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An Experimental study on Partial Replacement of Cement with Egg shell powder and Brick powder in Concrete

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ABSTRACT: In the present scenario, Concrete is the most widely used material in the Construction Industry. Concrete is used in large amounts because it is the only and extremely good building material. Due to rapid growth in construction activities concrete materials becomes scarcity such as cement. To minimize the use and consumption of cement there is a need to find alternative, appropriate and operative unused product. The main aim of this study is to determine the feasibility of cement with Egg shell powder and Brick powder by using different curing techniques. The cement is partially replaced with egg shell powder of 0%, 2.5%, 5%, 7.5%, 10% and brick powder of 0%, 5%, 10%, 15% by weight of cement. The curing is done at the age of 7, 28 days using different curing techniques such as Water curing, Moist sand curing, Membrane (Bee wax) curing and Wet curing. In this direction, the test results of Compressive strength, Split tensile strength and workability are evaluated and compared with Conventional concrete.

Keywords: Egg shell powder, Brick powder, Water curing, Moist sand curing, Wet curing, Membrane curing, Compressive strength, Split tensile strength, Workability.

I. INTRODUCTION

Concrete is the most widely used composite material today. The main reason behind using concrete is due to its high strength, durability and workability. The construction projects like Highways, Airports, Nuclear plants, Bridges, Dams etc. in India is increasing year after year. Such developmental activities consume large quantity of precious natural resources. The constituents of concrete are coarse aggregate, fine aggregate, binding materials and water. Rapid increase in construction activities leads to acute shortage of conventional materials. This leads not only faster depletion of natural resources but also increase the cost of construction of structures. In this view people started searching for suitable other viable alternative materials which could be used either as an additive or partial replacement to the conventional ingredients of concrete so that the existing natural resources could be saved to the positive extent, and could be made available for the future generation. Different industrial waste materials such as fly ash, blast furnace slag, quarry dust, tile waste, brick powder, broken glass waste, waste aggregate from demolition of structure, ceramic tiles, electronic waste of discarded old computers, TVs refrigerators, radios, waste paper mill pulp, iron filling, waste coconut, rice husk, marble aggregate, dust powder,machine crushed animal bones, chicken feather, egg shell, granite quarry sludge, palm oil fuel ash, copper dust, human hair etc. have been tried as a viable substitute to the conventional materials in concrete.

India is in fifth position in the world annual egg production. About 1.61 million tons of egg shells are being waste annually by disposing it as a landfill, which attracts vermin due to attached membrane and causes problems to human health and environment. It scientifically known that the eggshell is mainly composed of compounds of calcium. Calcium carbonate (CaCO3) is the major composition of the eggshell, accounting for 93.7% of the total composition of the eggshell. Similarly, calcium carbonate (CaCO3) is the primary raw material in the production of cement. The produced OPC is composed of four main Calcium compounds in the forms of dicalcium silicates (C2S), tricalcium silicate (C3S), tricalcium aluminate (C3A) and tetracalcium aluminoferrite (C4AF). It is therefore, indicated that cement and eggshells have the same primary composition in the calcium compounds. Calcium rich eggshell is a poultry waste with chemical composition nearly same as that of limestone. Use of eggshell waste instead of natural lime to replace cement in concrete can have benefits like minimizing use of cement, conserving natural lime and utilizing waste

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material.

In India, brick kiln industries are the third largest industries. Brick powder is a lavish material which generates as waste in brick kilns and construction sites. Secondary cementing materials like Brick Powder can be used to partially replace cement because of pozzolanic nature. Bricks are made up of different types of clays and other materials like sand. Clay composed of Alumina, Silica and other carbonates and oxides. Clay is responsible for the pozzolanic behavior of brick. Clay itself has no pozzolanic properties but when fired together with lime during brick making process it gains pozzolanic nature. The usage of brick powder in partial replacement of cement reduces the cost, consumption and increase eco-friendly.

All concrete requires curing in order that cement hydration can proceed so as to allow for development of strength, durability and other mechanical characteristics. To obtain good concrete, the placing of an appropriate mix must be followed by curing in a suitable environment, especially during the early stages of hardening. A number of curing techniques can be applied depending on various factors considered on site or due to the construction method. They range from the most popular water-submerged curing to moist sand, water-spray curing, polythene membrane sealing and steam curing (autoclaving). Also, there has been the introduction of membrane-forming curing agents/compounds which are widely accepted in developed nations because they can be applied quicker than sheets and require least amount of curing protection. They work by sealing the surface of the concrete but do not prevent complete evaporation of mix water. This study seeks to assess the effect of different curing methods on the compressive strength of concrete and to determine method(s) that is/are unsuitable which may impair the quality of the concrete.

The materials are proportioned by their weights. The tests are conducted as per the specified procedure of Indian Standard Codes. The obtained results are compared with that of conventional mix.

II. EARLIER RESEARCHES

Archa .A(2019) has conducted research on partial replacement of cement with brick powder and egg shell powder in concrete. In this research the cement is partially replaced with brick powder and egg shell powder of 0%,2.5%,5%,7.5% and 10% by weight of cement in concrete. The performance of conventional concrete and partially replaced concrete is compared. The Mechanical properties such as Compressive strength, Split Tensile strength and workability are determined. The results showed that the compressive strength increased upto 15% and the split tensile strength increased upto 10%.

Akeem Ayinde Raheem (2013) has researched on effect of curing methods on density and compressive strength of concrete. This study considered the effect of different methods of curing on density and compressive strength of concrete. Concrete cube specimens of mix 1:2:4 were prepared with water-cement ratio of 0.65. The cubes were cured using six methods (air curing, water-submerged curing, spray curing, polythene curing, moist sand curing and burlap curing) until testing ages of 3, 7, 14, 21 and 28 days when their densities and compressive strengths were determined. The results showed that densities of the specimens ranged from 2432.59 to 2502.72 Kg/m^3. Also, moist sand curing method produced concrete specimens with the highest 28-day compressive strength of 30.5N/mm^2 . Air curing method showed a 15% reduction in strength after 21-days thereby resulting in the lowest 28-day compressive strength of 17.8 N/mm^2. It was concluded that there exists a weak positive correlation between density and compressive strength of concrete specimens.

III. METHODOLGY

MATERIALS USED:

1.Egg shell powder (ESP): Calcium rich eggshell is a poultry waste with chemical composition nearly same as that of lime of egg shell waste instead of natural lime to replace cement in concrete can have benefits like minimizing use of cement conserving natural lime and utilizing waste material. Broken egg shells are collected from local poultry sources and are cleaned, dried and grind to fine powder .This powder is sieved through 90 micron sieve and used. The physical properties and chemical composition of Egg shell powder are tabulated in the below table: 1 and table: 2.

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Table: 1 Physical properties of Egg shell powder

S.No	Properties	Value
1.	Specific gravity	2.71
2.	Fineness of ESP	2.5%

Table:2 Chemical Composition of Egg shell powder

S.no	Chemical Composition	Results
1.	Calcium oxide (CaO)	52.15
2.	Magnesium oxide (MgO)	0.60
3.	Silicon dioxide (SiO2)	1.22
4.	Aluminum oxide(Al2O3)	0.28
5.	Ferric oxide(Fe2O3)	0.16
6.	Chloride(Cl)	0.011

2.Brick Powder : The waste brick powder is collected from the demolished buildings and compound walls and broken them into pieces and made as powder. This powder is then sieved using 90 micron sieve and used in cement replacement. . The physical properties and chemical composition of Brick powder are tabulated in the below table: 3 and table : 4.

Table:3 Physical properties of Brick powder

S. No	Properties	Value
1.	Color	Red
2.	Specific gravity	2.6
3.	Fineness	7%

Table:4 Chemical composition of Brick Powder

S .No	Chemical Composition	Results
1.	Silicon dioxide(SiO2)	62
2.	Aluminumdioxide (Al2O3)	36
3.	Ferric oxide (Fe2O3)	2.2

3. Cement: Cement is the individual unit of fine and coarse aggregate into a solid mass by virtue of its inherent properties of setting or hardening in combination with water. In this Ordinary Portland cement of Grade 53, which is known for its rich quality and high durability is used.

4. Coarse Aggregate: The Coarse aggregates passing through 25mm sieve and retained on 20mm sieve was used for the experiment.

5. Fine Aggregate: M-Sand passing through 4.75mm sieve was used for the experiment.

6. Water: Water is the key ingredient, which when

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mixed with cement forms a paste that binds the aggregate together. The water needs to be pure in order to prevent side reactions from occurring which may weaken the concrete.

MIX PROPORTION:

In this present study, an attempt has been made to study the hardened properties of M25grade concrete. The cement is partially replaced with egg shell powder of 0%, 2.5%, 5%, 7.5%, 10% and brick powder of 0%, 5%, 10%, 15% to the total weight Cement.

(A) Design stipulations for proportioning

- Grade designation : M25
- Type of cement : OPC 53 grade
- Minimumcementcontent:300kg/ m3
- Maximum W/C ratio : 0.5
- Workability:25mm (slump)
- Exposure condition : Mild
- Degree of supervision : Good
- Type of aggregate: Crushed angular aggregate
- Chemical admixture : Not used

(B) Test data for materials
a) Cement used : OPC 43 grade
b) Specific gravity of cement : 3.12
c) Specific gravity of
Coarse aggregate : 2.78
Fine aggregate : 2.69
d) Water absorption
Coarse aggregate : 0.59%
Fine aggregate : 1.4%
e) Free (surface) moisture
Coarse aggregate : Nil
Fine aggregate : Nil
f) Sieve analysis
CA : Conforming to Table 2 of IS: 383
FA: Conforming to Zone I of IS: 383
(C) Target strength for mix proportioning
f'ck = fck + 1.65 s
Where, f'ck = Target average compressive strength at 28 days
fck = Characteristic compressive strength at 28 days
s= Standard deviation, s = 4 N/mm2
Therefore, target strength = 25 + 1.65 x 4 = 31.6 N/mm2
(D) Selection of water cement ratio
From Table 5 of IS: 456-2000, maximum water cement ratio = 0.5
Based on experience adopt water cement ratio as 0.48 < 0.5, hence ok .
(E) Selection of water content
Maximum water content = 186litres (for 25mm – 50mm slump range) for 20 mm aggregates
(F) Calculation of cement content
Water cement ratio = 0.48
Cement content=186/0.48=387.5kg/m3>300 kg/m3
From Table 5 of IS: 456,
Minimum cement content for mild exposure condition = 300kg/m3 Hence OK
(G) Proportion of volume of coarse aggregate and fine aggregate content Volume of coarse aggregate corresponding to 20 mm size aggregate and fine aggregate (Zone I) for water-cement ratio of 0.5= 0.62 In the present case w/c ratio is 0.42. That is, it is less by 0.02 as the water cement is reduced, it is desirable to increase the coarse aggregate proportion to reduce the fine aggregate content. The coarse aggregate is increased at the rate of 0.01 for every decrease in water cement ratio 0.05.
Increase in CA= (0.01/0.05)×0.02=0.004
Corrected Volume of coarse aggregate = 0.624.
Volume of fine aggregate = 1-0.624 = 0.376.
(H) Mix Proportion
Cement = 387.5 kg/m³
Water = 186 litres
Fine aggregate = 698 kg/m³
Coarse aggregate = 1253 kg/m³
Water-cement ratio = 0.48
Obtained Mix proportion = 1 : 1.8 : 3.2 4 **MIXING** :The concretes were mixed in machine. Firstly, coarse aggregates and fine aggregates were dry mixed. Then cement, brick powder and egg shell powder were added to the dry mix and mixed together. Water was poured into the mixer drum and thoroughly mixed until a mix of uniform color is obtained.

CASTING: The cubes were casted in steel moulds of inner dimensions 150 x 150 x 150mm and the cylinders were casted in steel cylinders of 150mm diameter and 300mm height.

CURING: The test specimens are stored in a place free from vibration in moist air of at least 90% relative humidity and at a temperature of 27^0 C for 24 hours from the time of addition of water to the dry ingredients. After this period, the specimens are marked and removed from the moulds.

The curing methods are applied to the conventional concrete and the optimum mix concrete at the age of 7, 28 days. Hence the test results are compared.

1.Water curing: This involved the submersion of concrete cube specimens in water. The water or solution, in which the specimens are submerged, are renewed every seven days and are maintained at a temperature of 27^0C. The specimens are not allowed to become dry at any time until they have been tested.

2. Moist sand curing: This involved burying of the entire concrete cube specimens in wet sand which

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was kept moist by wetting with water on a daily basis.

3. Wet curing: This involved covering of the concrete cube specimens underneath gunny bags which are kept wet periodically.

4. Membrane curing: This involved of applying the layer of melted wax on the concrete cube specimens.

IV. OBSERVATIONS AND RESULTS

Table 5: Strength properties for Nominal Mix

S. No	Compressive strength N/mm^2		Split tensile strength N/mm^2	
	7 days	28 days	7 days	28 days
1	19.18	31.86	2.28	3.37
2	19.70	31.79	2.15	3.28
3	19.54	31.95	2.22	3.33
Mean	**19.47**	**31.86**	**2.21**	**3.32**

Table 6 : Strength properties of Egg shell powdered concrete

S. No	% of Egg shell powder	Compressive strength(N/mm^2)		Split Tensile strength N/mm2	
		7 days	28 days	7 days	28 days
1	0	19.47	31.86	2.21	3.32
2	2.5	20.62	32.95	2.32	3.45
3	**5**	**22.22**	**33.71**	**2.44**	**3.56**
4	7.5	21.79	32.62	2.35	3.37
5	10	21.18	31.12	2.28	3.23

Table : 7 Strength properties of Optimum mix concrete

Composition of ESP and BP	Compressive strength N/mm2 7 days	28 days	Split tensile strength N/mm2 7days	28 days
Conventional Concrete	19.47	31.86	2.21	3.32
ESP : 5% BP : 0%	22.22	33.71	2.44	3.56
ESP : 5% BP : 5%	23.12	34.35	2.63	3.64
ESP : 5% BP : 10 %	**24.48**	**36.16**	**3.04**	**4.16**
ESP : 5% BP : 15%	23.73	35.42	2.85	3.72

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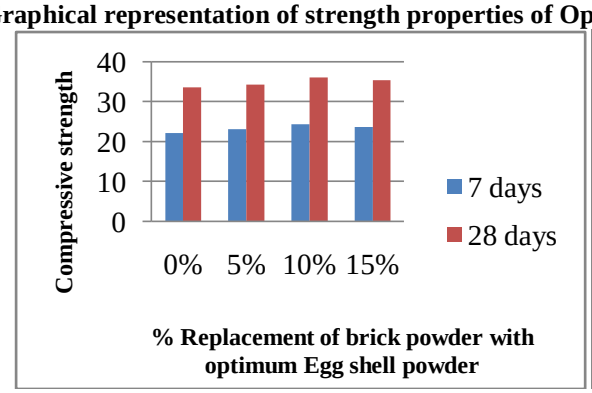
Graphical representation of strength properties of Optimum mix concrete



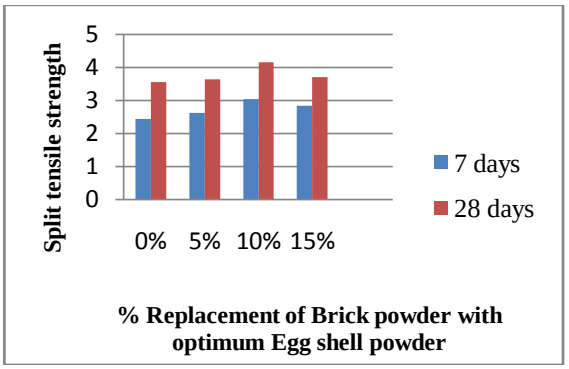
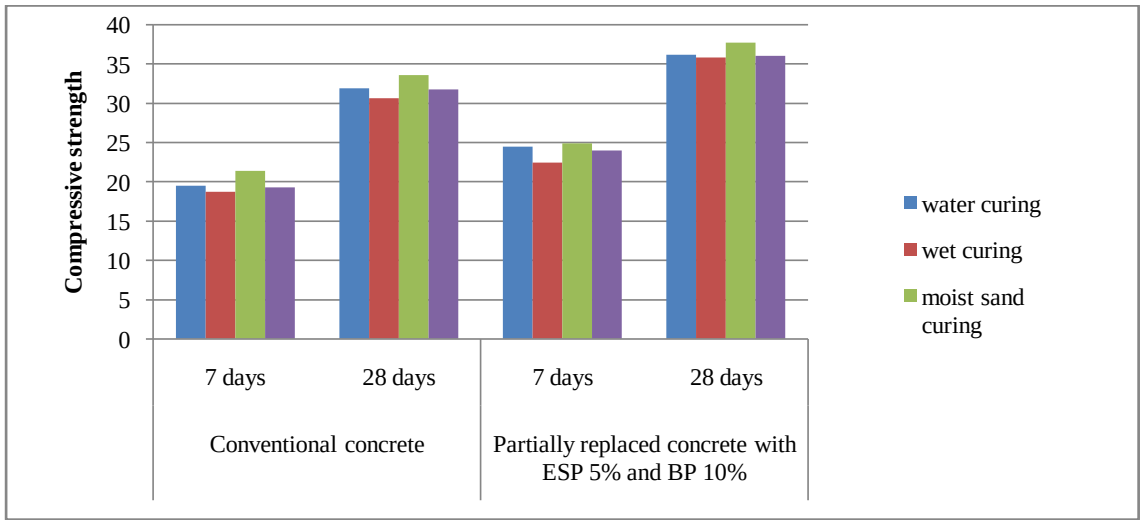


Table : 8 Compressive Strength of conventional concrete vs partially replaced concrete using different curing methods:

Curing methods	**Compressive strength N/mm2**			
	Conventional concrete		Partially replaced concrete with ESP 5% and BP 10%	
	7 days	28 days	7 days	28 days
Water curing	19.47	31.86	24.48	36.16
Wet curing	18.7	30.6	22.4	35.8
Moist sand curing	**21.34**	**33.54**	**24.86**	**37.71**
Membrane curing	19.23	31.7	23.97	36.02



V. CONCLUSIONS

From the experimental study of partial replacement of cement by brick powder and egg shell powder in concrete, following conclusions were obtained.

- The compressive strength of concrete made by partial replacement of cement with 5% egg shell powder and 10% brick powder increases up to 10 percent.
- Compressive strength decreased at 15% replacement, but it is higher than the

conventional concrete at 7 and 28 days

- The split tensile strength increased up to 10% replacement and it is found to be reduced for 15% replacement.
- After the curing of the concrete, it was found that the concrete got a reddish color which increased the aesthetical view of the concrete.
- By using different curing methods shows different compressive strength results. The moist sand curing gives higher compressive strength of 37.71 N/mm^2.

The experimental results have shown that the use of brick powder obtained from the demolished buildings and egg shell powder in the replacement of cement in concrete can provide an alternative solution to minimize the environmental pollution due to unscientific disposal of these wastes. So the replacement of cement with brick powder and egg shell powder using different curing techniques in concrete is really advisable.

REFERENCES

[1]. Bandhavya G.B1,Sandeep K2, Bindhushree G.B3 "An Experimental study on partial replacement of cement with Egg shell powder in concrete" International Research Journal of Engineering and Technology (IRJET).

[2]. Praveen Kumar R, VijaySarathy.R, Jose Ravindraraj.B "Experimental study on partial replacement of cement with Egg shell powder" International Journal of investigation in Engineering and Technology (IJIET).

[3]. Dhanalakshmi M1, DrSowmya N J2, DrChandrashekar A3 "A Comparative Study on Egg shell Concrete with Partial Replacement of Cement by Fly Ash" International Journal for Research in Applied Science & Engineering Technology (IJRASET).

[4]. Aarcha S1 , Ameena Shirin N S2 , Suryalekshmi K S 3 , Thasleema Rasheed 4 , Harindranath S5 "Partial Replacement of Cement with Brick Powder and Egg Shell Powder in Concrete" International Journal of Innovative Research in Science, Engineering and Technology (IJIRSET) Department of Civil Engineering, St Thomas college of Engineering and Technology, Chengannur, Kerala, India.

[5]. Muhammad Nasir Ayaz Khan et.al (2018), Effect of Brick Dust on Strength and Workability of Concrete, IOP Conf.Series : Materials Science and Engineering.

[6]. M. Usha Rani, J.Martina Jenifer "Mechanical Properties of Concrete with Partial Replacement of Portland Cement by Clay Brick Powder" Department of Civil Engineering, R.M.K. Engineering College, Chennai, Tamilnadu, India.

[7]. Obam, Ogah "Effect of curing methods on the Compressive strength of concrete" Department of Civil Engineering, University of Agriculture Makurdi, Nigeria.