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Experimental Investigation on Properties of Concrete by Partial Replacement of Fine Aggregate with Copper Slag and Cement with Egg Shell Powder by using Ansys Software

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Abstract- Concrete is always expected to be stronger and more durable than in the past while being cost and energy efficient. Moreover the major advantages that concretepossesses over the construction material have to be conserved. So, the need for improving the performance of concrete and concern for the environment impact arising from the continually increasing demand for concrete has lead the growing use of an alternative material components. An experimental investigation will be conducted to study the properties of concrete containing copper slag as a partial replacement of fine aggregates in the concrete mix design. Various durability test will be conducted on concrete to know the compressive strength, split tensile strength, flexural strength by varying proportions of copper slag(CS) with fine aggregate by 0%, 5%, 10%, 15%, 20%,25%, 30% and egg shell powder (ESP) as cement by 0%, 5%, 10%, 15%, 20%, 25%, 30% by weight. The obtained results will be compared with the conventional concrete, there by knowing the changes in the properties of concrete containing copper slag asa partial replacement of fine aggregate and egg shell powder as cement.

Keywords: Performance of concrete, Use of alternative material, Partial replacement, Strength Properties.

1. INTRODUCTION

The utilization of industrial waste or secondary materials has encouraged the production of cement and concrete in construction fields. New by-products and waste materials are being generated byvarious industries. Dumping or disposal of waste material causes environmental and health problems. Therefore, recycling of waste materials is to great potentials in concrete industry. 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 cement pointed out by Teik thye luin el (2006).

Copper slag possesses mechanical and chemical characteristics that qualify the material to be used in concrete as a partial replacement for Portland cement or as a substitute for aggregates. Copper slag has a number of favourable mechanical properties for aggregate use such as excellent soundness characteristics, good abrasion resistance and good stability reported by Gorai et al 2003. Copper slag also exhibits pozzolanic properties since it contains low CaO.

Cements used in construction are usually in organic often lime and calcium silicate based and can be characterized as either hydraulic or non- hydraulic, depending on the ability of the cement to set in the presence of water. To decrease the pollution from cement industry the waste materials are used to control the environmental impacts,Here the egg shell powder which are considered asthe waste material, usually egg shell powder whichconsists of Calcium carbonate which is also disposed in million tonnes. The egg shell gland contains very high level of calcium and hydrogen carbonates. Egg shell powder are used as a partial replacement by weight. The Egg shell powder of 0%, 5%, 10%, 15%, 20% is partially replaced withcement.

2. OBJECTIVE

The main objective is to study the feasibility of useof copper slag as fine aggregate and egg shellpowder as cement in concrete. The scope of the work includes knowing the strength parameters ofconcrete such as Compressive strength, Split tensile strength, Flexural strength in which copperslag and egg shell powder replaced with fine aggregate and cement by (0%+0%), (5%+5%), (10%+10%), (15%+15%), and (20% +20%) using
M40 grade of concrete.

3. MATERIALS USED

CEMENT:
Ordinary Portland cement is composed of calcium silicate, calcium aluminate and alumina ferrite. It is obtained by blending predetermined proportionslime stone clay and other minerals in small quantities which is pulverized and heated at high temperature-around 1500 degree centigrade to produce clinker. The clinker is then ground with small quantities of gypsum to produce a fine powder called Ordinary Portland cement (OPC).

Table 1 Properties of Cement

Properties	Results
Specific Gravity	3.16
Fineness	2.6
Initial Setting time	40 min
Final Setting time	10 hours

AGGREGATE:
Normally Sand is used as fine aggregate for preparing concrete. An individual particle in this range is termed as Sand grain. These sand grains are between coarse aggregate (2mm to 64mm) andsilt (0.004mm to 0.0625mm). Aggregate most of which passes through 4.75mm sieve is used. The Coarse aggregate for the work should be river gravel or crushed stone. Angular Shape aggregate of size is 20mm and below. The aggregate which and is found in many foods, including dairy products. Egg shell chopper is used to process eggshell into egg shell powder. Egg shell consist of $CaCO_3$ and it is a poultry waste to replace cement can have benefits like minimizing use of cement., conserves a natural lime and utilising waste materials.

Fig 1 Egg shell powder

Table 4 Properties of Egg Shell Powder

Properties	Results
Specific Gravity	1.73
Fineness	3.66%

COPPER SLAG :
Copper Slag is a by-product material produced from the process of manufacturing copper. The slag is a black glassy and granular in nature and has a similar particle size range like sand. As the copper settles down in the smelter, it has a higher density, impurities stay in the top layer and then are passes through 75mm sieve and retain on 4.75mm are known as coarse aggregate.

Table 2 Properties of Fine Aggregate

Properties	Results
Specific Gravity	2.83
Water Absorption	0.8%
Fineness	36.9%

Table 3 Properties of Coarse Aggregate

Properties	Results
Specific Gravity	2.75
Water Absorption	1%
Fineness	21.5%

EGG SHELL POWDER
The egg Shell is the hard outer shell of the egg. It mainly consist of calcium carbonate $CaCO_3$, normal calcium. The rest is made up of proteins and other minerals. Calcium is an essential mineral transported to a water basin with a lot of temperature for solidification.

Fig 2 Copper Slag

Table 5 Properties of Copper Slag

Properties	Results
Specific Gravity	3.1
Water Absorbed	0.4%

4.EXPERIMENTAL METHODS

1. Concrete Mix Design

The mix design is done by the various proportions of materials for M30 grade concrete which is used in the present study. Then the mix design is designed as per IS 10262-2009 standards.

Table 6 Mix Design Proportions

Cement kg/m^3	Fine Aggregate kg/m^3	Coarse Aggregate kg/m^3	Water kg/m^3
348	868	1032	195
1	2.5	3	0.40

2. Casting of Specimen

Cubes of Size 150mm x150mm x150mm, Cylinderof size 200mm x 300mm, Beam of size 700mm x 150mm x 150mm were casted. The materials which are mixed by coarse aggregate,manufactured sand, cement, egg shell powder, Copper slag and water. After the moulds were casted and compacted. Demoulding was done after24 hours of casting and specimens were allowed tocured in a water tank.

5. CONCRETE TESTS AND RESULTS

FRESH CONCRETE TESTS

SLUMP CONE TEST in M40 Grade ConcreteTable 7 Slump Cone Test

S.NO	% Replacement	Slump (mm)
1	0% CS + 0% ESP	0
2	5% CS + 5% ESP	25
3	10% CS + 10% ESP	27
4	15% CS + 15% ESP	30
5	20% CS + 20% ESP	35
6	25% CS + 25% ESP	50
7	30% CS + 30% ESP	75

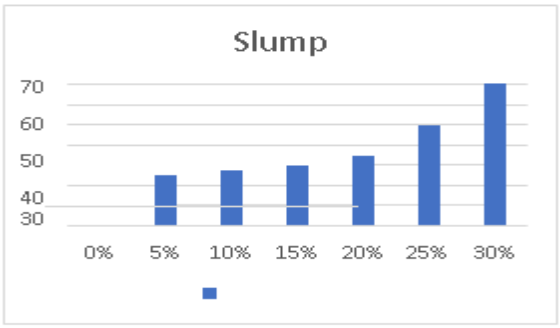

Fig 3 Slump Cone Test

COMPACTION FACTOR TEST in M40 Grade

Table 8 Compaction factor Test

S.NO	% Replacement	Compactionfactor
1	0% CS + 0% ESP	0.98
2	5% CS + 5% ESP	0.94
3	10% CS + 10% ESP	0.90
4	15% CS + 15% ESP	0.88
5	20% CS + 20% ESP	0.86
6	25% CS + 25% ESP	0.82
7	30% CS + 30% ESP	0.78

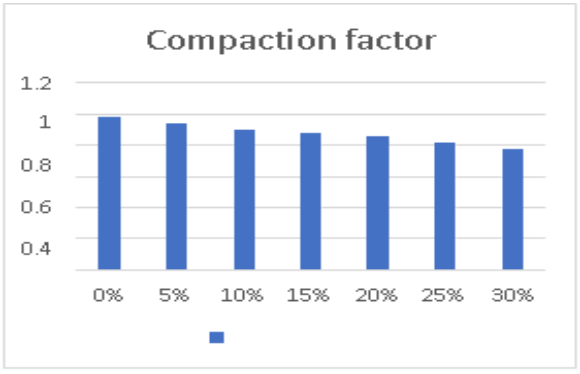

Fig 4 Compaction factor Test

HARDENED CONCRETE TEST

The individual variations of specimen was not more than ± 15 percent of the average. The specimen stored in water was tested immediately on the removal from the tank. The specimen were wiped off and the dimensions of the specimen and their weight were recorded before testing. The bearing surface of the testing machine were wiped clean the other

materials, which may come in contact with the compression plates. While placing in the cube in the machine, care was taken such that the load was applied to opposite side of the cube as casted and not to the top and the bottom. The maximum load applied to the specimen was recorded and any usual appearance in the type of failure was noted.

COMPRESSIVE STRENGTH OF CONCRETE

Table 9 Compressive strength test

S.NO	% Replacement	Compressive Strength		
		7 days	14 days	28 days
1	0% CS + 0% ESP	36.60	37.45	38.80
2	5% CS + 5% ESP	36.85	38.10	39.40
3	10% CS +10% ESP	38.24	39.75	41.10
4	15% CS +15% ESP	39.60	40.20	43.75
5	20% CS +20% ESP	37.45	39.15	42.10
6	25% CS +25% ESP	35.22	37.40	39.05
7	30% CS +30% ESP	32.80	33.45	35.03

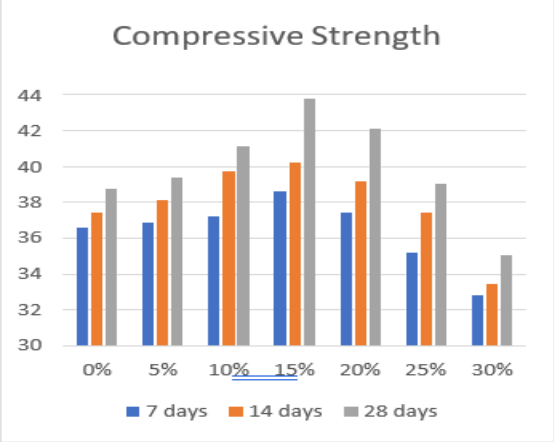

Fig 5 Compressive strength Test

SPLIT TENSILE STRENGTH TEST

Table 10 Split tensile strength Test

S.NO	% Replacement	Tensile Strength		
		7 days	14 days	28 days
1	0% CS + 0% ESP	3.78	3.86	3.96
2	5% CS + 5% ESP	3.83	3.95	4.02
3	10% CS + 10% ESP	3.98	4.05	4.24
4	15% CS + 15% ESP	4.02	4.16	4.37
5	20% CS + 20% ESP	3.92	4.06	4.23
6	25% CS + 25% ESP	3.84	3.92	3.98
7	30% CS + 30% ESP	3.72	3.85	3.84

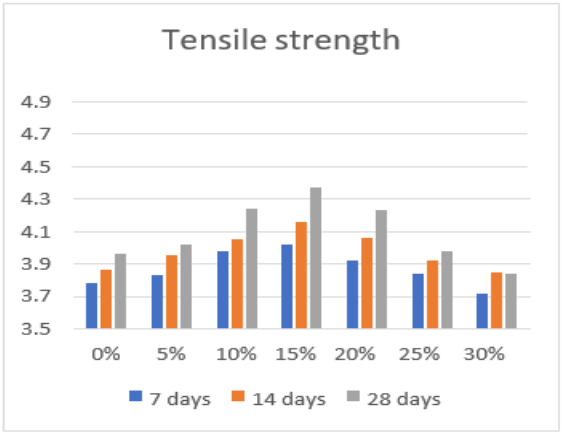

Fig 6 Split Tensile Strength Test

FLEXURAL STRENGTH TEST

Table 11 Flexural strength Test

S.NO	% Replacement	Flexural Strength		
		7 days	14 days	28 days
1	0% CS + 0% ESP	5.02	5.35	5.80
2	5% CS + 5% ESP	4.89	5.15	5.69
3	10% CS + 10% ESP	4.74	5.02	5.57
4	15% CS + 15% ESP	4.65	4.78	5.25
5	20% CS + 20% ESP	4.85	5.05	5.36
6	25% CS + 25% ESP	5.12	5.45	5.75
7	30% CS + 30% ESP	5.50	5.92	6.05

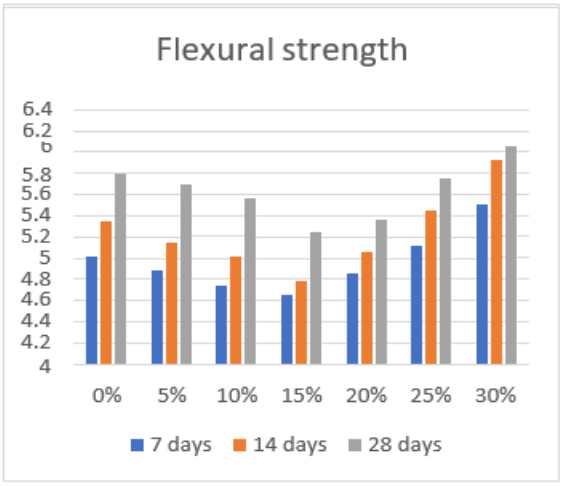

Fig 7 Flexural Strength Test

FLEXURAL STRENGTH RESULT BY USING ANSYS SOFTWARE

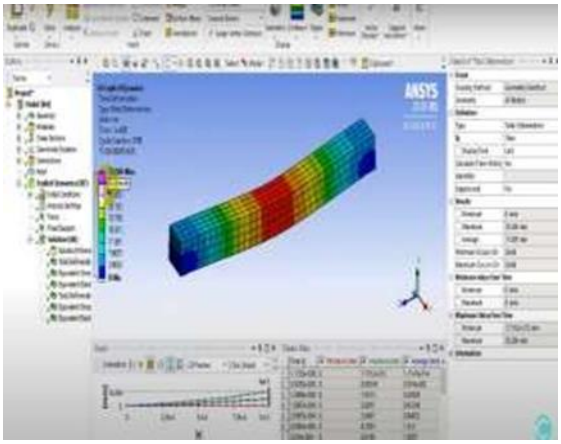

Fig 8 Flexural strength of Beam

6. CONCLUSION

1. The Cement, Fine aggregates and Coarse aggregate material qualities are within the permissible limits according to IS coderequirements, So we will use the materials for study.
2. Slump Cone value for the concrete increases with increasing in the percentage of copper slag and egg shell powder so the concrete was not workable.
3. The compaction factor value of concrete decreases with increases in the percentage of copper slag and egg shell powder.
4. The compressive strength of concrete at 15% replacement of copper slag and egg shell powder and is the optimum value for 7 days, 14 days and 28 days curing.
5. Split tensile strength for the cylindrical specimen is maximum at 15% of replacement of copper slag and egg shell powder.
6. The flexural strength of the beam is also maximum at 15% replacement of copper slag and egg shell powder.

So, the replacement of 15% of concrete with copper slag and egg shell powder is generally useful for better strength values in M40 grade of concrete.

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