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USE OF EGG SHELL POWDER (ESP) AND FLY ASH IN PARTIAL REPLACEMENT OF CEMENT IN CONCRETE

Sahil sharma[1], RishabhRaj[1], Ritwik Kashyap[1], Shivanand Kumar Chaudhary[1], Rahul M.[2]

[1]Student ,Dept. of Civil Emgineering, Dayanada Sagar College Of Engineering , Bengaluru, 560078 , karnataka , india.

[2]Assistant Professor, Dept. of Civil Emgineering, Dayanada Sagar College Of Engineering , Bengaluru, 560078 , karnataka , india

A B S T R A C T

Eggshell concrete is a cutting-edge green substance that recycles eggshell waste while decreasing the environmental damage caused by excessive cement manufacture. Recent research on eggshell concrete, on the other hand, are scarce, and the results may vary depending on the mix design. Although design of experiment is utilised to simplify and enhance the research of sustainable concrete, eggshell concrete analysis is still rare.

In all, 12 datasets were gathered from research using eggshell powder as a partial cement substitute that were available in the literature. The proportion of eggshell, percentage of fly ash, cement content, fine aggregate, coarse aggregate, and water were employed as input variables.

In addition to the fly ash, which is replaced by 30% of the weight of cement, egg shell powder is replaced by 5%, 10%, and 15%. The strength characteristics of egg shell based concrete, such as compressive strength and flexural strength test, were explored in an experimental study. It is discovered that adding egg shell powder and fly ash to concrete increases its strength, and a comparison is performed for the egg shell and fly ash increased concrete strength.

Keywords*: Egg Shell Concrete, Egg Shell Powder, Fly Ash, Compressive Strength and Flexural Strength test.*

1. INTRODUCTION

Concrete is made up of many components such as cement, fine aggregate, coarse aggregate, and water. Because concrete is so widely used, natural materials are in short supply, and there is no substance that can fill the function of this perfect material. As a result, in order to meet the needs of industries, we must replace all materials, either completely or partially. Different manufacturing firms, thermal power plants, municipal solid wastes, and other wastes all create trash in India. Waste management, both solid and liquid, is one of the world's most pressing issues. We require roughly 1.1 tons of earth resources to make one ton of Ordinary Portland Cement (OPC). Furthermore, when one ton of cement is manufactured, an equivalent quantity of carbon dioxide is emitted into the atmosphere, acting as a silent killer in the environment in numerous forms. In this context, the hunt for a less expensive alternative to OPC is critical.

Egg shells are agricultural waste products produced by chick hatcheries, bakeries, fast food restaurants, and other businesses that can harm the environment, resulting in ecological difficulties and pollution that require remediation. When egg shells are left in the refrigerator for an extended period of time, they might cause allergies. The use of egg shell waste instead of natural lime to substitute cement in concrete has several advantages, including reducing cement use, preserving natural lime, and repurposing waste. Calcium, magnesium carbonate, and protein are the main components of the egg shell. Before used with concrete, Egg Shell Powder (ESP) is a fine-grained powder with the proper proportions that is sieved to the desired size.

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2. MATERIALS USED

- Cement: Cement is the important required material for the construction of concrete. Cement is a well-known construction
- material and has engaged a very important place in construction work. In this investigation Portland cement of 53 grades was used. The specific gravity of cement is 3.11.

- Fine Aggregate: Fine aggregate has a greater favorable impact on the qualities of fresh concrete and cured concrete in high performance concrete. As a result, fine aggregate plays a crucial function in the concrete mix.

- Coarse Aggregate: Without aggregate, large castings of neat cement paste would essentially self-destruct upon drying. Coarse aggregate are particles greater than 4.75 mm, but generally range between 9.5 mm to 37.5 mm in diameter. They can either be from primary, secondary or recycled.

- Fly ash: Fly ash in Portland cement concrete (PCC) provides a number of advantages and improves the performance of the concrete in both the fresh and hardened states. Fly ash increases the workability of flexible concrete and the strength and durability of hardened concrete when used in concrete. The utilization of fly ash is also cost-effective.

- Eggshell powder: Egg shells are agricultural waste materials created by chick hatcheries, bakeries, and fast food restaurants, among others, that can harm the environment, resulting in ecological issues/contamination that require remediation. The egg shell is made up of many layers of CaCO3 that grow together.

3. METHODOLOGY

- It is the method followed to perform the experiment. In this section we have made step wise procedure to perform experiment which is briefly described as follows.

- Collection of materials- As a partial substitute material for coarse aggregates, egg shell powder and fly ash were used. Drying samples of defined volume in the oven for 24 hours is required.

- Mix Design done using IS 10262:2009.

- Casting of Cubes (150*150*150) mm3 as well as beams (100*100*500) mm3

- Curing of specimen.

- Testing of Specimen.

- Result

4. TESTS ON CONCRETE

- Tests on Fresh Concrete.

- Vee-Bee Consistometer Test: The main goal of the Vee-Bee test is to figure out how workable newly mixedconcrete is. The Vee-Bee test determines the mobility of freshly mixed concrete.

- b) Slump Cone Test: This test was performed to determine the fresh concrete's workability. According to IS456:2000, the aggregate size should not exceed 20mm during testing.

- c) Compaction Factor Test: The compaction factor test is an alternate method of determining the workability of fresh concrete. Compaction factor apparatus is utilized, which consists of two hoppers with trap doors and a cylinder.

- Tests on hard concrete.

- Compressive Strength Test: The capacity of a material or structure to resist or sustain compression is referred to as compressive strength. In this test, a push force is applied to both sides of the concrete specimen in accordance with IS 516 to establish the maximum compression that concrete can bear without failure. The cube should be 150 x 150 x 150 mm in dimension, with an aggregate of no more than 20 mm. It should take between 7 and 28 days to complete.

- Flexural Strength Test: Flexural testing is used to measure how flexible or bendable a material is. It comprises putting a sample between two points or supports and loading it from a third point or two points, as in 3-Point Bend and 4-Point Bend testing, respectively. A beam with dimensions of 100x100x500mm was subjected to a flexure strength test. All of the beams were tested using third point loading. The load is applied until the system breaks down.

5. RESULTS AND DISCUSSIONS

1. EXPERIMENTAL TESTING RESULTS:

Table below shows the results of the trials for each combination, compressive strength, flexural strength test. The compressive strength and flexural strength test at 14 and 28 days have been tested and results are being shown in below table.

***COMPRESSIVE STRENGHT OF CONCRETE (N/mm^2)**

% EGG SHELL	FLY ASH	14DAYS	28DAYS
1. 0%	30%	16.66	24.67
2. 5%	30%	19.73	26.80
3. 10%	30%	21.89	29.45
4. 15%	30%	18.58	27.78

***FLEXURAL STRENGTH (N/mm^2)**

From each concrete mixture, beams of size 100mmx100mmx500mm have been casted for the determination of flexural strength.

The concrete specimens were cured under normal conditions and tested after 14 and 28 days. Experimental results for beams flexural strength for M25. For mix 0%, 5%, 10%, 15% for 14 and 28 days are tabulated in below table.

%Egg Shell	Fly Ash	Flexural strength after 14 days	Flexural strength after 28 days
1. 0%	30%	3.01	3.27
2. 5%	30%	3.35	3.70
3. 10%	30%	3.60	4.12
4. 15%	30%	3.55	3.90

6. DISCUSSION

COMPRESSION STRENGTH:

The Compressive strength of concrete mixes made with Egg shell powder was determined at 14 and 28 days of curing. The testresults are given in above table and shows the variation of compressive strength (M25) with age for various egg shell powder and fly ash percentages with variations. The variation of compressive strength with egg shell powder percentages at different ages. The compressive strength of the egg shell powder concrete is compared to the conventional concrete. It has been seen that there is increase in strength with the increase in egg shell powder percentage and highest strength gain at 10%. Hence, the maximum strength isgained at 10%.

FLEXURAL STRENGTH:

The Flexural strength of concrete mixes made with Egg shell powder and fly ash was measured at the ages of 14 and 28 days of curing.

The test results are given in above table and the variation of flexural strength (M25) with eggshell powder percentages at different percentage. The flexural strength of the egg shell powder concrete is c, ,ompared to the conventional concrete.

There is increase in strength with the increase in egg shell powder percentages up to 15% however, the maximum strength is gain at 10%.

The rate of increase in strength is more prominent after 28th day.

7. CONCLUSION

Based upon the experimental work we conducted on the utilization of eggshell powder and admixture as partial replacement of cement, we reached on the following conclusion:

- Eggshell, once washed properly before grinding and drying in room temperature and then grinding properly into powder form, using 90mm sieve the fines can be determined and can be used as supplementary cementitious material, which can reduce the dependency of cement in for production of concrete as well as reducing the disposal of eggshell in open landfills which can cause significant health issues to the people living nearby.

- The fineness of extra cementitious materials has a significant impact on concrete characteristics. Extensive grinding is necessary to create finer materials, which increases the specific surface area of the material. This surface area is the primary reason why finer materials absorb more water.

- With the use of flyash as an additive, the compressive strength of the concrete rises by up to 15%, and the maximum result is observed at 10%. The addition of Fly ash enhances the strength as well, but from a cost standpoint, simply replacing the egg shell powder is adequate. With the addition of egg shell powder, the flexural strength of the egg shell concrete improves by up to 15%, with a maximum result at10%. The egg shell powder on the mix's surface may hasten the carbonation process and, in the long run, diminish permeability.

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