BEHAVIOUR OF CONCRETE CONTAINING EGG SHELL POWDER AS CEMENT REPLACING MATERIAL

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***Abstract*: Throughout the world, concrete is being widely used for the construction of most of the buildings, bridges etc. Hence, it has been properly labeled as the backbone to the infrastructure development of a nation. Development of a nation not only depends upon the technology but also depends upon the infrastructure. Without concrete infrastructure is not possible. Thus concrete is indispensible material in every construction. The major element of concrete is cement. Since cement price is volatile and demand is so high, an alternate material can be used for replacement of cement. Since several replacement experiments were done for coarse and fine aggregate. Hence we go for replacement for cement. The alternate material in our project used was powdered Eggshell. In the present study, these Egg shell Powder is used as a partial replacement of cement and various properties like workability, compressive strength, split tensile strength and flexural strength were determined. Egg shell powder is varied upto 24% (0%, 6%, 12%, 18%, and 24 %) in this research work.**

***Keywords*: Concrete, characterization, eggshell power (ESP), Workability, Egg Shell Powder**

1.0 INTRODUCTION

To meet out this rapid infrastructure development a huge quantity of concrete is required. Concrete is a composite material which has relatively high compressive strength, but significantly lower tensile strength. At present, for a variety of reasons, the concrete construction industry is not sustainable. Firstly, it consumes huge quantities of virgin materials which can remain for next generations. Secondly, the principal binder in concrete is Portland cement, the production of which is a major contributor to greenhouse gas emissions that are implicated in global warming and climate change. Thirdly, many concrete structures suffer from lack of durability which may waste the natural resources. A major component of concrete is cement and it is one of the three primary producers of carbon dioxide, a major greenhouse gas. 900kg of CO2 are emitted for every ton of concrete. As of 2001, the production of Portland cement contributed 7% to global CO2 emission, largely due to the sintering of limestone and clay at 1500°C. The CO2 emission of concrete is directly proportional to the cement content used in the concrete mix. Cement manufacture contributes greenhouse gases both directly through the production of carbon dioxide when calcium carbonate is thermally decomposed, producing lime and carbon dioxide and also through the use of energy, particularly from the combustion of fossil fuels. There is a growing interest in reducing carbon emission related to cement production from both academic and industrial sectors. Recycling of waste components contributes to energy savings in cement production, to conservation of natural resources and to protection of the environment. Hence, currently, the entire construction industry is in search of a suitable and effective waste product that would considerably minimize the use of cement and ultimately reduce the construction cost. On the other hand The price of building materials now a days is very high in different parts of the nation; particularly developing areas like Punjab, Delhi, etc. This high and uncontrolled rising cost can be reduced to minimize by use of different building materials that are cheap, locally available and bring about a reduction in the overall self-weight of the building. Some industrial and other products that would otherwise dump the environment as waste or at best be put into only limited use could gainfully be employed as building material. This paper analyses the material namely; Egg Shell Powder which can be utilized as alternative materials to substitute cement in the building industries, in order to evaluate and affirm the suitability of replacing cement with egg shell powder in concrete Structures.

1.1 EGG SHELL POWDER

Eggshell is generally thrown away as a waste. The egg shell also creates some allergies when kept for a longer time in garbage. Disposal is a problem. It creates undesirable smell which can cause irritation. The chemical composition of Eggshell powder and cement were found to be similar. The main component of eggshell was calcium carbonate (around 51%).Eggshell consists of several mutually growing layers of CaCO3, the innermost layer-maxillary 3 layer grows on the outermost egg membrane and creates the base on which palisade layer constitutes the thickest part of the eggshell. 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. Eggshell has a cellulosic structure and contains amino acids; thus, it is expected to be a good bio-sorbent and it was reported that large amounts of eggshells are produced in some countries, as waste products and disposed in landfills annually. The top layer is a vertical layer covered by the organic cuticle. The eggshell primarily contains calcium, magnesium carbonate (lime) and protein. In many other countries, it is the accepted practice for eggshell to be dried and use as a source of calcium in animal feeds. The quality of lime in eggshell waste is influenced greatly by the extent of exposure to sunlight, raw water and harsh weather conditions. It is the fine grained powder with suitable proportion which is sieved to the

required size before use with concrete/mortar Eggshell waste been evolved from poultry farms, restaurants and hotels. These wastes are used in animal feeds and in many countries they are thrown off. Such waste is collected and implemented in our project.

Table 1.1: Physical Properties of Egg Shell Powder

Name	Physical Properties
Specific Gravity	0.85
Moisture content	1.18
Bulk Density (g/m3)	0.8
Particle Density (g/m3)	1.012
Porosity (%)	22.4 BET
Surface area m2/g	21.2

Figure 1: Egg Shell Powder

2.2 LITERATURE REVIEW

Doh Shu Ing et al studied the Eggshell Powder as Potential Filler in Concrete. In this investigation, five different percentages of eggshell powder with respect to cement were added into the concrete mix of Grade 25. The materials used were mainly Portland cement, crushed sandstone, river sand, plasticizing accelerator and eggshell powder. From the investigation, all the slump results of eggshell concrete were at medium degree of workability ranging from 65-75 mm. Eggshell concrete of 10% achieved the highest compressive strength at 42.82 N/mm2 which is 57% higher than the control specimen. There is an increasing trend of flexural strength from 2.36 to 3.50 N/mm 2 with the increase of eggshell powder from 0 to 20%. Besides that, the eggshell concrete has shown significant reduction in water absorption and water penetration.

K. UMA SHANKAR J et al studied the use of experimental analysis on effective utilization of industrial waste materials of egg shell, GGBS and saw dust ash. The aim of the work is to study the suitability of egg-shell powder, Ground Granulated Blast Furnace slag and saw dust ash as a partial replacement of cement. The chemical compositions of these Industrial wastes taken under study are almost similar to that of Ordinary Portland cement. In this experimental work, egg shell plays a major role, as it is used in all the combination of the concrete cubes. The industrial wastes are grounded to the fineness of cement, and the properties of cement such as initial setting time, final setting time, fineness test, soundness of cement, water absorption, etc. are conducted on the replaced sample. The tests revealed encouraging results for the study. The sample of blended cement consists of 20% of egg shell powder, 50% of GGBS and 10% of Sawdust ash.

Divya B et al investigated on Cement Concrete at Mixed with Egg Shell Powder. In this project eggshell pealed out of boiled eggs. The collected eggshell is washed and heating upto 1800C for 24 hours using hot air oven. After that the eggshell is cooled using designator and grinded eggshell is sieved using 90 micron sieve size. Tap water is used for mixing and curing of concrete specimens. Table 1 shows the properties of materials. The experimental investigation consisted by varying percentage of eggshell powder as partially replaced with ordinary Portland cement 43 grade. The percentage of eggshell was varied by 5%, 10%, 15%, and 20%. The concrete cubes of 150 X 150 X 150 mm cubes were tested. The compressive strength of 7days and 28days strength

was determined. The concrete mix proportion is 1:1.5:3 in which cement is partially replaced with eggshell powder as 5%, 10%, 15%, and 20% by weight of cement. The compressive strength was determined at curing of 7 and 28 days.

BYSANI MYTHILI et al studied on Limited Substitution of EGG Shell Powder with Cement in Concrete. This project reports the results of experiments evaluating the utilization of egg shell powder from egg production trade as partial replacement for standard cement in cement mortar. The chemical composition of the egg shell powder and compressive strength of the cement mortar made up our minds. The cement mortar of combine proportion 1:3 during which cement is part replaced with egg shell powder as 5%, 10%, 15%, 20%, 25%, 30% half-hour by weight of cement.. There was a pointy decrease in compressive strength on the far side five-hitter egg shell powder substitution. Egg shell powder obtained from industrial wastes is superimposed in numerous ratios for cement replacement. The compressive strength made up our minds at hardening ages 28 days the admixtures used are Saw dirt ash, ash and small oxide to reinforce the strength of the concrete combine with 5% egg shell powder as partial replacement for cement and it had been found that replacement of 5 % Egg shell powder + 22 % of Micro silica are often superimposed with none reduction in compressive strength properties of typical cement.

Mohamed Ansari M et al studied the Replacement of Cement using Eggshell Powder. The paper describes the effect and experimental result of replacement of eggshell powder in cement. The compressive test was carried out for concrete replaced with 10%, 15% and 20% of eggshell powder in Portland Pozzolona cement. The compressive strength were tested for concrete cubes of dimension 150 x 150 x 150 mm. The test was carried in compressive test machine of capacity 100KN. In compressive strength test the loading rate was 50KN/s. The compressive test was conducted on 150mm cube specimens at 7thday and also to be done on 28th day. The results which came after carrying out all tests found successful which indicates that eggshell powder can be used as a replacement material for cement. From the results it is proved that replacement of eggshell powder if about 10 % to 15 % is effective and when we increasing further the percentage of eggshell powder decrease the compressive strength.

3.0 EXPERIMENTAL WORK

3.1 GENERAL

The purpose of this research is to identify the factors that contribute to strength gain in ESP concrete specimen. This section summarizes design mix of concrete

3.2 MATERIALS USED

- Cement
- Sand
- Coarse aggregates
- Egg shell powder
- Plasticizers
- Water

3.3 PREPARATION OF MIX SAMPLES

The mix proportioning for M20 grade concrete utilized in the current work. It's designed as per IS 10262-1982 standards. The combination proportioning adopted was cement: sand: coarse aggregate: water/cement quantitative relation severally. Mix proportion used in this study was 1:1.72:2.83 (M 25) conforming to IS 10262-2009 with water-cement ratio of 0.4 and Superplasticizer of 0.75%. The experimental investigation consisted by varying percentage of eggshell powder as partially replaced with ordinary Portland cement 43 grade. The percentage of eggshell was varied by 6 %, 12 %, 18 %, and 24 %. The concrete cubes of 150 X 150 X 150 mm cubes were tested. The compressive strength of 7days and 28days strength was determined.

Table 1: Mix Proportion of Concrete cubes

Designation	Mix	Water (kg/m^3)	Cement (kg/m^3)	Type	Weight of Egg Shell Powder (kg/m^3)	Fine Agg. (Sand) (kg/m^3)	Coarse Agg (kg/m^3)
C-0	Control	150	375	-	-	645	1061.25
C-1	6 %	150	352.5	Egg Shell Powder	22.5	645	1061.25
C-2	12 %	150	330	Egg Shell Powder	45	645	1061.25

C-3	18 %	150	307.5	Egg Shell Powder	67.5	645	1061.25
C-4	24 %	150	285	Egg Shell Powder	90	645	1061.25

4.0 RESULT & DISCUSSION

In this Section the analysis of the results of the different tests Compressive and split tensile strength test on the egg shell powder concrete sample is done.

COMPRESSIVE STRENGTH TEST

Compressive strength of the specimen shall be calculated by dividing the maximum compressive load taken by the specimen by its cross-sectional area. The compressive strength of concrete is one of the most important properties of concrete. Concrete specimens of 150 x 150 x 150 mm cubes were cast with different proportions of concrete.

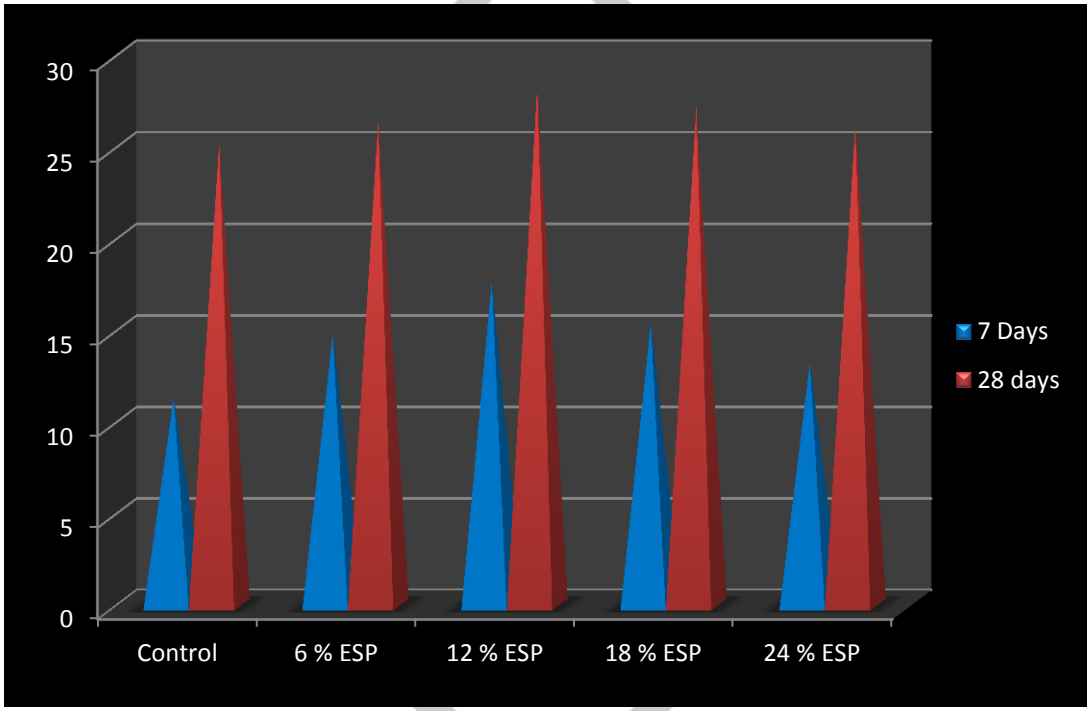

Figure 2: Compressive strength of Various Mixes

SPLIT TENSILE STRENGTH TEST

After curing of cylinders for respective days it was placed in testing machine having a maximum capacity of 1000 KN. The load is applied on the cylinder specimens. The cylinder specimen was failed at ultimate load which was noted from dial gauge reading.

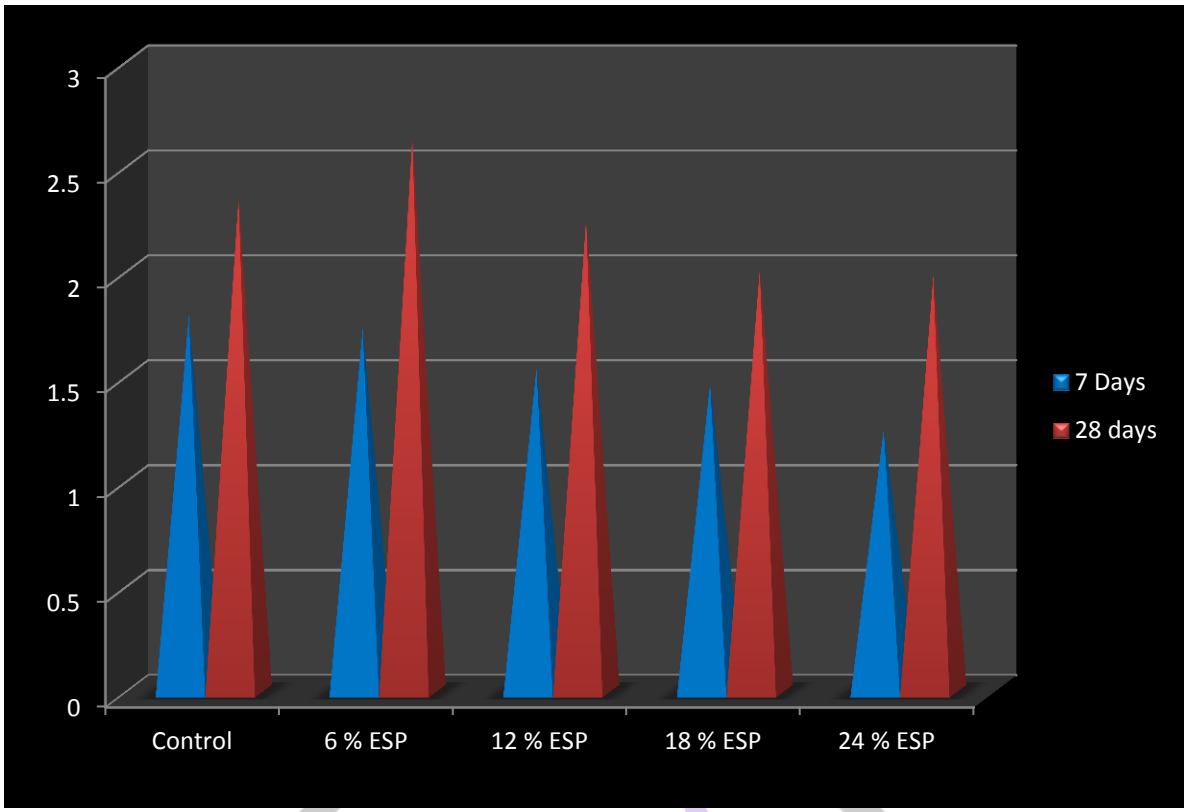

Figure 3: Split Tensile strength of Various Mixes

CONCLUSION

In this study, effect of egg shells on some mechanical and physical properties of concrete was investigated. After the investigation into the effect of eggshell ash on the strength properties of a concrete, the following conclusions were drawn:

1. The workability of concrete is decreased by increasing the amount of Egg shell powder

2. The results demonstrated that, irrespective of ESP percentage replacement there was good relationship between compressive strength and split tensile strength.

3. Optimum Compressive strength is obtained at 12 % replacement of egg shell powder in concrete samples.

4. As the percentage of Egg shell powder increased beyond 6 % in concrete, the split tensile strength is found to be decreased compared to control concrete mix.

5. Optimum flexural strength is obtained at 12 % replacement of egg shell powder in concrete samples.

6. The workability of concrete is decreased by increasing the amount of Egg shell powder

7. The results demonstrated that, irrespective of ESP percentage replacement there was good relationship between compressive strength and split tensile strength.

8. Optimum Compressive strength is obtained at 12 % replacement of egg shell powder in concrete samples.

9. As the percentage of Egg shell powder increased beyond 6 % in concrete, the split tensile strength is found to be decreased compared to control concrete mix.

10. Optimum flexural strength is obtained at 12 % replacement of egg shell powder in concrete samples.

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