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An experimental investigation of eggshell concrete

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ABSTRACT

Reduce and Reuse of the alternative materials is much important to sustain our energy resources. In the field of construction, the use of admixtures and re-utilization of available wastage materials is not a new one. But this article is deals with a study of Egg Shell Powder as a partial replacement of cement in concrete to make two advantages, to improve the strength as well as to reuse & reduce the egg shell wastage. Because the egg shell wastage is huge in our country around 2Lakh Tonnes per year. The various characteristics of ESP are examined and it is allowed to concrete as a partial replacement of cement. The various proportions such as 2.5, 5, and 7.5% are tried in this investigation and the strength achieved by ESP concrete is much better than a nominal concrete. Every admixture has its own strength in their dosage level, likewise there was a sharp decrease in the strength when the proportion of ESP is beyond the level of 5%.

KEY WORDS: eggshell, concrete, investigation.

1. INTRODUCTION

In 2004 ASTM International is allowed incorporation of up to a 5 % mass fraction of limestone in ordinary Portland cement. Hawkins (2003) reported that use of up to 5 % limestone does not affect performance of Portland cement. Furthermore, Bentz (2009) reported that higher limestone percentage can also be used in concrete at lower w/c ratios. Limestone powder substitution for cement makes sense in concretes saving money and energy and reducing carbon dioxide emissions. However, as limestone is a natural mineral resource, quarrying and consequent prolonged use of limestone may again lead to problems associated with environment and sustainable development. Furthermore, lime production involves energy intensive process and consumes water. Therefore, identifying analogous material from waste and using the same in concrete production could be a wise idea. Calcium rich egg shell 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 material. According to a study eggshell waste generation in India, the United States and the United Kingdom is 190000, 150000 and 11000 tons per annum respectively.

1.1. The main objectives of this study are: To experimentally investigate the suitability of Egg Shell waste powder as a substitute material for partial replacement of cement. To find a new source of binding material for concrete. To effectively utilize industrial waste in concrete without affecting its quality. To prevent the environmental hazards due to dumping of egg shell waste. To manage and improve our environment by reducing and reusing the waste materials optionally.

1.2. Egg Shell Powder (ESP): Egg shell powder is meant by the formation cruse the egg shell. It contain the large no of chemical element for ca, si, k.if the specific gravity of ESP is 2.14, the egg shell has been crushed at micron level. The shell itself is about 95% CaCO3 (which is also the main ingredient in sea shells). The Remaining 5% includes Magnesium, Aluminum, Phosphorous, Sodium, Potassium, Zinc, Iron, Copper, Ironic acid and Silica acid.

1.3. Physical and chemical analysis: Particle size allocation of OPC, Egg shell powder was decided. Physical properties such as specific gravity, bulk density, and fineness of OPC (IS 8122-1985), Egg shell powder were calculated. Specific surface area of OPC and ESP were calculated as per IS 4031 (part 2)-1995 by means of Blain's air permeability tool. The physical properties of OPC, ESP are contrasted in Table 1 Chemical examination for oxide composition of OPC (IS 4032-1985) and Egg shell powder was calculated. Chemical composition data for OPC and all composite material are contrasted in Table.

1.4. Mix Design for M40 Concrete using IS method: Water: cement: F.A.: C.A. = 0.4: 1: 1.65: 2.92, Considering 20 mm: 10mm = 0.6: 0.4, Mix details per m^3 are summarized below:
Cement =400 kg, Water =160 kg, Fine aggregate = 660kg, Coarse aggregate 20 mm = 701 kg, Coarse aggregate 10 mm = 467 kg, Admixture = 0.6 % by weight of cement = 2.4 kg, ESP = 900 gm.

Fig.1.Egg shell powder

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%
Specific gravity	3.12	2.14

Table.1.Chemical properties of cement & ESP

Table.2.Physical properties of fine aggregate and coarse aggregate

Description	Fine aggregate	Coarse aggregate
Fineness modulus	2.369	6
Water absorption	0.51%	0.3%
Specific gravity	2.63	2.68

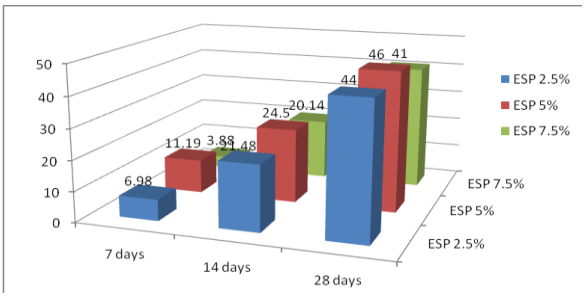

Figure.2. ESP comparision chart

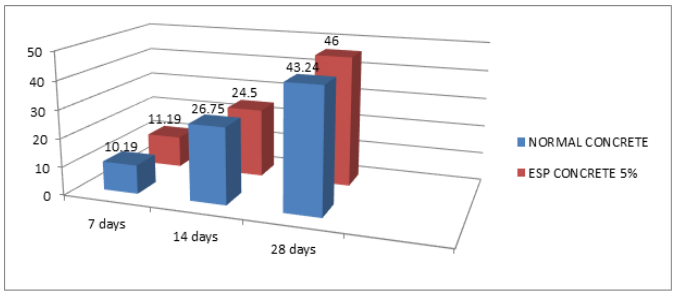

Fig.3.Nominal Concrete Vs ESP concrete

Table.3. Cube casting and testing

Curing Periods	Compressive Strength (N/mm²)		
	ESP. 2.5%	ESP. 5%	ESP. 7.5%
7days	6.98	11.19	3.88
14days	21.48	24.50	20.14
28days	44	46	41

CONCLUSION

Recycling and reusing of egg shell was achieved. The recirculation of egg shell was successfully implemented in the construction work. The wastage was minimized much and it converted to a construction material as a partial replacement of cement in concrete. The properties like water absorption and other strength are found to be good. Thus the behavior of egg shell concrete was investigated effectively and compared with nominal concrete.

The ESP gives appreciable result than a nominal concrete.

ESP Concrete=46 N/ mm^2, Nominal Concrete= 43.24 N/mm^2

Thus the environment can manage in a green approach by reducing and reusing the materials.

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