Experimental Study on Partial Replacement of Cement with Egg Shell Powder

Praveen Kumar R
Post Graduate Student, Department of Civil Engineering, Prist University, Trichy-Thanjavur Highway,Vallam, Thanjavur - 613 403

Vijaya Sarathy.R
Assistant Professor, Department of Civil Engineering, Prist University, Trichy-Thanjavur Highway,Vallam, Thanjavur - 613 403

Jose Ravindraraj.B
Assistant Professor, Department of Civil Engineering, Prist University, Trichy-Thanjavur Highway, Vallam, Thanjavur- 613 403

Abstract - The Egg shell usually which are disposed, is used as an alternate for the cement since the shell is made up of Calcium. A combination of Egg shell with silica fumes are used in different combinations to find the feasibility of using the Egg shells as an alternate to cement Egg shell powder replaces 10%, 20% and 30% in addition with the silica fume by 5%, 10%, 15% of weight of cement. Concrete is cast and Compressive test, Tensile and Flexural tests were carried out to find the best combination which results in optimum percentage of strength.

I. INTRODUCTION

The aim of this study is to study the chemical composition of the egg shell to find its suitability of replacement in the concrete. To examine the feasibility of utilising the egg shell and silica fume as cement replacement material. To study the strength parameters of the egg shell powder mixed specimens and to compare it with conventional specimens. The scope of the study is to cast the concrete specimens and conduct the compressive strength test, split tensile strength test test and flexural strength test at 7^{th} & 28^{th}day, with the specified combinations of egg shell powder and compare it with the controlled concrete specimens. In this project M30 Concrete is designed for various combinations.

II. LITERATURE REVIEW

Amu et al., (2005) carried out the practical experiment and reported that Egg Shell Powder (ESP) can be used as a supplement for industrial lime on an expansive clay soil and also reported that the combination can be used where high subgrade performance is not necessary. Freire and Holanda (2006) carried out the investigation on egg shell waste and found out its use in a ceramic wall tile paste. Based on the presence of $CaCO_3$ in egg shell it can be used as a alternative raw material in the production of wall tile materials they Also found that egg shell can be used as an excellent alternative for material reuse and waste recycling practices. Lau yih bling (2010) conducted the investigation in egg albumen and reported that foamed concrete were prepared by egg albumen which has reduce the cost and time of project. 1 per cent and 5 per cent egg albumen were used. From the investigation it is concluded that 5 per cent of EAFC consists of unstable compressive strength and higher flexural strength with increase density when compared with control foamed concrete which was 64 per cent and 35 per cent. In this study it is proved that Egg Albumen Foamed Concrete (EAFC) can produce light weight concrete which is more environment friendly and improved properties.

Amu and Salami (2010**)** carried out the experiment and stated that common salt with egg shell on lateritic soil obtaining a good compliment for egg shell as a useful stabilizer for road works. Stabilization obtained by adding 2-10 per cent of common salt with optimum egg shell powder. The result showed that the addition of common salt improved the compaction and CBR characteristics of egg shell stabilized soils. Ngo slew kee (2010) investigated on the topic of "Effect of coconut fiber and egg albumen in mortar for greener environment" and reported he effect of coconut fiber and egg albumen on mortar compressive and flexural strength. 3 types of samples were tested to compare the strength development of each others that was mortar control, mortar containing 0.1 per cent coconut fiber with 1 per cent egg albumen and mortar containing 0.5 per cent coconut fiber with 5percentegg albumen.

The strength of mortar containing 0.1 per cent coconut fiber with 1 per cent egg albumen was higher than the mortar control whereas the mortar containing 0.5 percent coconut fiber ± 5 per cent egg albumen was lower strength than the mortar control. The strength of mortar containing 0.1 per cent coconut fiber with 1 per cent egg albumen was higher than the mortar control whereas the mortar containing 0.5 per cent coconut fiber ± 5 per cent egg albumen was lower strength than the mortar control.

Okonkwo et al., (2012) has concluded in his research that Egg Shell ash can be used as an alternate for cement which resulted in higher compressive strength on lateritic soil. Constant Cement of 6 and 8 per cent added with the egg ash powder of 0-10 per cent at 2 per cent intervals shows increase in 35 per cent of compressive strength but fell short of the strength requirements the durability. Ultimately they found that soil-cement egg shell mixture can be used for road pavements. Arash Barazesh et al., (2012) carried out the experiment on the effect of eggshell powder on plasticity index in clay and expansive soils and reported that plasticity index of the soil can be improved by adding egg shell wastes with the clay soil and can be used in construction projects including earth canals and earth dams.

III. MATERIALS

Locally available opc cement of grade 53 was used in this work, table 1 shows composition of cement. Coarse aggregate and fine aggregate and water were used from local source..the specific gravity of fine aggregate and coarse aggregate was found to be 2.65 and 2.7 respectively.
Egg shells from local hotels were collected, the weight of each egg shell produces 1 teaspoon of Egg Shell Powder approximately and normally it weighs 5 grams.Table 2 shows composition of egg shell and table 3 shows chemical composition of silica fume.

The grinded egg shells were sieved through the 90 micron sieve size and then packed to use it in the cement replacement.

MIX PROPORTION

IS Method was used for mix design and finally for M30 Grade of concrete the mix was 1: 1.87:3.37

TABLE 1
COMPOSITION OF OPC 53

S. NO	OXIDE CONTENTS	PERCENTAGE (%)
1	CaO	50.7
2	SiO_2	0.09
3	Al_2O_3	0.03
4	MgO	0.01
5	Fe_2O_3	0.02
6	Na_2O	0.19
7	P_2O_5	0.24
8	SrO	0.13
9	NiO	0.001
10	SO_3	0.57
11	Cl	0.219

Since the Egg shell is having a very low silica content, Silica fume is added as an admixture with the Concrete to provide the necessary strength and the addition will increase the durability of concrete in the Chlorine Environment.

TABLE 2

COMPOSITION OF EGG SHELL

S. NO	OXIDE CONTENTS	PERCENTAGE (%)
1	CaO	60-67
2	SiO_2	17-25
3	Al_2O_3	3-8
4	Fe_2O_3	0.5-6.0
5	MgO	0.1-4.0
6	K_2O, Na_2O	0.4-1.3
7	SO_3	1.3-3.0

TABLE 3

CHEMICAL COMPOSITION OF

SILICA FUME

S. NO	OXIDE CONTENT	PERCENTAGE (%)
1	SiO_2	90.21
2	CaO	0.30
3	Fe_2O_3	0.15
4	Al_2O_3	0.12
5	MgO	0.73
6	SO_3	0.01
7	Na_2O	0.46
8	K_2O	1.51

IV. METHOD OF CAST AND TESTING OF SPECIMENS

Concrete cubes of 150mm X 150mm x 150mm has been cast according to the specifications mentioned in the IS codes : 516 :1959. The Concrete specimens were cast based on the specifications and tested to determine the feasibility of egg shell powder in concrete.

TABLE 4

MIX COMBINATION FOR CASTING OF CONCRETE SPECIMENS

S.No	MIX COMBINATION	CEMENT (%)	ESP (%)	SF (%)
1	C100 E0 S0	100	0	0
2	C90 E10 S0	90	10	0
3	C80 E20 S0	80	20	0
4	C70 E30 S0	70	30	0
5	C85 E10 S5	85	10	5
6	C80 E10S10	80	10	10
7	C75 E10 S15	75	10	15
8	C75 E20 S5	75	20	5

9	C70 E20 S10	70	20	10
10	C65 E20 S15	65	20	15
11	C65 E30 S5	65	30	5
12	C60 E30 S10	60	30	10
13	C55 E30 S15	55	30	15

V. RESULTS

The concrete with the above mentioned ratio are cast into Cubes and Prisms as per IS specifications and the following results has been inferred.

TABLE 5

COMPRESSIVE STRENGTH OF CONCRETE CUBES.

S.NO	MIX COBINATION	7^{TH} DAY (N/mm^2)	28^{TH} DAY (N/mm^2)
1	CONTROL	17.15	31.52
2	E5 S0	18.01	35.21
3	E10 S0	17.83	34.45
4	E15 S0	17.61	31.50
5	E5 S2.5	18.78	34.46
6	E5 S5	18.15	34.11
7	E5 S7.5	17.21	32.90
8	E10 S2.5	18.23	33.92
9	E10 S5	17.48	33.81
10	E10 S7.5	17.02	31.94
11	E15 S2.5	17.53	31.40
12	E15 S5	17.40	31.22
13	E15 S7.5	16.02	29.55

FIGURE 1

COMPRESSIVE TEST AT 7^{TH} DAY

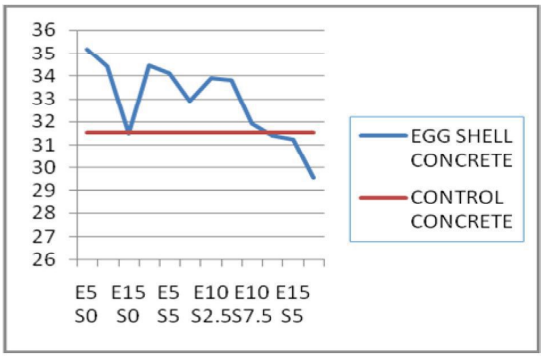
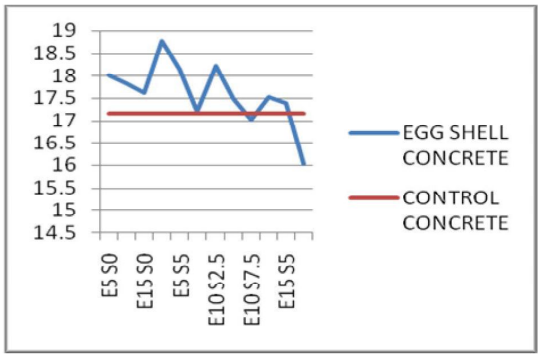


FIGURE 2

COMPRESSIVE TEST AT 28TH DAY



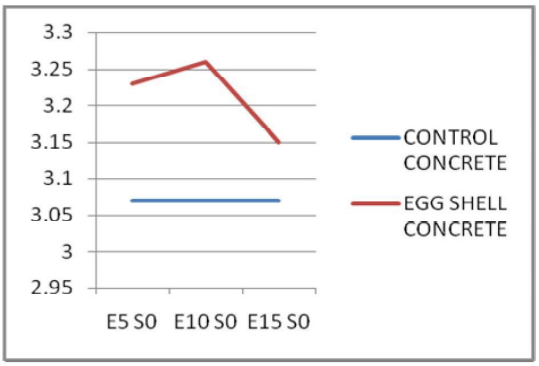
VI. FLEXURAL STRENGTH TEST RESULT

The prisms of size 150 mm in cross section length and 300mm in longitudinal length are cast are used for to test the Flexure Strength of the Concrete as per the specifications of IS 516:1959

TABLE 6
FLEXURAL STRENGTH TEST OF BEAM SPECIMENS

S.NO	MIX COMBINATION	7^{TH} DAY (N/mm^2)	28^{TH} DAY (N/mm^2)
1	CONTROL	3.07	4.48
2	E5 S0	3.23	4.78
3	E10 S0	3.26	4.65
4	E15 S0	3.15	4.55

FIGURE 3FLEXURAL TEST AT 7^{TH} DAY



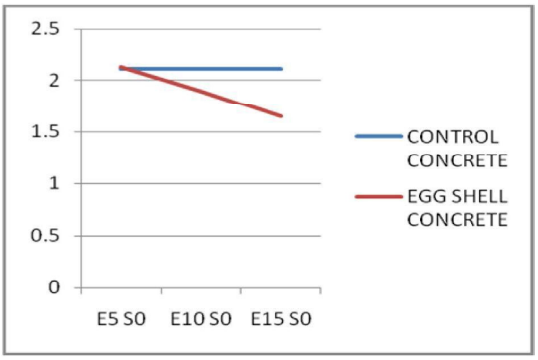


FIGURE 4 FLEXURAL TEST AT 28TH DAY

VII. SPLIT TENSILE STRENGTH TEST RESULT

Cylindrical prisms of 150mm diameter and 300mm in length are cast to determine the Split tensile Strength of the designed mix.

TABLE 7

SPLIT TENSILE STRENGTH TEST OF CYLINDER SPECIMENS

S.NO	MIX COMBINATION	7TH DAY (N/mm2)	28TH DAY (N/mm2)
1	CONTROL	2.108	3.137
2	E5 S0	2.120	3.230
3	E10 S0	1.89	2.560
4	E15 S0	1.65	2.310

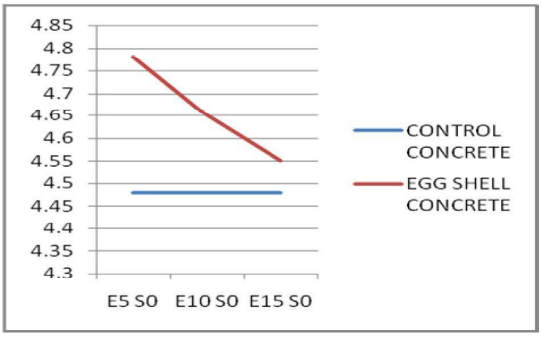


FIGURE 5

SPLIT TENSILE TEST AT 7TH DAY

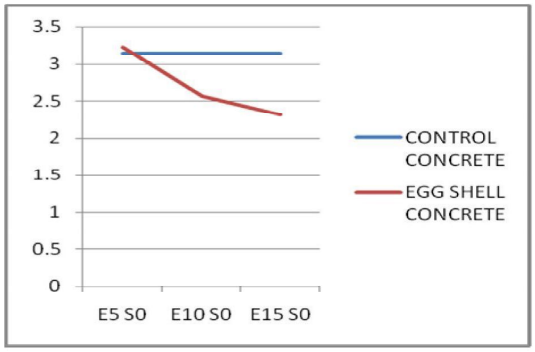


FIGURE 6

SPLIT TENSILE TEST AT 28TH DAY

From the above results it has been conclude that the Egg shell concrete at lower percentage provides maximum strength in compression and Flexural and moreover the Loss of strength in the Split tensile can be overcomes by providing the Reinforecement.

VIII. CONCLUSION

Extensive experimentation has been carried out to determine utilization of the egg shell powder as cement replacement material by making the cement mortar and concrete. Also to find out the effect of addition of silica fume with the cement. Based on the results obtained from the experimental work the following conclusions can be drawn

- The concrete compressive strength with egg shell powder as cement replacement material increases up to 15 percent without silica fume.
- Addition of silica fume also enhances the strength but in economical point of view only the egg shell powder replacement is sufficient enough for getting higher strength.
- The split tensile strength of the egg shell powder concrete decreases with the addition of egg shell powder. This can be increased if the concrete is used with reinforcement.
- The flexural strength of the egg shell concrete increases with the addition of egg shell powder upto 15 percent.

From the experimental work result it is clear that egg shell powder alone can be replaced as cement which increases the strength parameters meanwhile reduces the cement usage.

REFERENCES

[1] Bureau of Indian Standards, IS 10262 : 2009, Concrete Mix Proportioning-Guidelines.
[2] Bureau of Indian Standards, IS 12269 : 1987, "OPC-53 Grade Cement.
[3] Bureau of Indian Standards, IS 4031 : 1968,For Determining the properties of Cement.
[4] Gary D. Butcher and Richard D. Miles;(1995) 'Factor causing Poor pigmentation of Brown shelled Eggs' University of Florida, Originally published 1995 reviewed on April 2004.
[5] Amu O.O., Fajobi A.B., and Oke B.O., (2005), Effect of Eggshell Powder on the Stabilizing Potential of Lime on an Expansive Clay Soil, Research Journal of Agriculture and Biological Science , Vol. 1, pp. 80-84.
[6] Amu, O.O., & Salami,B.A..(2010), Effect of common salt on some Engineering Properties of Eggshell stabilized lateritic soil, ARPN, Journal and Applied Sciences 5, pp 64-73.
[7] Lau Yih Bing,(2010) Effect of Foamed Concrete with Albumen Concrete, University of Malaysia, Pahang, Institution open access Journal.
[8] Beaudoin J.J., and Feldman R. F., (1979), Partial replacement of cement by fly ash in autoclaved products theory and practice, International Journal of material science Vol. 14, pp. 1681-1693.
[9] Ngo slew kee (2010), Effect of Coconut fibre and Egg albumen in mortar for greener Environment, University of Malaysia, Pahang, Institution open access Journal
[10] Chinnaraju.K., Subramanian.K., and Senthil kumar S.R.R., (2010), Strength properties of HPC using binary, ternary and quaternary cementitious blends structural concrete, Thomas Telford , pp. 1464-4177
[11] Freire M.N., and *Holanda J. N. F., (*2006), Characterization of avian eggshell waste aiming its use in a ceramic wall tile paste, Journal of Ceramica, Vol. 52, pp. 240-244.
[12] Arash Barazesh, Hamidreza sab, Mehdi Gharib and Moustafa Yousefi Rad, Laboratory Investigation of the Efffect of Eggshell powder on Plasticity Index in Clay and Expansice soils, European Journal of Experimentl Biology, pp 2378-2384, 2012.
[13] Kévin Beck, Xavier Brunetaud, Jean-Didier Mertz and Muzahim Al-Mukhtar, (2010), On the use of eggshell lime and tuffeau powder to formulate an appropriate mortar for restoration purposes, Geological Society, London, Special Publications Vol. 331, pp. 137-145.

[14] Okonkwo U. N., Odiong I.C., and Akpabio, E. E. (2012), Effects of egg shell ash on strength properties of cement-stabilized lateritic, International Journal of Sustainable Construction Engineering & Technology Vol. 3.
[15] Shetty M.S.,Concrete Technology and Practice, sixth edition, S.Chand and company limited.