens are allowed for testing.

Table 4: Mix proportions per cubic meter of concrete (W/c = 0.42)

Mix	Cement (kg)	FA (Kg)	CA (kg)	Water (ltrs)	Plasticizer (ltrs)
Normal	399	670	1182	167.58	2.8(0.7 %)
7.5% ESP	399	670	1182	167.58	2.8(0.7 %)
10%ESP	399	670	1182	167.58	3(0.75 %)
12.5% ESP	399	669	1181	167.58	3.2(0.8 %)
Ratio	1	1.68	2.96	W/C = 0.42	-----

2 TESTS FOR SPECIMENS

2.1 Compressive Strength Test

This test is conducted by using 3000kN (CTM). The cube was kept in the CTM & the load is given at a constant rate of 140kg/cm2, till the specimen fails and the corresponding load noted as ultimate load. The cube compressive strength is computed by using standard formula. The obtained results are presented in the next chapter.

2.2 Split Tensile Test

This test is conducted by using 3000kN compression testing machine (CTM). The cylinder is placed at the bottom compression plate and is aligned in such a way that center lines marked on the ends. Of the specimen are a vertical. Then the top plate of the CTM is brought in contact at the top the cylinder. The load applied at the uniform rate of 140kg/cm2 and the failure load is noted. Strength is calculated by the splitting tensile the formula of $2P/\pi dl$ and results are presented in the next chapter.

2.3 Shear Strength Test

This test is conducted by using 3000kN (CTM). The cube was kept in the CTM & the load is given at a constant rate of 140kg/cm2 the shear strength is characterized as the heap at which a protest can withstand toward a path of parallel to the substance of the material, instead of opposite to the surface. Shear strength is the most extreme shear stretch which a material can withstand without break. And the cube is placed in such a manner the load is applying to the 150*60 section of the 150*90*60 mould and the load at which it breaks are recorded.

3. RESULTS AND DISCUSSION

3.1 Compressive strength

For every concrete mix, the compressive strength is determined on three 150×150×150mm cubes at 7 days and 28 days of curing. Following table give the compressive Strength test results of concrete with constant 7.5,10 and 12.5% of Egg Shell Powder and varying 20,25,30 and35 % of GGBS for each interval. The test results of the cube compressive strength are presented in Table and figures below.

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 7.5, 10 and 12.5% Egg Shell Powder and 20, 25, 30 and 35% of GGBS ranges from 21.92 to 25.47 MPa at 7 days and 35.1 to 40.15 at 28 days From the Experimental Results it is clears that the compressive strength of concrete made with 10% 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 to10% replacement and GGBS up to 25% replacement without affecting the required strength.

Table 5: Compressive Strength of Concrete

Sl.N0	Mix (ESP+GGBS)	Compressive Strength (N/mm2)	
		7days	28days
1	Convectional	23.22	37.53
2	7.5+20	24.07	38.07
3	7.5+25	24.36	38.96
4	7.5+30	23.77	37.77
5	7.5+35	23.03	37.30
6	10+20	24.72	38.22
7	10+25	25.47	40.15
8	10+30	24.07	38.80
9	10+35	23.6	37.47
10	12.5+20	22.80	35.40
11	12.5+25	23.1	35.70
12	12.5+30	22.96	35.84
13	12.5+35	21.92	35.10

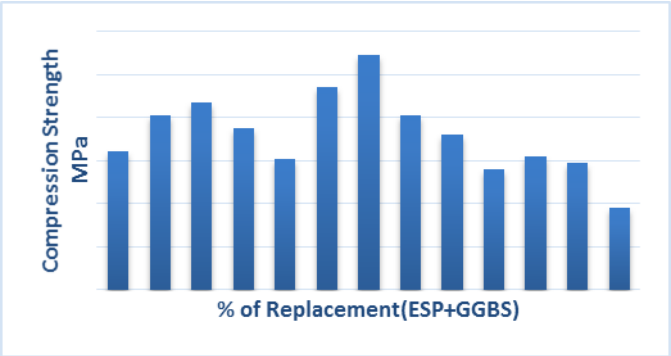

Fig 1: Compressive Strength of Concrete at 7 days

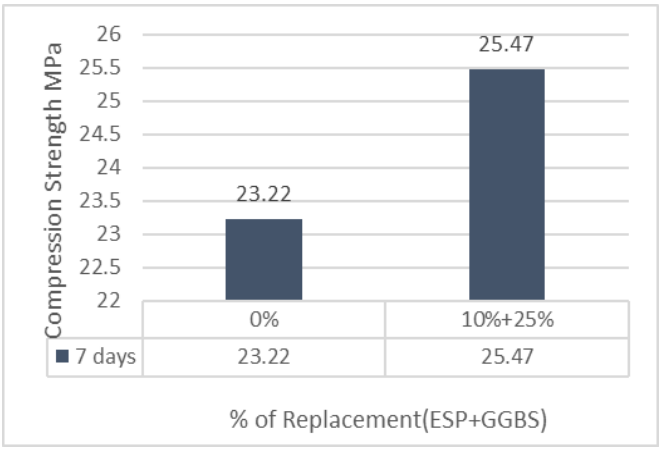

Fig 2: comparison of Compressive Strength with conventional concrete at 7 days

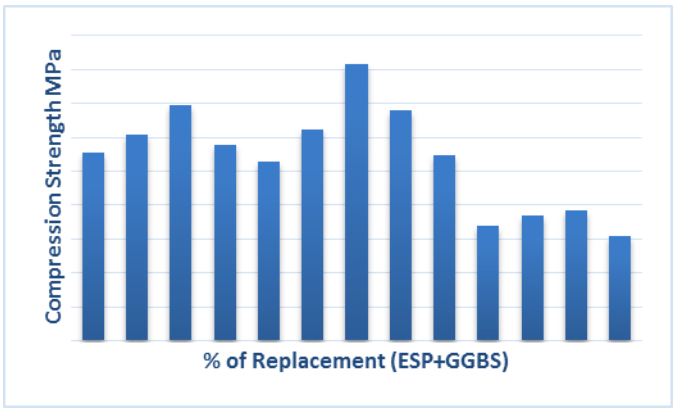

Fig 3: Compressive Strength of Concrete at 28 days

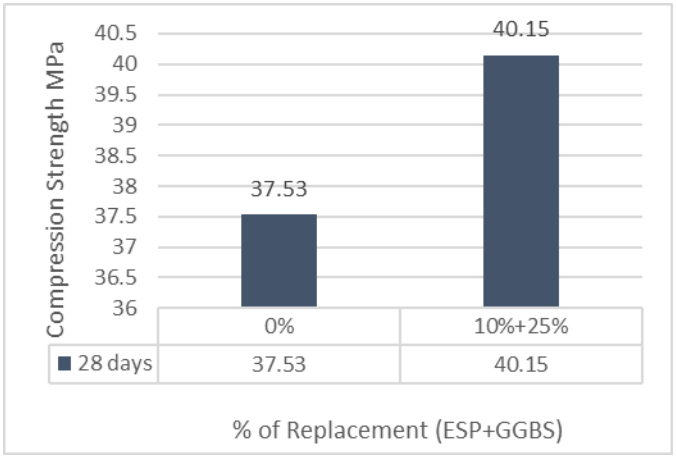

Fig 4: comparison of Compressive Strength with conventional concrete at 28 days

3.2 Split Tensile Strength Test Result

Test has been conducted after7days and 28 days of curing. Split-tensile is conducted on 150 mm diameter & 300 mm length cylinders bas per IS 5816 – 1999. Following tables from 9 to 11 & figure 4 to 6 give the split tensile strength results of concrete made with constant 7.5,10 and 12.5% of Egg Shell Powder and varying 20,25,30 and35 % of GGBS for each interval.

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 7.5, 10 and 12.5% Egg Shell Powder and 20, 25, 30 and 35% of GGBS ranges from 1.48 to 2.14 MPa at 7 days and 2.4 to 3.2 at 28 days. From the Experimental Results it is clears that the compressive strength of concrete made with 10% 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 to10% replacement and GGBS up to 25% replacement without affecting the required strength.

Table 6: Split Tensile Strength of concrete

Sl.N0	Mix (ESP+GGBS)	Split Tensile Strength (N/mm2)	
		7days	28days
1	Convectional	1.95	3.01
2	7.5+20	1.86	2.85
3	7.5+25	1.90	2.97
4	7.5+30	1.88	2.68
5	7.5+35	1.79	2.54
6	10+20	2.02	3.11
7	10+25	2.14	3.20
8	10+30	1.98	3.11
9	10+35	1.86	2.87
10	12.5+20	1.70	2.66
11	12.5+25	1.76	2.69
12	12.5+30	1.70	2.53
13	12.5+35	1.48	2.40

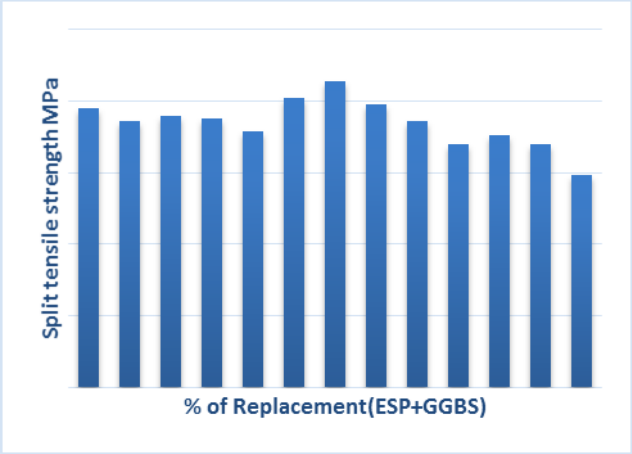

Fig 5: Split Tensile Strength of Concrete at 7 days

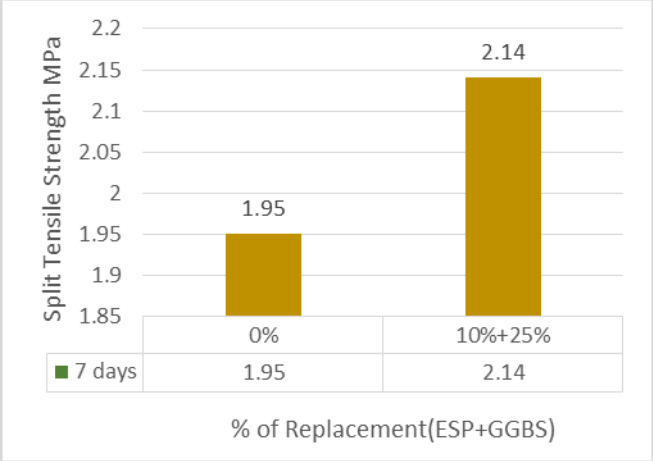

Fig 6: Comparison of Split Tensile Strength With conventional concrete at 7 days

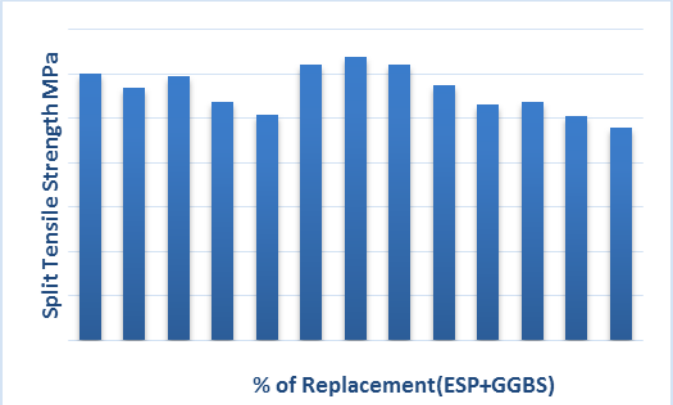

Fig 7: Split Tensile Strength of Concrete at 28 days

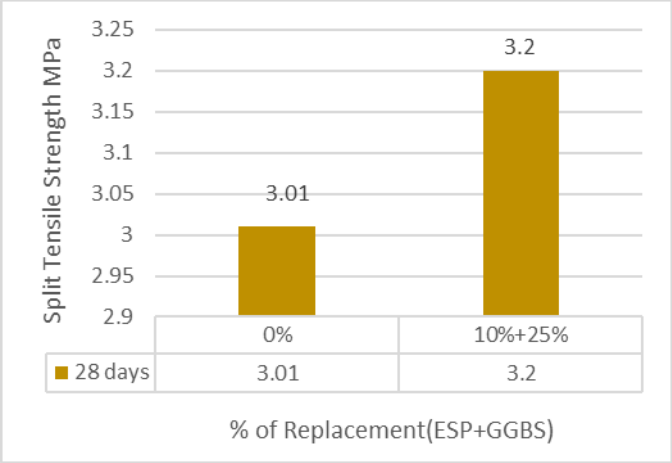

Fig 8: comparison of Split Tensile Strength With conventional concrete at 28 days

3.3 Shear Strength Test Result

The shear strength test for concrete is additionally one of the essential and furthermore imperative properties of the concrete. The shear strength is characterized as the heap at which a protest can withstand toward a path of parallel to the substance of the material, instead of opposite to the surface

Table 7: Split Tensile Strength of concrete

Sl.N0	Mix (ESP+GGBS)	Shear Strength (N/mm2)	
		7days	28days
1	Convectional	12.4	18.32
2	7.5+20	13.51	20.18

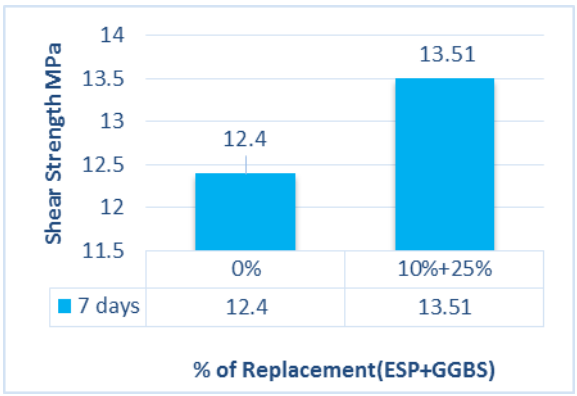

Fig 9: comparison of Shear Strength vs with conventional concrete at 7 days

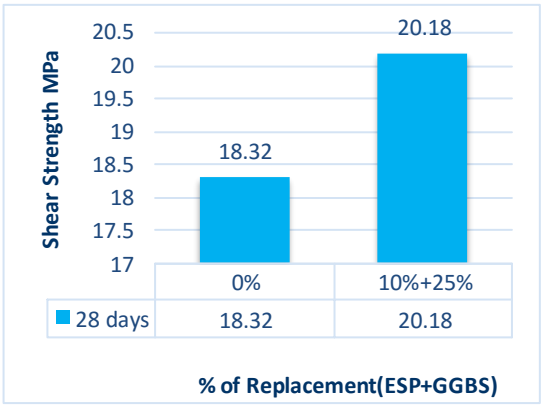

Fig 10: comparison of Shear Strength With conventional concrete at 28 days

4 CONCLUSIONS

The compressive strength of conventional concrete3 is 23.22Mpa at 7 days, whereas compressive strength 0f partially replaced cement by an amount of 10% ESP and 25% of GGBS at 7 days found to be 25.47 Mpa. Also it is found that the compressive1 strength1 of partially replaced concrete 1 have 8.83 % ehigher1 strength than1 the conventional concrete respectively

The Compressive strength of conventional concrete is 37.53Mpa at 28 days, whereas compressive strength of partially replaced cement by an amount of 10% ESP and 25% of GGBS at 28 days found to be 40.15 Mpa. Also it, is found that the 1compressive 2strength of partially replaced concrete have 6.52% ehigher1 strength than1 the conventional concrete respectively

The Splits Tensile strength of conventional concretes is 1.95 Mpa at 7 days, whereas Split Tensile strength of partially replaced cement by an amount of 10% ESP and 25% of GGBS at 3 days found to be 2.14 Mpa. Also it is founds1 that the Splits1 Tensiles1 strength of partially replaced concrete has 8.87% highers1 strength than1 the conventional concrete respectively.

The Split Tensile strength of conventional concretes is 23.01 Mpa at 28days, whereas Split Tensile strength of partially replaced cement by an amount of 10% ESP and 25% of GGBS at 28 days found to be 3.20 Mpa. Also it is founds that the Split Tensiles strength of partially replaced concrete has 5.93 % higher strength than the conventional concrete respectively.

The shear strength of conventional concrete is 12.40 Mpa at 7 days, whereas shear strength of partially replaced cement by an amount of 10% ESP and 25% of GGBS at 7 days found to be 13.51 Mpa. Also it is found that the shear strength of partially replaced concrete have 8.21 % higher strength than the conventional concrete respectively.

The shear strength of conventional concrete is 18.32 Mpa at 28 days, whereas shear strength of partially replaced cement by an amount of 10% ESP and 25% of GGBS at 28 days found to be 20.18 Mpa. Also it is found that the shear strength of partially replaced concrete have 9.21% higher strength than the conventional concrete respectively.

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