Experimental Study On Concrete by Partial Replacement of Cement with Fly Ash and Egg Shell Powder

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Abstract: Concrete is the mostly widely used manmade construction material in the world, and is second only to water as the most utilized substance on the planet. For every one tone production of cement, one ton of CO2 is released into the atmosphere. India is the second largest cement producing country next to china. The depletion of natural resources and environmental pollution are the reasons to replace the conventional materials of the concrete, with alternate materials. When the cement is replaced by the pozzolonic materials, which upon Hydration, produces cementitious products resulting in the additional strength and durability properties. But theses by products are available only within the vicinity of such industries. The main objective of our project is to find the maximum percentage of replacement of cement in concrete by fly ash (0%, 10%, 15%, 20%, 25%, and 30%) and egg shell powder (5%). The experimental investigation is carried out by replacing the cement by fly ash and egg shell by different percentages. In this project we studied the compressive strength, split tensile strength and flexural strength.

Keywords---**Aggregates,Cement,EggShellPowder,FlyAsh,Water.**

I. INTRODUCTION

Concrete is widely used globally due to its versatility, durability, sustainability, and cost-effectiveness. India has become a major player in the poultry industry, ranking third in egg production and fourth in broiler production worldwide. The country is experiencing significant growth in poultry production, with an annual increase of over 14%, contributing significantly to the global egg supply. Around 250,000 tons of eggshells are produced globally each year by the food processing industry alone. In India, it is estimated that 10,000-11,000 tons of eggshells are discarded annually by egg processors. The majority of eggshell waste ends up in landfills without any treatment, leading to significant environmental concerns. Finding sustainable alternatives for managing this waste is crucial. One potential solution is to convert the waste into useful energy through bioconversion processes.concrete consists of three main ingredients 1. Cement

2. Aggregates

3. Water

II. LITERATURE REVIEW

2.1.Malhotra, (2005) discussed the role of supplementary cementing materials and super plasticizers in reducing greenhouse gas emissions. Author also discussed different ways of reducing CO2 emission. With emphasis on developing countries the author discussed that their infrastructure needs lead them to use huge amounts of cements. This huge need of cement can be reduced by replacing cement with easily available good quality of fly ash from the thermal power stations. Author also mentions the development of high performance; high volume fly ash concrete that incorporates large dosages of super plasticizer which enhances the durability of concrete. The paper also discussed about different cementing materials that can be used in concrete making as replacement of cement to reduce the cement consumption and also reduce the CO2 emission to atmosphere.

2.2 Poon, Lam & Wong, (1999) from their experimental results concluded that replacement of cement by 15% to 25% by fly ash results in lower porosity of concrete and plain cement mortars. Literature discussed has shown improvement in the workability and durability of concrete by partial replacement of cement with fly ash. However 28 days strength was reported to be lower by replacement of cement with fly ash, than concrete without replacement of cement with fly ash. Analysing the literature it is seen than grinding of fly ash is less effective. This may be due to destruction of spherical shape of fly ash which is helpful in increasing workability and reducing voids. Grinding cost

 DOI : 10.35291/2454-9150.2024.0137

also offsets partial cost advantage of cheaper fly ash over cement. Low reactivity of low lime Indian fly ashes as compared to high lime fly ash restricts use of higher volumes of fly ash is for cement replacement. Lower reactivity of fly ash makes it urgent to develop a method for replacing higher volumes of cement with fly ash without grinding or activation of fly ash.

2.3 Namagg &Atadero, (2009) described early stages of a project to study the use of large volumes of high lime fly ash in concrete. Authors used fly ash for partial replacement of cement and fine aggregates. Replacement percent from 0% to50% was tested in their study. They reported that concrete with 25% to 35% fly ash provided the most optimal results for its compressive strength. They concluded that this was due to the pozzolanic action of high lime fly ash. (Jones & McCarthy, 2005) made an extensive laboratory based investigation in to unprocessed low lime fly ash in foamed concrete, as a replacement for sand. For a given plastic density, the spread obtained on fly ash concretes were up to 2.5 times greater than those noted on sand mixes. The early age strengths were found to be similar for both sand and fly ash concrete, the 28-day values varied significantly with density. The strength of fly ash concrete was more than 3 times higher than sand concrete. More significantly while the strength of sand mixes remained fairly constant beyond 28 days, those of fly ash foamed concrete at 56 and 180 days were up to 1.7 to 2.5 times higher than 28 days values respectively.

III. MATERIALS USED FOR REPLACEMENT OF CEMENT

3.1. Fly Ash

Fly ash is a heterogeneous by product material produced in the combustion process of a coal used in power stations. It is a fine grey colored powder having spherical glassy particles that rise with the flue gases. As fly ash contains pozzolanic material components which reach with lime to form cementations materials. Thus, fly ash is used in concrete, mines, landfills and dams.

Fig.1.fly ash

3.1.1 Advantages of Fly Ash

- When fly ash is added to concrete, the amount of Portland cement may be reduced.
- Fly ash use is also cost effective.
- Fly ash use in concrete improves the workability of plastic concrete, and the strength and durability of hardened concrete.

3.1.2 Disadvantages of Fly Ash

- Increase in salt scaling produced by higher proportions of fly ash.
- Increased need for air-entraining admixtures.
- Seasonal limitation. Slower strength gain.

3.2 Egg Shell Powder

The egg shell wastelands in the poultry manufacturing have been highlighted because of its recovery potential. Egg shell 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 another method for processing and using egg shells waste in an ecological friendly way. There is a need to find a low cost solution. Removal of egg shell waste are usually not income centers but cost centers. Therefore, the least cost of removal is most necessary. Some of the options left should be watched at very critically and the most cost effective method of recycling are considered.

Fig.2.Egg Shell Powder

3.2.1 Advantages of Eggshell powder

- The utilization of eggshell powder in cement also helps to reduce the carbon dioxide emissions from cement factories by reducing clinker production.
- The utilization of solid wastes, like eggshells, will help create a sustainable environment by minimizing the solid wastes that are disposed into the environment.

3.2.2 Disadvantages of Eggshell powder

- During immersion in acid and alkali solutions, because eggshell contains a high amount of calcium, which reacts readily with acid and alkali solutions
- The compressive strength of the eggshell concrete decreases gradually when the amount of eggshell powder increased.

IV TESTS ON CONCRETE

4.1 Slump Cone

4.2 Compressive Strength

4.3 Split Tensile Strength

4.4 Flexural Strength

 DOI : 10.35291/2454-9150.2024.0137

4.1 Slump test:

Slump testing procedure was conducted as per IS 1191:1959. In this test the mould was being placed on a smooth horizontal rigid and non absorbent surface, such as a carefully levelled metal plate, the mould being firmly held in place while it is being filled.

4.2 Compressive Strength test:

Compressive strength or crushing strength is the main property observed in testing the cubes. Cubes are tested to calculate compressive strength by applying gradual loading in Compression Testing Machine. The reading of the failure load is occurred on the top of the machine in the indicator. The compressive strength has been calculated by the formula Compressive strength (fck) =Applied load /cross sectional are (f_{ck}) = P/A

$$= \frac{load}{area} N/mm^2$$

4.3 Split Tensile Strength test:

IS Code 5816:1999 The measured splitting tensile strength f_{cr}, of the specimen shall be calculated to the nearest 0.05 N/mm^2 using the following formula:

$$f_{cr} = \frac{2P}{\pi ld}$$

Where, P = maximum load in Newton applied to the specimen

l = length of the specimen

d = diameter of the specimen

4.4 Flexural Strength test:

IS Code 516:1959 use for method of tests for flexural strength of concrete the size of beam 500mmx 150mmx150mm. The specimens were tested after deep curing for 28days.the central point loading method was used for this testing. Flexural strength. $f_{cr} = 3PL/bd2$ N/mm^2

Where p = load, L = distance from centre of two supports, b = depth of specimen, d = width of specimens.

V.EXPERIMENTAL RESULTS AND DISCUSSIONS

5.1 Compressive Strength

Table1 Observation for compressive strength of cubes

S. No	% Replacement of fly ash	% Replacement of egg shell powder	Compressive strength	
			14 days	28 days
1	0	0	25.46	31.23
2	10	5	31.78	42.00
3	15	5	27.33	31.53
4	20	5	21.74	29.78
5	25	5	17.93	19.10

5.2 Split Tensile Strength

Table 2 Observation for compressive strength of cylinders

S. No	% Replacement of fly ash	% Replacement of egg shell powder	Split tensile strength	
			14 days	28 days
1	0	0	2.519	3.120
2	10	5	2.719	3.31
3	15	5	2.466	3.102
4	20	5	2.31	3.04
5	25	5	2.01	3.16

5.3 Flexural Strength

Table3 Observation for flexural strength of

S. No	% Replacement of fly ash	% Replacement of egg shell powder	Flexural test	
			14 days	28 days
1	0	0	2.43	2.86
2	10	5	2.70	3.04
3	15	5	2.60	2.95
4	20	5	2.57	2.90
5	25	5	2.28	2.52

5.4 GRAPHS

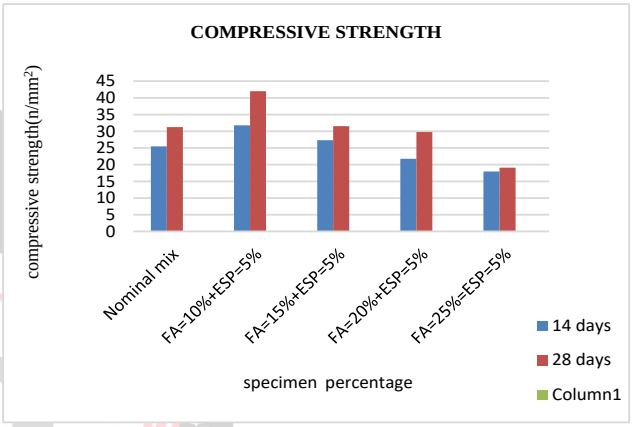

Fig.3.Compressive strength for 14 & 28 days

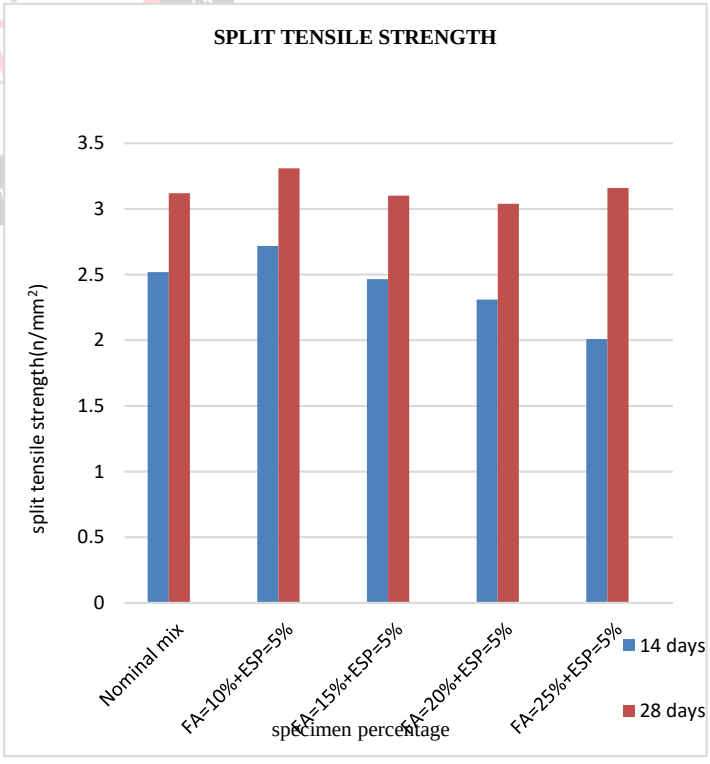

Fig.4.Split tensile strength for 14 & 28 days

 DOI : 10.35291/2454-9150.2024.0137

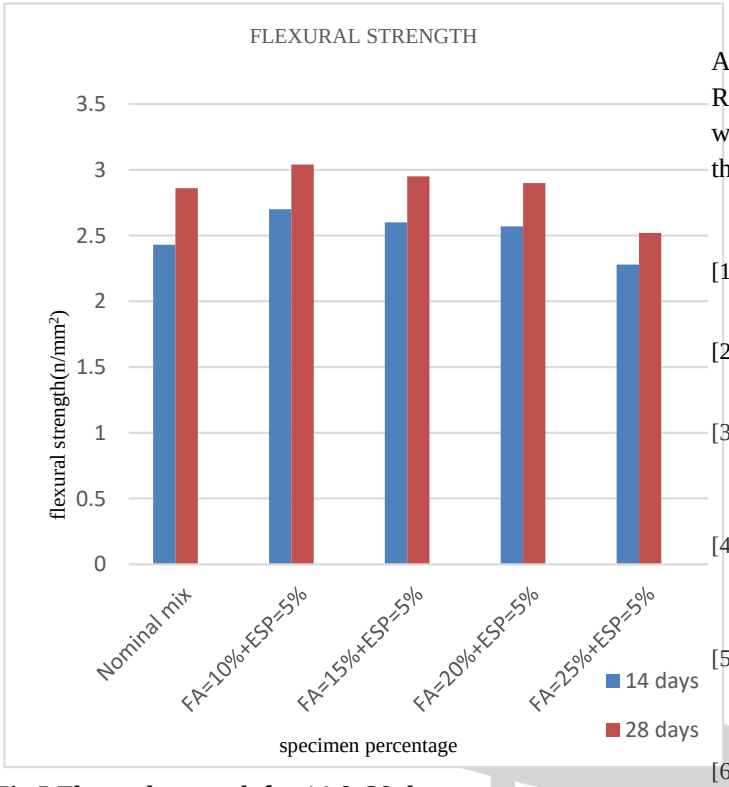

Fig.5.Flexural strength for 14 & 28 days

VI CONCLUSIONS

This study presents the effective way of utilizing the fly ash and egg shell powder in concrete. The egg shell powder is available in the most of the tropical countries at free of cost or at very low price.

The following conclusions can be drawn from the present investigations.

1. Compressive strength, spit tensile strength and Flexural strength of cement partially replaced with fly ash and egg shell powder concrete continued to increase at certain level at14 and 28 days.

2. Compressive strength is higher than normal concrete for 10% fly ash and 5% egg shell powder replacement at 14, 28 days. There is an increase of 24.82% when compared to normal concrete.

3. Split tensile strength is higher than normal concrete for 10% fly ash and 5% eggshell powder replacement at 14, 28 days. There is an increase of 7.93% when compared to normal concrete.

4. Flexural strength is higher than normal concrete for 10% fly ash and 5% egg shell powder replacement at 14, 28 days. There is an increase of 11.12% when compared to normal concrete.

5. If egg shell powder is added to concrete, the workability and density is reduced.

ACKNOWLEDGMENT

Authors are thankful to management, principal of Sir C R Reddy college of Engineering, Eluru and all the persons who have helped directly and indirectly in completion of this paper.

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 DOI : 10.35291/2454-9150.2024.0137