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AN EXPERIMENTAL INVESTIGATION ON PARTIAL REPLACEMENT OF CEMENT WITH EGG SHELL POWDER AND FINE AGGREGATE WITH COPPER SLAG IN CONCRETE

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Abstract:** This research was carried out to determine the optimum percentage of eggshell powder as partial cement Replacement and Copper Slag as partial replacement of Fine aggregate. The construction industries are searching for 'alternative products that can reduce the Construction cost. Over 5% of global CO2emissions can be attributed to Portland cement production. Demand for cement continues to grow. Different ESP concretes were developed by replacing 4-16% of ESP for cement. Concrete plays the key role and a large quantity of concrete is being utilized in every construction practices. The egg shell usually which are disposed, is used as an alternate for the cement since the shell is made up of calcium. An egg shell are used in different combinations to find the feasibility of using the egg shells as an alternate to cement. aim of this project is to prevent the pollution of environment by the improper disposal of the Eggshell waste, a remain from eggshells domestic waste such as schools, restaurant, bakeries, homes and fast food hotels, by using it as an additive material inform of ash & powder in conventional concrete with grade M35 since it is normally used in construction sites. Copper slag is considered as one of the waste materials which can have a promising future in construction industry as partial or full substitute of either cement or aggregates. For each ton of copper production, about 2.2 tonnes of copper slag is generated. This slag is currently used for many purposes like land filling, construction of abrasive tools, roofing granules, cutting tools and rail road ballast material, which are not very high value added application. The Copper Slag is replaced with sand in percentage (10%-40%). The optimum proportion of replacement was found by conducting the following tests. Compressive strength test, Flexural strength test and Split Tensile Strength Test.

Keywords:** Egg Shells Powder, Copper Slag, Super Plasticizer, Compressive Strength, Split Tensile Strength, Flexural Strength

I. INTRODUCTION

Concrete is being widely used for the construction of most of the buildings, bridges and it is also known as backbone to the infrastructure development of a nation. At present, for a variety of reasons, the concrete industry is not sustainable. Firstly, it consumes huge amount of natural resource due to which no virgin material will be left for future generation. Secondly, the major component of concrete is cement. Lot amount of green house gas will be emitted in the manufacturing processes of cement The aim of this study is to study the chemical composition of the egg shell to find its suitability of replacement in the concrete and copper slag as replaced with fine aggregate. The utilization of industrial waste or secondary materials has encouraged the production of cement and concrete in construction field. New by-products and waste materials are being generated by various industries. Dumping or disposal of waste materials causes environmental and health problems. Therefore, recycling of waste materials is a great potential in concrete industry. For many years, by-products such as fly ash, silica fume and slag were considered as waste materials. Concrete prepared with such materials showed improvement in workability and durability compared to normal concrete and has been used in the construction of power, chemical plants and under-water structures. Over recent decades, intensive research studies have been carried out to explore all possible reuse methods. Construction waste, blast furnace, steel slag, coal fly ash and bottom ash have been accepted in many places as alternative aggregates in embankment, roads, pavements, foundation and building construction, raw material in the manufacture of ordinary Portland. Copper slag is considered as one of the waste materials which can have a promising future in construction industry as partial or full substitute of either cement or aggregates. For each ton of copper production, about 2.2 tonnes of copper slag is generated. This slag is currently used for many purposes like land filling, construction of abrasive tools, roofing granules, cutting tools and rail road ballast material, which are not very high value added application. various research efforts have been directed toward the utilization of waste materials. Fly ash is one of the residues produced in the combustion of coal in power generation facilities. Furthermore, the production and use of concrete has an enormous environmental effect this is because Cement is an energy consumer and CO_2 fabricated material. Other factors and causes of CO_2 emission are things such as products that use high temperature processes to produce elements such as cement, bricks; these are considered as a main user of energy and emitter of greenhouse gases. Other material productions that can lead to CO_2 emission are lead, iron and other chemical creation such as ammonia and titanium dioxide that can definitely cause negative impact to the environment. The rice husk ash is obtained by burning of rice husk ash at temperature between 550 oC to 700 oC, then the rice husk may forms as cellular micro

structure is produced. The rice husk ash has rich silica content of non-crystalline (or) amorphous silica form. It shows that rice husk can be used as supplementary cementitious materials due to its pozzolanic action. Cement replaced with Egg Shells Powder in various percentages (0%, 4%, 8%, 12% and 16%) and sand replaced with Copper Slag in various percentages (0%, 10%, 20%, 30% and 40%). The optimum proportion of replacement was found by conducting the following tests.

Fig. 1.1 Egg Shells

Fig. 1.2 Copper Slag

II. MATERIALS AND THEIR PROPERTIES

A. Cement

The cement use for the experimental studies was Ultra tech cement 43 grade OPC as per the specifications of Indian Standard Code IS: 8112-1989. The specific gravity of the cement was 3.08. The initial and final setting times were found as 85 minutes and 520 minutes respectively.

Table 2.1 Characteristics Properties Of Cement

Sr. No.	Characteristics	Experimental value	Specified value as per IS:8112-1989
1	Consistency of cement (%)	32%	---
2	Specific gravity	3.08	3.15
3	Initial setting time (minutes)	85	>30 As Per IS 4031-1968
4	Final setting time (minutes)	520	<600 As per IS 4031-1968
5	Compressive strength (N/mm^2) (I) 3 days (II) 7 days (III) 28days	 24.5 34.5 46.5	 >23 >33 >43
6	Soundness (mm)	1.00	10
7	Fineness of Cement	4%	10% As Per IS 269-1976

B. Coarse Aggregate:

The coarse aggregate used were a mixture of two locally available crushed stone of 20 mm and 10 mm size in 70:30 proportion. Coarse aggregate of maximum size 20mm and minimum 10 mm is used throughout the concrete. The specific gravity of course aggregate is 2.97.

C. Fine Aggregate:

Fine aggregate is used in this experimental study for concrete is river sand conforming to zone- II. The specific gravity of fine aggregates 2.44.

D. Egg Shells Powder:

Eggshells are agricultural throw away objects produced from chick hatcheries, bakeries, fast food restaurants among others which can damage the surroundings and as a result comprising ecological issues/contamination which would need appropriate dispersed into atmosphere. This created environmental and health concerns problems. Instead of dispersing it into atmosphere or sending it to land fill it can be effectively used in concrete production as supplementary material to cement..Specific Gravity of Egg Shells Powders 2.19.

Table No. 2.1

S.No.	Chemical Property	Percentage (%)
1	CaO	53%
2	MgO	1 %
3	Sio2	1.5%
4	Al203	0.28%
5	Fe2 O3	0.36%
6	Cl	0.011%

E. Rice Husk Ash (Rha)

Copper slag is a by-product obtained during the matte smelting and refining of copper has been reported by Rewari, Haryana The major constituent of a smelting charge are sulphides and oxides of iron and copper. Copper slag is a by-product material produced from the process of manufacturing copper. As the copper settles down in the smelter, it has a higher density, impurities stay in the top layer and then are transported to a water basin with a low temperature for solidification. The end product is a solid, hard material that goes to the crusher for further processing. Copper slag is an industrial by-product material produced from the process of manufacturing copper.. Specific Gravity of Copper Slag is 3.95.

TABLE NO. 2.2

S/NO.	Physical property	Copper Slag
1	Particle Size	Irregular
2	Appearance	Black & Glassy
3	Specific Gravity	3.95
4	Fineness Modulus	4.5
5	Water Absorption	0.85
6	Moisture Content	0.1

F. Admixture: Conplast P211

- Water reducing concrete admixture (Super plasticizers)
- For Better and Increase Strength of concrete 0.5% of weight of Cement

G. Water :

Water used for mixing and curing was clean and free from injurious amounts of oils, acids, alkalis, salts and sugar, organic substances that may be deleterious to concrete. As per IS 456- 2000 Potable water is generally considered satisfactory for mixing and curing of concrete. Accordingly potable tap water was used for the preparation of all concrete specimens.

Table No.-2.2 Physical Properties of Aggregates

Sr. No.	Properties of Material	
1	Specific Gravity of Fine Aggregate	2.44
2	Specific Gravity of Coarse Aggregate	2.97
3	Specific Gravity of Copper Slag	3.95
4	F.M. of Coarse Aggregates	8.07
5	F.M. of fine aggregate	3.55
6	Free Moisture Content	1.75%

III. EXPERIMENTAL PROGRAM

As recommended by the IS Standard of a particular size cubical moulds of size 150mm×150mm×150mm and cylinder mould of depth 150mm was ,height 300mm and dia of 100mm and beam mould of 150mm×150mm×700mm made of cast iron were used to cast concrete specimens to test compressive strength ,split tensile strength and flexural strength respectively. The quantities of cement, fine aggregates, coarse aggregates, and water for each batch were weighted to an accuracy of 1kg separately. Eggl Shells Powders and Copper Slag is added to this mixture in dry form. Finally, coarse aggregates were added and thoroughly mixed to get a uniform mixture throughout the batch. Required dosage of water was added in the course of mixing.foe eliminate the voids a proper vibration was doing by the vibrating machine.. Surface of concrete was finished level using a trowel and date along with batch number was marked properly on it. Finished specimens were left to harden and removed from moulds approximate after 24 hours of casting. They were then placed in water tank containing portable water and were left for curing.

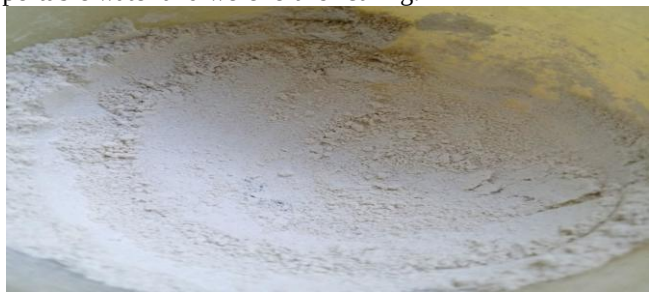

Fig 3.1 Egg Shells Powders

Fig 3.2 Addition of ESP & Copper Slag into Mix

IV. TESTING OF CONCRETE

The test compression and split tensile strength was checked at the age of 7 and 28 days of moist curing and were then tested. Specimens were tested on 1000 tones capacity of universal testing machine (UTM). The load was applied gradually without any shock and increased at constant rate of 14 N/mm²/minute until failure of specimen takes place, thus the compressive strength of specimen was found out by dividing the compressive load to area under compression. For flexural strength testing a flexural testing machine was used as recommended by IS code.

Fig. No.4.1: Testing of Cube

Table-4.1: Compressive Strength by Adding ESP & Copper Slag in Concrete

Sr. No.	Egg Shells Powder	Copper Slag	Compressive strength in 7 days	Compressive Strength in 28 days
1	0	0	28.95	43.92
2	4	10	29.99	44.74
3	8	20	30.74	45.40
4	12	30	31.33	46.14
5	16	40	28.29	43.10

Table-4.2: Flexural Strength by Adding Glass Fibre & Silica Fume in Concrete.

Sr. No.	Egg Shells Powder	Copper Slag	Flexural strength in 7 days	Flexural strength in 28 days
1	0	0	2.06	2.88
2	4	10	2.14	2.95
3	8	20	2.21	2.99
4	12	30	2.24	3.04
5	16	40	2.01	2.86

Table-4.3: Split Tensile Strength by Adding Glass Fibre & Silica Fume in Concrete

Sr. No.	Egg Shells Powder	Copper Slag	Split Tensile strength in 7 days	Split Tensile strength in 28 days
1	0	0	2.21	3.41
2	4	10	2.54	3.56
3	8	20	2.73	3.89
4	12	30	3.07	4.12
5	16	40	2.09	3.32

4.1 INTERPRETION OF TEST RESULTS

4.1.1 Compressive strength

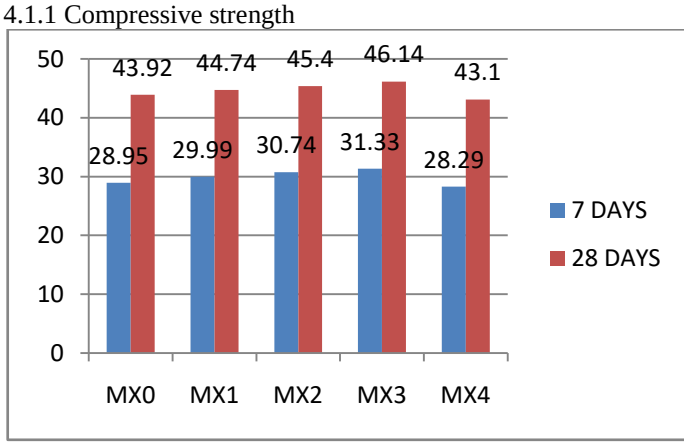

Fig.4.3 : Graph comparing compressive strength for 7 and 28 days

4.1.2 Flexural Strength

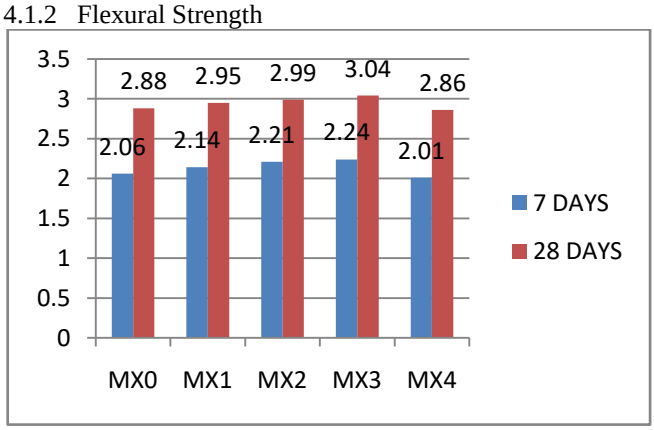

Fig 4.4 Graph comparing Flexural strength after 7 & 28 days

4.1.3 Split Tensile Strength

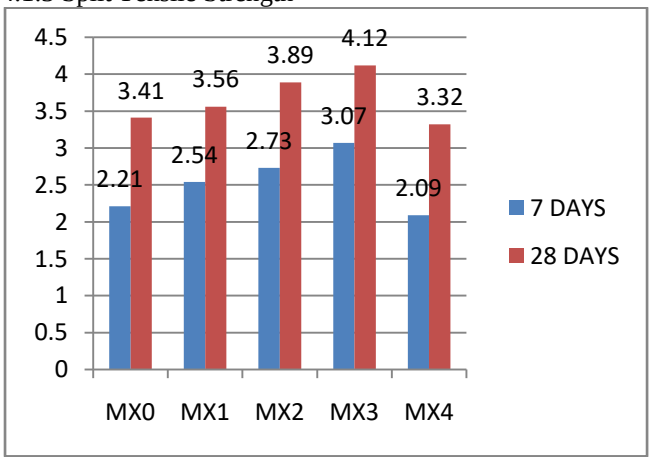

Fig. 4.5: Graph comparing Spilt Tensile strength for 7 and 28 days

V. CONCLUSION

From the results of the present research the following conclusion may be drawn:-

1. The workability of concrete had been found to be increase with ESP and Copper Slag based Concrete.
2. The workability of concrete had been found to be decrease with increasing the ESP and Copper Slag more than 16% ESP and 40% Copper Slag.
3. Maximum compressive strength obtained for 28 days is 46.14 N/mm2 with the replacement of 12% of cement by ESP and Fine Aggregate by 30% Copper Slag in Concrete Maximum flexural strength obtained for 28 days is 3.04N/mm2 with the replacement of 12% of cement by ESP and Fine Aggregate by 30% Copper Slag.
4. Maximum split tensile strength obtained for 28 days is 4.12N/mm2 with the replacement of 12% of cement by ESP and Fine Aggregate by 30% Copper Slag
5. Compressive strength increase with increasing the percentages of 12% of cement by ESP and Fine Aggregate by 30% Copper Slag in concrete.
6. Flexural strength increase with increasing the percentages of 12% of cement by ESP and Fine Aggregate by 30% Copper Slag in concrete.
7. Split tensile strength increase with increasing the percentages 12% of cement by ESP and Fine Aggregate by 30% Copper Slag in concrete.
8. It is found that the addition of Super Plasticizer into concrete the small change in compressive strength, flexural strength and split tensile strength.
9. Environmental benefits.
10. Cost of Construction has been reduced by adding Egg shells powder and Copper Slag

REFERENCES

[1] Mobasher et al (1996) investigated the effect of copper slag on the hydration of cement based materials. Upto 15% by weight of copper slag was used as a Portland cement replacement.

[2] Teik-Thye Lim and Chu (2006) conducted a study on the feasibility of using spent copper slag as fill material in land reclamation. The physical and geotechnical properties of the spent copper slag were first assessed by laboratory tests, including hydraulic conductivity and shear strength tests.

[3] Ramazan Demirbog and Rustem Gul (2007) investigated the use of Blast furnace slag aggregates (BFSA) to produce high-strength concretes (HSC). These concretes were made with total cementitious material content of 460-610 kg/m3. Different water/cement ratios (0.30, 0.35, 0.40, 0.45 and 0.50) were used to carry out 7- and 28-day compressive strength and other properties.

[4] K. Uma Shankar Jet Al., (2008) revealed that the use of egg shell powder, GGBS and saw dust ash as concrete. Egg shell plays a major role, as it is used in all the combination of the concrete cubes. 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 saw dust ash.

[5] Mtallib And Rabiu Et Al., (2009) carried out the investigation on properties of ESA as an admixture in concrete. They conducted consistency test on ESP. It was observed that higher the contents of ESA in the cement, the faster the setting of cement. The decreased setting time of OPC was due to addition of ESA portrays ESA as an accelerator.

[6] Jayasankar Et Al. (2010) conducted a experimental study on properties of concrete by substituting rice husk ash, fly ash and egg shell powder to cement in concrete. M20, M25 and M30 mix design was used with 5%, 10%, 15% and 20% variation of egg shell powder, rice husk ash and fly ash to cement and also in the combination of ESP +fly ash, ESP + RHA, fly ash + RHA, fly ash + RHA + ESP.

[7] Al-Jabri Et Al.,(2011) investigated the effect of using copper slag as a fine aggregate on the properties of cement mortars and concrete. Various mortar and concrete mixtures were prepared with different proportions of copper slag ranging from 0% (for the control mixture) to 100% as fine aggregates replacement.

[8] Marthong And Agrawal., (2012) carried out a comparative study on effects of concrete properties by partially replacing ordinary Portland cement of varying grades by fly ash.

[9] Amarnath Yerramala Et.Al., (2014) studied the Properties of concrete with eggshell powder as cement replacement.

[10] Doh Shu Ing And Chin Siew Choo Et Al., (2014) carried out an investigation on egg shell powder as potential additive to concrete.

[11] Zhang S (2015) Waste glass as partial binder precursor and fine aggregate replacement in alkali activated slag/fly ash system.

[12] Quina MJ, Soares MA, Quinta-Ferreira R (2016) Applications of industrial eggshell as a valuable anthropogenic resource. Resources, Conservation and Recycling.

[13] Witoon T (2011) Characterization of calcium oxide derived from waste eggshell and its application as CO2 sorbent. Ceramics International 37(8): 3291-3298.

[14] TEXT BOOK - Shetty M. S., (2013), "Concrete Technology - Theory and Practical", S.Chand Publishing.

[15] IS 456-2000, Indian Standard, Plain and Reinforced Concrete - code of pratice.

[16] IS 383-1970, Indian Standard Specification for Coarse and Fine Aggregates from Natural Sources for Concrete.

[17] IS 10262-2009, Indian Standard Recommended Guidelines for Concrete Mix Design.

[18] U.N. Okonkwo, I.C. Odiong, and E.E. Akpabio, The effects of eggshell ash on strength properties of cement-stabilized lateric, Int. J. of Sustainable Construction Engineering and Technology, 13(1),18-25

[19] A.U. Elinwha and Y.A. Mohmood, Ash from timber waste as cement replacement material, 24(2), 219-222 (2012)

[20] F. Udoeyo, H. Inyang, D. Young, and E. Oparadu, Potential of wood waste ash as an additive in concrete, J. Mater. Civ. Eng., 18(4), 605–611

