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"AN EXPERIMENTAL INVESTIGATION ON WORKABILITY AND MECHANICAL PROPERTIES OF M_{20} GRADE CONCRETE MADE WITH EGG SHELL"

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Abstract - *The worldwide demand for concrete increases consistently in the construction industry and the production of cement for its usage in conventional concrete obviously leads to the increased emission of greenhouse gases on to the environment, contributing to about 5-8% of overall greenhouse gas emission of the world. This proves the need for an eco-friendly alternative for conventional concrete.*

The egg shell powder usually which are disposed is used as an alternate for the cement since the shell is made up of calcium. Egg shell waste is evolved from poultry farms, restaurants and hotels such waste are collected and implemented in our project.

The project is carried out by different test like compressive test, split tensile, flexural test with different proportions of egg shell powder (10% 20% 30% 40% 50%) in M_{20} Grade Portland Pozzolana cement.

Key Words: Portland Pozzolana cement [PPC], Egg shell powder [ESP], fine aggregate, coarse aggregate.

1. INTRODUCTION

Concrete is a mixture of different materials like cement, coarse aggregate and fine aggregate. Use of concrete is very large so availability of natural material is reduced and there is no material which plays the role of this ideal material. So to fulfill the requirement of industries we have to replace fully or partially all the material. In India number of waste materials is produced by different manufacturing companies like thermal power plant, municipal solid waste and other waste. During manufacturing of one tones of cement an equal amount of carbon dioxide is released into the atmosphere which acts as a silent killer to the environment hence a cheaper substitute to the cement is needful one.

Egg shell powder consists of several mutually growing layers of CaCO3. The eggshell primarily contains calcium magnesium carbonate. The quality of lime in eggshell waste is influenced greatly by the extent of exposure to the sunlight, raw water and weather conditions. It is the fine grained powder with suitable proportion which is sieved to the required size use with the cement.

The Portland Pozzolana Cement is a kind of Blended Cement which is produced by either inters grinding of OPC clinker along with gypsum and pozzolanic materials in certain proportions or grinding the OPC clinker, gypsum and Pozzolanic materials separately and thoroughly blending them in certain proportions.

Portland Pozzolana Cement also commonly known as PPC cement. These types of cement are manufactured by using pozzolanic materials as one of the main ingredient. The percentage of pozzolanic material used in the preparation should be between 10 to 30. If the percentage is exceeded, the strength of cement is reduced.

Pozzolana is a natural or artificial material containing silica in a reactive form. It may be further discussed as siliceous or siliceous and aluminous material which in itself possesses little, or no cementitious properties but will in finely divided form and in the presence of moisture, chemically react with calcium hydroxide at ordinary temperature to form compounds possessing cementitious properties. It is essential that Pozzolana be in a finely divided state as it is only then that silica can combine with calcium hydroxide (liberated by the hydrating Portland Cement) in the presence of water to form stable calcium silicates which have cementitious properties.

1.1 Advantages of Eggshell

Considerable reduction in alkali-silica expansions.

Ideal for painting in occupied spaces.

Excellent durability and washable finish.

Saves money; less material required.

1.2 Objectives of the project

a) The objective of this project is to study the chemical composition of the egg shell to find its suitability of replacement in the concrete.
b) To examine the feasibility of utilizing the egg shell as cement replacement material.
c) To study the engineering properties of fresh concrete using the egg shell powder
d) To study the hardened concrete properties such as compressive strength test, split tensile strength test and flexural strength test of M_{20} grade concrete.

2. Eggshell powder

The eggshell wastelands in the poultry manufacturing have been highlighted because of its recovery potential. Eggshell waste is available in huge amounts from the food processing, egg breaking and shading industries. The food indulgence industry is in need of investigation to find other methods for processing and using egg shell waste in an ecological friendly way. There is a need to find a low cost solution. Removal of egg shell waste is not income centers but cost centers.

Source of sample for testing	:	Sample supplied by the customer
Customer's reference	:	Letter dated 13.03.2019
Sample received for testing on	:	14.01.2019
Total number of samples tested	:	01(one)
Brand/ Type *	:	Not Specified
Sample Identification*	:	Egg Shell
UIN	:	263
Project#	:	Not Specified
Period of Test	:	14.03.2019 to 20.03.2019
Condition of sample during testing	:	Satisfactory
Test Method	:	IS: 1727-1967 (Reaffirmed 2013) and IS: 4032 – 1985 (Reaffirmed 2014)

Sl. No.	Test Conducted	Test Results (% by mass)
1	Loss on ignition	45.16
2	Insoluble Residue	0.15
3	Silicon dioxide (SiO_2)	1.48
4	Aluminium Oxide (Al_2O_3)	0.38
5	Ferric Oxide (Fe_2O_3)	0.18
6	Calcium Oxide (CaO)	51.03
7	Magnesium Oxide (MgO)	0.80
8	Sulphuric trioxide (SO_3)	0.044
9	Chloride (Cl)	0.010

* as furnished by the customer

FIGURE-1: Chemical Test Result on Egg shell powder Sample

3. METHODOLOGY

The experimental investigation was carried out on the specimen to study the strength-related properties of Concrete with egg shell powder. The specimen size for cube, cylinder and prism are 100mm x 100mm x 100mm, 150mm x 300 mm and100mm x 100mm x 500mm respectively as per IS specifications. The ambient curing is done at 3days 7days and 28 days. Minimum three specimens were casted for each mix.

Table -1: Mix Proportion Per Cubic Meter.

Mix proportion	Cement In "kg/m³"	Egg shell powder In " kg/m³"	Fine aggregate In "kg/m³"	Coarse aggregate In "kg/m³"	Water In "Liters"
Mix-1: Cement=100% ESP=0%	355	-	753	1178	178
Mix-2: Cement=90% ESP=10%	320	35	753	1178	178
Mix-3: Cement=80% ESP=20%	284	71	753	1178	178
Mix-4: Cement=70% ESP=30%	249	106	753	1178	178
Mix-5: Cement=60% ESP=40%	213	142	753	1178	178
Mix-6: Cement=50% ESP=50%	178	178	753	1178	178

4. RESULT AND DISCUSSION

4.1 COMPRESSIVE STRENGTH

The compressive strength of concrete is also known as ultimate strength of concrete is the load which cause the failure of the specimen divided by the area of the cross section in uniaxial under a given rate of loading. The specimens were tested at different ages (3, 7 and 28 days of curing) for compressive strength in accordance with Bureau of Indian Standards. The compressive load was applied at a rate of 1.2 KN/sec using a compressive testing machine having capacity of 2000 KN as shown in fig. for each trail 3 cubes were casted and tested at the age of 3, 7 and 28 days. The average values of compressive strength were adopted in each case.

Table -2: Test Results of 3, 7 and 28 Days Compressive Strength of Concrete cubes

Mechanical Properties	Age In Days	MIX PERCENTAGE					
		0%	10%	20%	30%	40%	50%
Compressive Strength In "N/mm²"	3	20	15	9	7	6	4.5
Compressive Strength In "N/mm²"	7	18	14	11	10	8.5	6
Compressive Strength In "N/mm²"	28	28.5	23	21.5	18	16.5	12

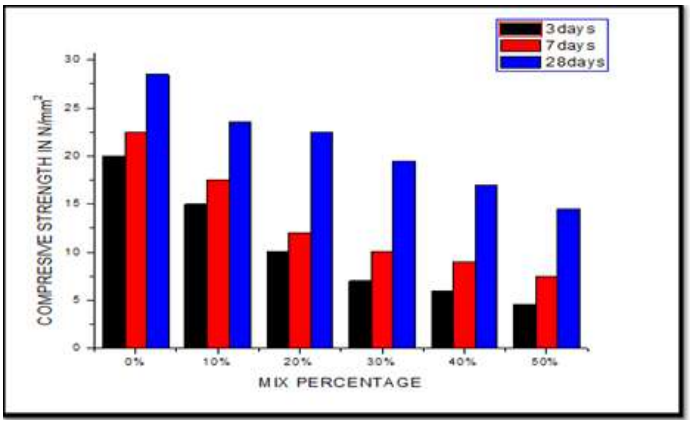

Chart -1: Graphical representation between 3, 7 and 28 days Compressive Strength of Concrete

4.2 SPLIT TENSILE STRENGTH

Tensile strength is one of the basic and important properties of concrete. Size of test sample of 10cm diameter, 20cm height and 0.3cm thick cylindrical mould is used. The

compressive testing machine load is applied. The load at which the sample in the end fails is noted and split tensile strength is calculated.

Table -3: Split Tensile Strength at 28 days

Mechanical properties	Age In Days	Mix Percentage					
		0%	10%	20%	30%	40%	50%
Split Tensile Strength In "N/mm²"	28	3.2	2.9	2.68	1.95	1.65	1.43

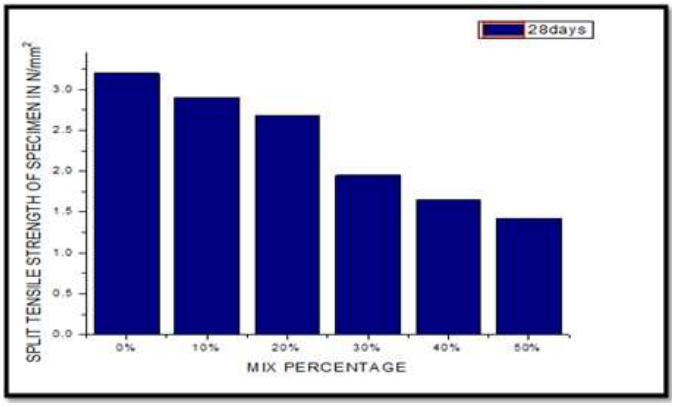

Chart -2: Graphical representation of 28 days Tensile Strength of Concrete

4.3 FLEXURAL STRENGTH TEST

The prism is generally tested to identify the flexural behavior of the hardened concrete. The test is carried in a universal testing machine of 100T load ability. Standard prism of size 10cm x 10cm x 50cm was tested under two point loading to study the flexural strength of concrete.

The following table shows the flexural strength of Conventional Concrete (M_{20}) grade at different mix proportion.

Table - 4: Flexural Strength at 28 days

Mechanical Properties	AGE IN DAYS	MIX PERCENTAGE					
		0%	10%	20%	30%	40%	50%
Flexural Strength In "N/mm²"	28	5.37	4.38	3.28	2.68	1.95	1.45

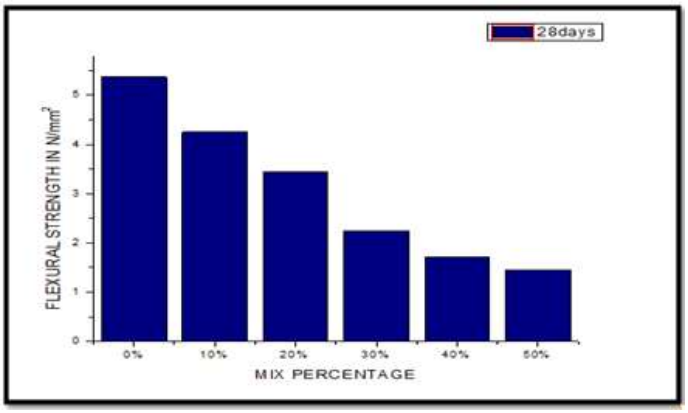

Chart -3: Graphical representation of 28 days Flexural Strength of Concrete

5. CONCLUSIONS

- Based on the experimental investigation the following Conclusion is drawn:
- Egg shell powder concrete had less compressive strength, split tensile strength and flexural strength compared to convectional concrete.
- Thus the optimum percentage for replacement of Egg shell powder with cement upto is 10% and decreased with further increase. this may be due to the following effect:
- Growth of hydration product in concrete.
- Eco friendly concrete with use of Egg shell powder in cement.
- The percentage mix of Egg shell powder upto 10% has the good strength and decreases gradually when mixed with PPC.
- Hence the Eggshell replacement with PPC up to 10% gives the better strength.
- Addition of Egg Shell powder to cement concrete lead to reduction in workability.

6. REFERENCES

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