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An Experimental Investigation on Partial Replacement of Cement by Poultry Waste and Corn Cob ash in Concrete

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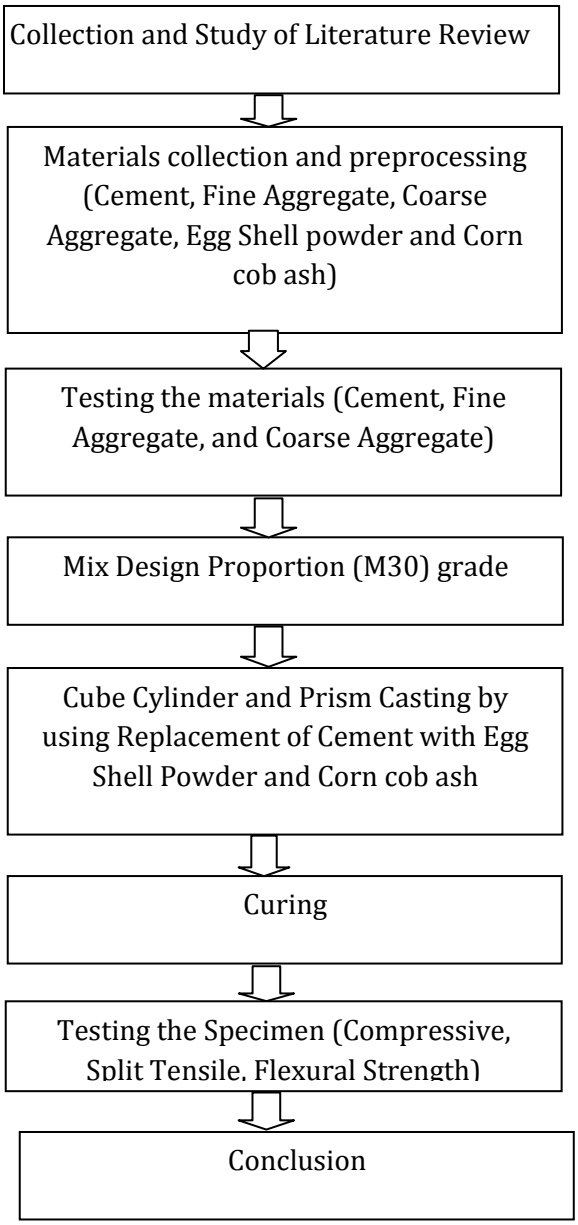
Abstract – *In Developing countries the cost of construction materials is gradually increasing by using the unused materials that would minimize the use of cement and decreases the creation cost. Concrete is a mixture of cement, fine aggregate, coarse aggregate and water. Here the substitute materials are poultry waste such as egg shell powder and corn cob ash. These materials are replaced partially for cement. These replaced materials are managed in eco-friendly way. Calcium content is rich in egg shell powder, Corn cob ash cost is low and can be used for the construction of any type of structure. Egg shell powder and Corn cob ash are used for replacement of cement Partially in specified ratios of 5%,10%,15%. Concrete cube, cylinder, prism were casted and then cured in water for the period of 7 days, 14 days, 28 days and tested for its compressive strength test, flexural strength test, split tensile test*

Key Words*: *Egg shell powder, corn cob Ash, Compressive Strength, Flexural Strength, Split Tensile Strength.

1. INTRODUCTION:

Concrete is most widely used material for construction and it is also a composite material used for construction that hardens over time. The binder of the fine aggregate and coarse aggregate is cement. The cost of the cement increases in developing countries so experimental projects were done for partial replacement of cement. Egg shell is a poultry waste these shells were dried and grained in the powder form and collected and used in concrete as a partial replacement material for cement. Corn cob is a waste product can be obtained during the production of corns these corn cob are burnt in open form and collected. Egg shell powder and Corn cob ash is partially replaced for ordinary Portland cement i.e 5%,10%,15% of partial replacement of cement. Concrete cube, cylinder, prism were casted and cured for the period of 7 days, 14 days, 28 days and conducted the test on the specimen for its compressive strength, tensile strength test and flexural strength test.

2. METHODOLOGY:



3. MATERIALS:

- Ordinary Portland cement (M30)
- Fine aggregate

- Water
- Coarse aggregate
- Egg Shell Powder
- Corn cob Ash

4. CHEMICAL COMPOSITION:

Table -1: Chemical Composition of the materials

Chemical composition	Cement	ESP	CCA
SiO_2	20.8	0.08	47.78
Al_2O_3	5.6	0.03	9.40
Fe_2O_3	4.1	0.02	8.31
CaO	64.1	52.1	16.70
MgO	2.1	0.01	7.80
Na_2O	0.6	0.15	1.89
K_2O	0.4	-	5.42
SO_3	2.2	0.57	1.9
LOI	2.4	47.8	-

5. PROPERTIES:

5.1. CEMENT: (OPC 43 Grade)

Portland cement is manufactured by crushing, milling and proportioning the following materials

- Lime or calcium oxide, CaO: from limestone, chalk, shells, calcareous rock.
- Silica, SiO_2: from sand, clay or argillaceous rock.
- Aluminium oxide, Al_2O_3: from bauxite, recycled aluminium

5.2. FINE AGGREGATE

Fine aggregate are essentially any natural sand particles from the land through Mining process. Fine aggregates are the particles that pass through 4.75mm sieve and retain on 0.075mm sieve. Specific gravity is 2.4. Fineness modulus is 2.6. Bulk density (partial compact) is 1461Kg/m^3. Bulk density (fully compact) is 1635Kg/m^3.

5.3.POULTRY WASTE (EGG SHELL POWDER):

Egg shell powder consist of calcium carbonate and other organic compounds. It is also the cheapest and most widely available waste product. The specific gravity of ESP is 2.37.

Fig.1 Egg shell powder

5.4. CORN COB ASH:

Specific gravity of CCA is 2.55.Corn Cob ash is obtained by burning of corn cob waste. CCA as about 70 % of combined content of SiO_2 and CaO.

Fig.2 Corn cob ash

6. MIX PROPORTION:

The common method of expressing the proportions of ingredients of a concrete mix is in the terms of parts or ratios of cement, fine aggregates, coarse aggregates.IS Method used for mix design and finally for M30 grade of concrete. The mix was 1:1.87:3.37.

7. APPLICATION:

In the present study these egg shell powder and corn cob ash 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 varied up to 24% (0%,6%,12%,18%& 24%) in the research work. Further use of corn cob ash as a value added material as in the case of binary blended cement concrete, reduces consumption of cement.

8. PURPOSE:

Cement replacement materials are naturally occurring materials or waste products that can be used in concrete mix to partially replace of ordinary Portland cement. Egg shell powder and corn cob ash used in replacement of cement in concrete. It reduces the cement production. The primary objective of replacement is to direct the organization towards profit maximization or cost minimization.

9. MIXING OF THE MATERIALS:

Fig.3 Mixing of the materials

Mixing of materials is essential for the production of uniform specimen. The mixing should ensure that the mass becomes homogeneous, uniform in color and consistency. The percentage replacement of cement with egg shell powder and corn cob ash were 5%,10%,15% are mixed.

10. CASTING OF THE MATERIALS:

After the mixing, the concrete is taken in a testing process and immediately fill the cube mold, cylinder mold and prism mold and compacting the concrete thoroughly either by vibrator or by hand. Any air in the concrete will reduce the strength of the specimen.to over compact the concrete may cause segregation of the aggregates and cement paste in the mix. The size of the cube is 150mmx150mmx150mm,the size of the cylinder is 300mm height, 150mm diameter and the size of the prism is 100x100x600mm.

11. CURING OF THE SPECIMENS:

After remolding the specimens, the specimens (cube, cylinders and prism) are kept in a water for curing to promote the hardening of concrete by proper curing, the durability of concrete are increased and shrinkage is reduced.

Fig.4. Curing the materials

12. TESTING THE SPECIMEN AND TEST RESULT:

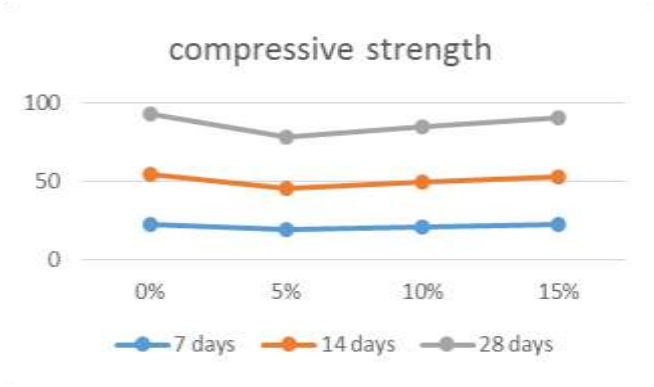
12.1 COMPRESSIVE TEST STRENGTH:

Compressive test is the most common test conducted for concrete cube. The size of the cube is 150mmx150mmx150mm.the cube specimen were cured and tested for 7 days, 14 days. The specimen were placed in the compression testing machine and applied the pressure at which a given concrete sample fails. The compressive strength has been performed for 5%, 10%,15% replacement of cement with egg shell powder and coconut shell ash.

Compressive strength = (P/A) in N/mm^2

Table no: 2 Compressive strength result

s.no.	Percentage replacement of ESP and CCA	7 days (KN/m^2)	14 days (KN/m^2)	28 days (KN/m^2)
1	Conventional	23.05	31.54	38.58
2	5% of ESP+CCA	19.48	26.01	32.77
3	10% of ESP+CCA	21.03	28.27	35.08
4	15% of ESP +CCA	22.52	30.01	37.66



12.2 SPLIT TENSILE STRENGTH TEST:

Split tensile strength test is a method to determine the tensile strength of concrete. split tensile strength test is conducted on compression testing machine. split tensile strength test was carried out on a cylinder. the size of a cylinder is 300mm height and 150mm diameter. the specimen(cylinder) is cured and tested for 7 days,14 days,28 days in compression testing machine.

Split tensile strength = $2P/\pi LD$ in N/mm^2

Table no: 3 Split Tensile strength result

s.no.	Percentage replacement of ESP and CCA	7 days (KN/m^2)	14 days (KN/m^2)	28 days (KN/m^2)
1	Conventional	2.6	3.2	3.25
2	5% of ESP+CCA	2.1	2.51	2.8
3	10% of ESP+CCA	2.35	2.98	3.05
4	15% of ESP +CCA	2.51	3.19	3.12

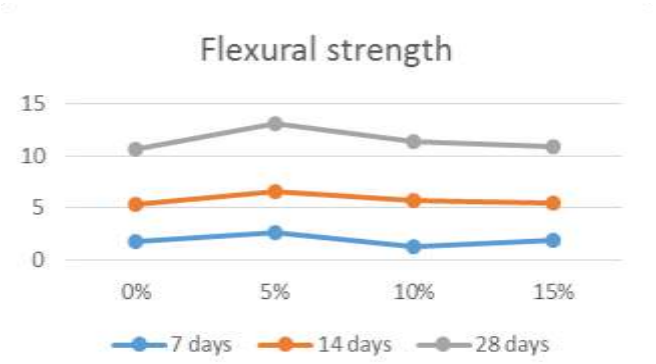
12.3 FLEXURAL STRENGTH TEST:

Flexural strength evaluates the tensile strength of concrete indirectly. It tests the ability of un reinforcement concrete beam and slab to withstand failure in bending. Results of flexural test on concrete expressed as a modulus of rupture which denotes as (MR) in MPa or psi.

Flexural strength test $F = PL/(bd^2)$ in N/mm^2

Table no:4 Flexural strength result

s.no.	Percentage replacement of ESP and CCA	7 days (KN/m^2)	14 days (KN/m^2)	28 days (KN/m^2)
1	Conventional Concrete	1.8	3.61	5.2
2	5% of ESP+CCA	2.62	4.02	6.4
3	10% of ESP+CCA	1.45	4.4	5.66
4	15% of ESP +CCA	1.75	3.57	5.43



13. CONCLUSIONS:

- In this Experimental study we investigate that partial replacement of cement by using the waste materials to reduce the production of the cement.
- The Partial Replacement materials are Egg shell powder and Corn cob ash.
- The Egg shell is a poultry waste and corn cob is an agricultural waste product. Corn cob increases the workability and resists the chemical attack in concrete.

- The Compressive strength value decreases and maintains the strength during the partial replacement of 15 % of replacing materials.
- Split tensile strength is also maintains the same strength for partial replacement compared to before replacement.
- Flexural strength of concrete gradually increases according to period of curing.
- Addition of Egg shell powder and Corn cob ash provides the same strength.
- The egg powder leads to enhance the resistance to segregation of fresh concrete and Corn cob ash increases the workability of concrete.
- This shows that mechanical properties of concrete increases. When the cement is partially replaced in concrete with waste materials such as Egg shell powder and Corn cob ash.

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