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A Study on Partial Replacement of Sand by Egg Shell and Earthenware Aggregate in M-20 Concrete

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Abstract - *This research is on the use of Egg Shell Powder (ESP) and Earthenware Aggregates (EA) as alternate materials, in the formation of concrete mix of grade M 20, which then compared with Standard Concrete of same grade against its Strength.*

In this research Partial replacement of sand is done with egg shell powder at 5% and EA are replaced at 20%, 25% and 30%, 35%, 40% by weight of cement and sand respectively .For this purpose standard concrete of grade M 20 in a design mix proportion was formed and then tested for strength i.e. compressive strength test that result in optimum compressive strength at 7 days and 28 days, and also checked against durability. These test results have been compared with the compressive strength and durability of standard concrete of grade M 20 at 7 days and 28 days respectively.

Key Words: Concrete, Strength, Eggshell Powder, Earthenware, Aggregates.

1. INTRODUCTION

Accumulation of waste material is increasing rapidly because enormous growth in population is providing a source for it and this causes crises to disposal of waste. One solution of this crisis lies in reusing of waste materials in formation of some useful products. The concrete is globally a major construction material which is using in construction of various structures from ancient time to till today and remain sustain in future. Population growth, urbanization, globalization and environmental pollution are some factors which are responsible for social and economic transformation of the society. Environmental pollution causes severe damage to human civilization on the earth and to solve this problem, concept of Green Concrete emerging nowadays.

1.1 Alternate Materials used in Concrete formation

a) Egg Shell Powder (ESP) – The egg shell powder obtained from the waste egg shells of chicken (poultry waste), which throw away in open ground by user. Eggshell waste generation in India, the United States and United Kingdom is, 190000, 150000 and 11000 tones per annum respectively. These egg shells are treated as waste and their accumulation in landfills attracts vermin due to attached membrane and causes environment pollution, indirectly affects the human health.

b) Earthenware Aggregate (EA) - The earthenware aggregates obtained from waste and broken earthen wares. These are made up of terracotta clay, often referred as 'red clay earthenware', when calcined or fired at cone range 4 – 1 (firing temperature range - 1060 – 1154oC). Earthenware is the mixture of clay-silt and sand, by specific fraction. The appropriate composition of raw materials for ceramic products using red clays.

2. Literature review

Soundara, B., P.P. Vilasini (2015) studied on "Effect of egg shell powder on the properties of Clay". In their study, they concluded that, the suitability of Egg shell Powder (ESP) as a possible stabilizing material used to improve the properties of clay. They collected soil samples and stabilized with egg shell powder in properties of 1 % to 10 % of dry weight of soil. It is observed that the addition of ESP has the ability to control the plasticity index of the soil.

Yarramala, A. (2014) conducted a research into "Use of Poultry Waste in Concrete through the development of Concrete incorporating Eggshell Powder (ESP)". Different ESP concretes were developed by replacing 5-15% of ESP for cement. The results indicated that ESP can successfully be used as partial replacement of cement in concrete production. The data presented cover strength development and transport properties. With respect to the results, at 5% ESP replacement the strengths were higher than control concrete and indicate that 5% ESP is an optimum content for maximum strength. In addition, the performance of ESP concretes was comparable up to 10% ESP replacement in terms of transport properties with control concrete. The results further show that addition of fly ash along with ESP is beneficial for improved performance of concretes.

Bediako, M., et al. (2016) has studied on "Early and late characterization of Portland Cement containing Calcined Low Grade Kaolin Clay". They stated by their experiments that heat treated low grade kaolin clays are now considered as a suitable pozzolanic material to Meta kaolin's. However their suitability as a good pozzolanic material depends on geochemistry and structure of clay which is usually influenced by the geographical environment. Influence of calcined material on early and late strength material on the early and late strength development of Portland cement was analyzed. The results showed that the strength enhancement on the optimum mixture was due to the growth of the stable mono sulphate compounds at the octahedral environment resulting from meta stable aluminates phases at the tetrahedral environment. For greater reliability on concrete strength performance, the study recommended the use of 20% calcined clay of Nyamebekyere clay as Portland cement replacement.

Srinivasan, S. R., et al. (2016) reported that the "Use of Clay with Sand as its suitability to replace it in producing conventional concrete". They found that the optimum value obtained for 3 % - 4 % replacement of clay/silt content. The 28 days average compressive strength was observed to increase by about 0.3 % - 27.6 %, split tensile strength by 10.5 % - 30.6 % when compared with control mix. It is also concluded that due to high water absorption rate of clay w-c ratio was increased as replacement percentage increases and compression and tensile strength of concrete was decreases. It was discovered that the higher the clay/silt content, the strength of concrete is decreases..

3. METHODOLOGY

Table 1 Proportion of Egg Shell Powder and Earthenware

S.no.	Sand %	Earthenware %	Egg shell powder	Mass Of F.A	Mass of Earthenware	Mass of Egg shell powder
1	55	40	5	367.82856	284.10912	74.68848
2	60	35	5	401.26752	248.59548	74.68848
3	65	30	5	434.70648	213.08184	74.68848
4	70	25	5	468.14544	177.5682	74.68848
5	75	20	5	501.5844	142.05456	74.68848

4. RESULTS AND DISCUSSION

4.1 SLUMP TEST

Table 2 Slump value

S.No.	Mixes	Earthenware %	Egg shell powder%	Slump(mm)
1	Mix1	20	5	115
2	Mix2	25	5	100
3	Mix3	30	5	85
4	Mix4	35	5	75
5	Mix5	40	5	70

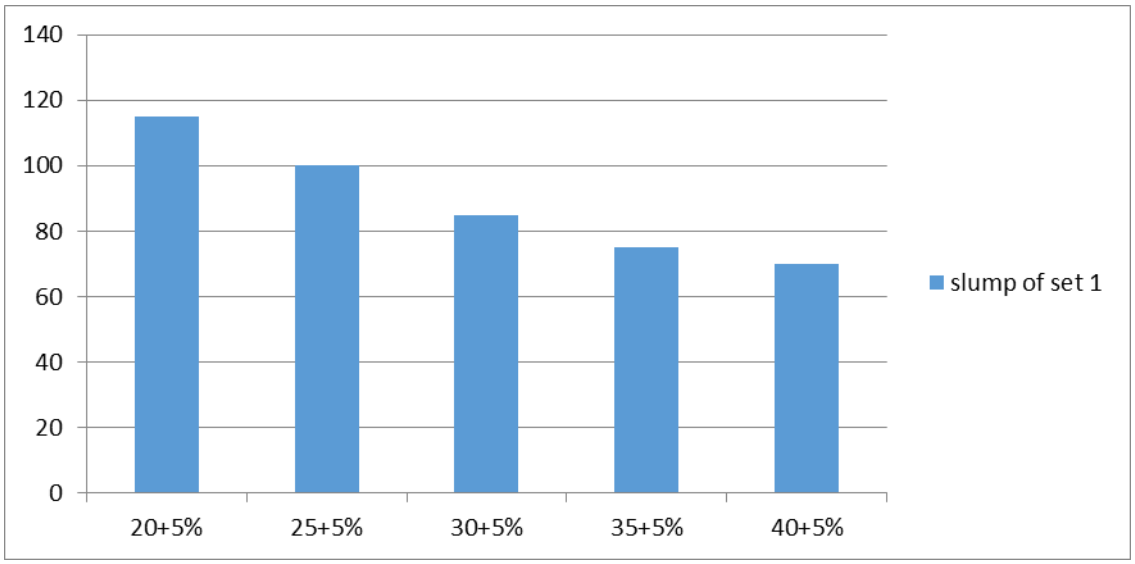
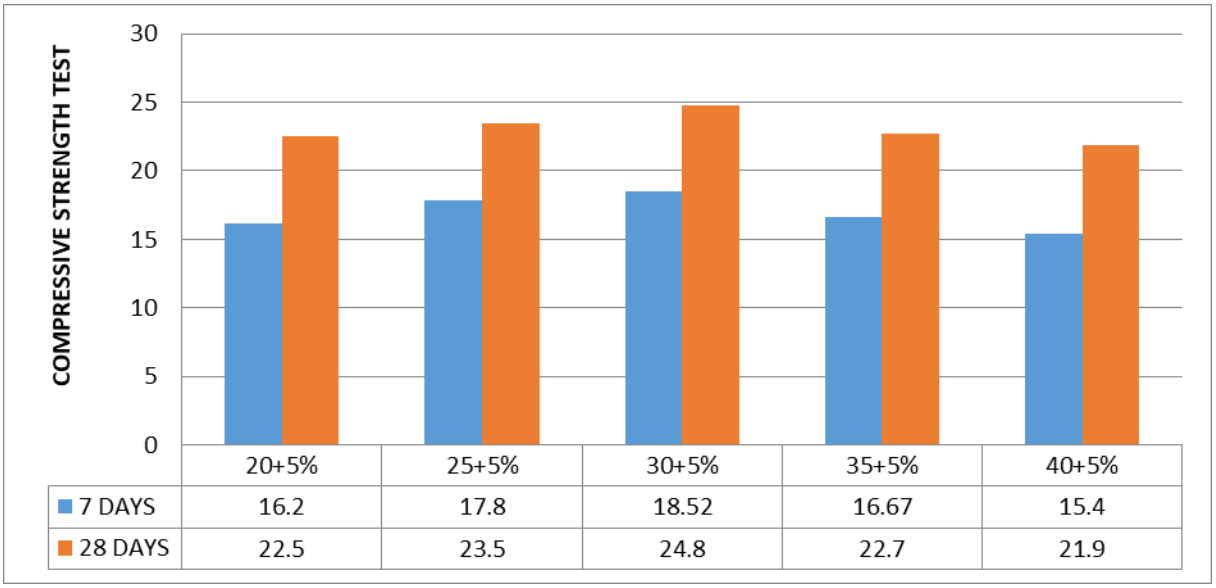


Fig.1.1 Variation in slump

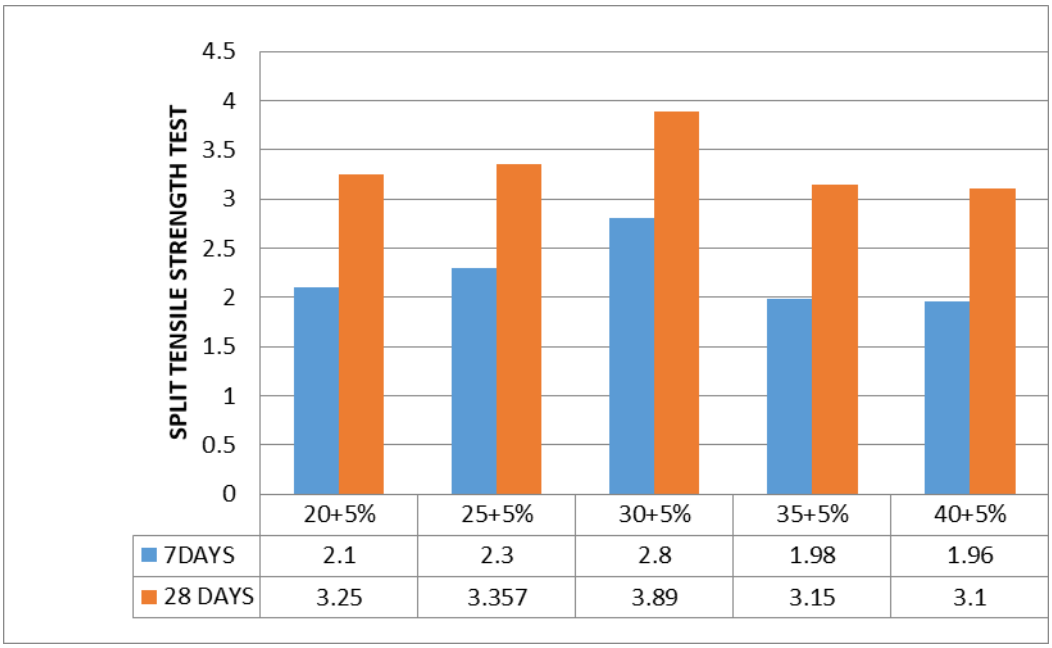
4.2. COMPRESSIVE STRENGTH:



	20+5%	25+5%	30+5%	35+5%	40+5%
7 DAYS	16.2	17.8	18.52	16.67	15.4
28 DAYS	22.5	23.5	24.8	22.7	21.9

Fig.1.2. variation in compressive strength in 7 and 28 days

4.3 SPLIT TENSILE STRENGTH TEST



	20+5%	25+5%	30+5%	35+5%	40+5%
7DAYS	2.1	2.3	2.8	1.98	1.96
28 DAYS	3.25	3.357	3.89	3.15	3.1

Fig.1.3. Variation in split tensile strength in 7 and 28 days

CONCLUSIONS

- Mix ratio of M20 (cement: aggregate: sand+ ESP + EA) give the optimum strength in this study.
- As the percentage of ESP + EA gradually increases, the Compressive strength of concrete will also increase with condition that percentage of E.A (30%)+ESP (5%) should not exceed (30+5) % and the strength is 18.52 N/mm^2 for 7 days and 23.8N/mm^2 in 28 days. After this proportion a slight decrement was observed.
- The compressive strength of concrete increase with the increase of age of maturity.
- The split tensile strength also tend to increase up to 30% after that a decrement is observed in strength of concrete.
- According to the value of compressive strength collected, the value is high and it show that EA +ESP suitable to use as sand replacement upto (30+5)%. All the value of compressive strength surpasses the minimum value of compressive strength for normal concrete. So, egg shell powder and earthenware can apply as cement and sand replacement in concrete mix for construction industry.

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