

# STUDY ON STRENGTH AND DURABILITY OF CONCRETE BY USING FLY ASH RICE HUSK ASH AND EGG SHELL POWDER

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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 concrete possesses over the construction materials have to be conserved. The possibility of being fabricated practically anywhere, the ability to make the form imposed by the shape of a mould and a low cost of components and manufacture. These factors have driven advances in improving the performance of concrete over years and continue to do so the need for improving the performance of concrete and concern for the environmental impact arising from the continually increasing demand for concrete has lead the growing use of alternative material components.

An experimental investigation will be conducted to study the properties of concrete containing Fly ash, Rice Husk ash and Egg shell powder as a partial replacement of cement in the concrete mix design. Various Strength tests compressive strength, split tensile strength, flexural strength and durability of concrete by varying proportions of RHA and ESP with constant variation 5% of FA. The experimental trials used for this study are 0%FA+0%RHA+0%ESP, 5%FA+0%RHA+0%ESP, 5%FA+5%RHA+5%ESP, 5%FA+10%RHA+10%ESP, 5%FA+15%RHA+15%ESP by weight of cement for M30 grade concrete . The obtained results will be compared with the conventional concrete, there by knowing the changes in the properties of concrete containing FA, RHA, and ESP as partial replacement of cement.

**Key words:** Fly ash, Rice husk ash, Egg shell powder, compressive strength, split tensile strength, flexural strength, durability.

## 1. Introduction

It is observed that various study reports have been brought to light as regards the assessment of individual efficiency of Fly ash and Rice husk ash blended concrete. Nevertheless, there is a scarcity in

respect of the study reports which focused on the joint execution of fly ash and rice husk ash. The underlying reason for the current exploration is to precisely assess Fly ash, Rice husk ash (RHA) and Egg shell powder (ESP) chemically, physically and miner logically differentiated, to explore the feasibility of their employment as a cement substituting substance in the concrete industry.

Fly ash is the utmost general pozzolan and is found extensively applied universally in concrete works. It is universally acknowledged that the employment of fine fly ash upgrades the qualities of mortar and concrete [9, 24]. Even though the porosity of the paste is enhanced on account of the inclusion of fly ash, the average pore size gets decreased, resulting in a minimal porous paste [9, 25]. The interfacial domain of the interface between aggregate and the matrix also gets refined in view of the employment of the use of fly ash [9, 26]. It is estimated that in India, the entire coal ash production exceeded 10 core tons in 2010. With an eye on scaling up the employment of fly ash, and to fine-tune the property of concrete, several investigators have resorted to employment of large volumes of Class F fly ashes in concrete.

The supplementary pozzolanic agent from agriculture by-products like rice husk ash (RHA) are emerging as hot topics of incessant investigation. Rice husk ash consists of high silica substance in the shape of non-crystalline or amorphous silica. Hence, it is a pozzolanic material which can be employed as additional cementitious objects (9). Rice husk is an agricultural remainder derived from the external covering of rice grains during milling procedure. It comprises 20% of the 500 million tons of paddy generated in the world.

Eggshells are agricultural throw away objects produced from chick hatcheries, bakeries, fast food restaurants among others which can damage the surroundings and as a result comprising ecological issues/contamination which would need appropriate treatment. In the ever soaring tasks to change waste to wealth, the efficiency of adapting eggshells to advantageous application constitutes a concept worth-accepting. It is systematically acknowledged that the eggshell chiefly consists of compounds of calcium. Okonkwo [16] has proficiently proposed that eggshell comprises 93.70% calcium carbonate (in calcium), 4.20% organic matter, 1.30% magnesium carbonate, and 0.8% calcium phosphate. It is estimated that roughly 90 million tones of hen egg are generated throughout the world every year. In India 77.7 billion eggs are produced in the year 2010-2011. Tamil Nadu, amassing a share of around 20 per cent, is ranked second with almost 2,000 core eggs created in the state every year. The next in the list of prominent egg producing states in India comprise Maharashtra, Haryana, Punjab and West Bengal. With this end in view, tests were performed in three stages as per normal test processes. In the initial stage, chemical composition, physical traits, and categorization of Fly ash (FA), Rice husk ash (RHA) and Egg shell powder (ESP) were executed. This comprised assessment of normal steadiness, preliminary setting period, concluding setting period and compressive strength of RHA blended cements. In the second stage, investigation on concrete specimens was performed.

### Objectives of the study

From this study the following conclusions were made

1. The main aim of this work is utilization of nano materials (Fly ash, Rice husk ash and Egg shell powder) as cement which is mixed (addition & partial replacement) with OPC to investigate the affect of these waste materials on various parameters of concrete grade i.e. M30.
2. To evaluate and compare the results of workability, compressive strength, split tensile strength, flexural strength and durability of M30 grade of concrete by using FA, RHA, ESP with standard concrete.

3. To compare the engineering properties of so improved concrete for M30 (addition & partial replacement) specimens with controlled mix concrete.
4. To ensure the optimum use of domestic and industrial waste and reduce the carbon footprints.
5. The primary objective is to generalize the properties of concrete with the use of waste material such as FA, RHA, ESP.

### 2. Literature reviews

**Dinesh et al** has conducted the experiment by replacing fine aggregate by rice husk ash and egg shell powder. Here they had replaced the Egg shell up to 10%, 20%, 30%, 40% & 50% using M25 grade concrete. They had conducted test for 7 days, 14 days and for 28 days. Based on the analysis in the present experimental work, they had concluded that the tensile strength, flexural strength was decreased with increasing egg shells percent.

**Jayasankar et al** has investigated the experiment by partially replacing cement with flyash and egg shell powder. They had conducted experiment by varying percentage of RHA, ESP, Fly ash in M20, M25 and M30 concrete. Based on the results obtained from the experiment it can be concluded that, RHA, Fly ash and ESP mixed cubes has equal strength with that of conventional concrete cubes in certain categories.

**Karthick et al** has conducted experiment by replacing the fine aggregate by egg shell. Here they had replaced the Egg shell up to 10%, 20%, 30%, 40% & 50%. They concluded that, the tensile strength, flexural strength was decreased with increasing egg shells percent.

### 3. Materials and methodology

The following are the materials used in this study

#### Cement

Ordinary Portland cement of 53 grade from the local market was used and tested for physical and chemical properties as per IS: 4031 – 1988 and found to be conforming to various specifications as per IS: 12269-1987. For this study Ultratech cement of OPC

53 Grade was used which is shown in the above figure



OPC 53 Grade cement

### Fine aggregates

In the present investigation fine aggregate is natural sand from local market is used. The physical properties of fine aggregate like specific gravity, bulk density, gradation and fineness modulus are tested in accordance with IS :2386.



Fine aggregates

### Coarse aggregates

The crushed coarse aggregate of 12.5 mm maximum size rounded obtained from the local crushing plant, Robo silicon, keesera gutta; Hyderabad is used in the present study. The physical properties of coarse aggregate like specific gravity, bulk density, gradation and fineness modulus are tested in accordance with IS ; 2386.



Coarse aggregates

### Fly ash

Fly ash, also known as "pulverised fuel ash" in the United Kingdom, is a coal combustion product that is composed of the particulates (fine particles of burned fuel) that are driven out of coal-fired boilers together with the flue gases. Ash that falls to the bottom of the boiler is called bottom ash. In modern coal-fired power plants, fly ash is generally captured by electrostatic precipitators or other particle filtration equipment before the flue gases reach the chimneys.



Fly ash

### Rice husk ash

Rice husk ash is used in concrete construction as an alternative of cement. The types, properties, advantages and uses of rice husk in construction is discussed. The rice paddy milling industries give the by-product rice husk. About 100 million tons of rice paddy manufacture by-products are obtained around the world. They have a very low bulk density of 90 to 150kg/m<sup>3</sup>. This results in a greater value of dry volume.



Rice Husk ash

### Egg Shell Powder

The eggshell also creates some allergies, when kept long time in garbage and disposal of eggshell also one the biggest problem. It also create undesirable smell which can cause irritation. The main ingredient in eggshells is calcium carbonate (the same brittle white stuff that chalk, limestone, cave stalactites, sea shells, coral, and pearls are made). The shell itself is

about 95% CaCO<sub>3</sub> (which is also the main ingredient in sea shells). The remaining 5% includes Magnesium, Aluminium, Phosphorous, Sodium, Potassium, Zinc, Iron, Copper, Ironic acid and Silica acid. Eggshell has a cellulosic structure and contains amino acids.



Egg shell powder

#### Water

Fresh and clean water is used for casting and curing of specimen. The water is relatively free from organic matters, silt, oil, sugar, chloride and acidic material as per requirements of Indian standard.

#### Mix design of concrete

Final trial mix for M30 grade concrete is 1:1.86:2.89 at w/c of 0.50

Mix trials used in the study

1. M0- 0%FA+0%RHA+0%ESP
2. M1- 5%FA+0%RHA+0%ESP
3. M2- 5%FA+5%RHA+5%ESP
4. M3- 5%FA+10%RHA+10%ESP
5. M4- 5%FA+15%RHA+15%ESP

## 4. Experimental study

### Casting of cubes and cylinders

Casting of cubes and cylinders as done for M30 grade concrete, the mix proportion is for which we are casting cubes for normal concrete, with the partial replacement of cement with Rice husk ash, flay ash and egg shell powder.



Filling the mould (for 150 mm cube 3 equal layers)

### Compacting with compacting bar

150 mm moulds should be filled in three approximately equal layers (50 mm deep). A compacting bar is provided for compacting the concrete. It is a 380 mm long steel bar, weighs 1.8 kg and has a 25 mm square end for ramming. During the compaction of each layer with the compacting bar, the strokes should be distributed in a uniform manner over the surface of the concrete and each layer should be compacted to its full depth.



Compacting the concrete in the cube mould (For 150 mm cube at least 35 tamps per layer)



Finishing

### Tests to be conducted on concrete

Compressive strength

- 7 days specimens age
- 14 days specimens age
- 28 days specimens age

Split tensile strength of specimens

- 7 days specimens age
- 28 days specimens age

Flexural strength of specimens

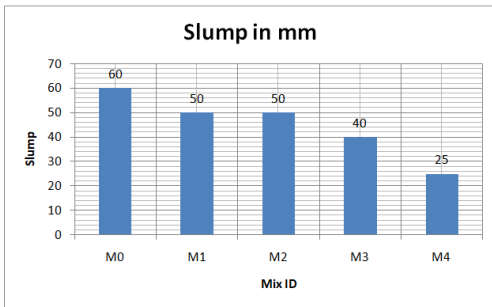
- 7 days specimens age
- 28 days specimens age

Durability of concrete

- 90 days specimens age

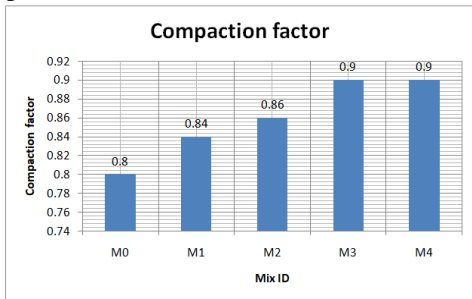
5. Results and analysis

Slump cone test results



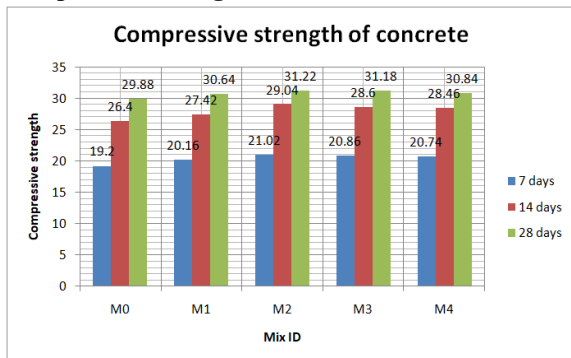
Comparison of slump cone test results

Compaction factor test results



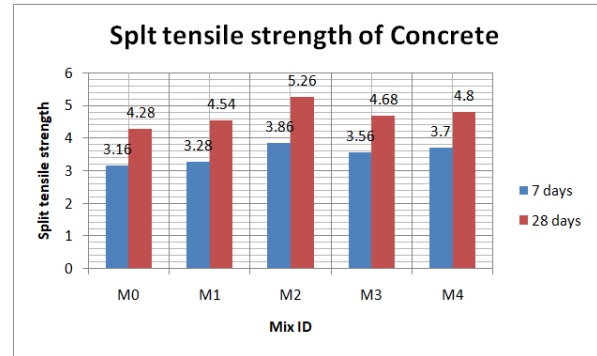
Comparison of compaction factor test results

Compressive strength of concrete



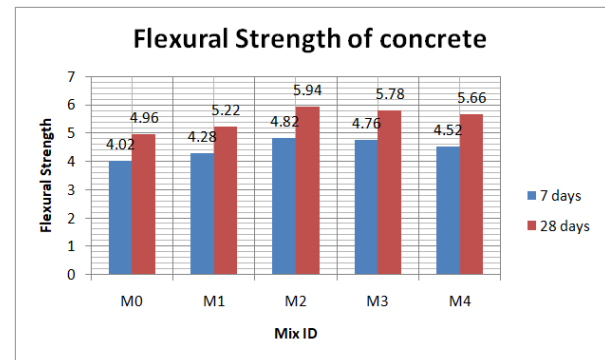
Comparison of compressive strength

Split tensile strength



Comparison of split tensile strength

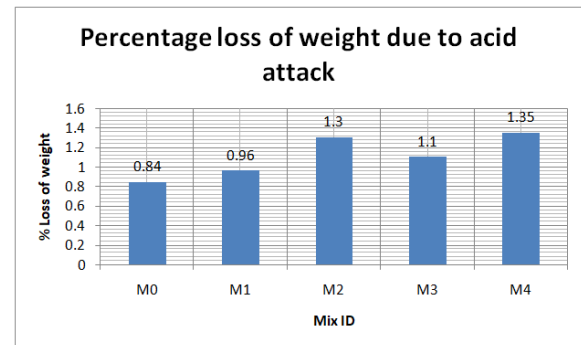
Flexural strength



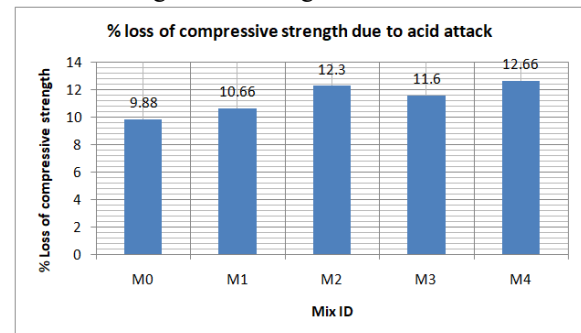
Comparison of flexural strength

Durability of concrete

Acid attack test

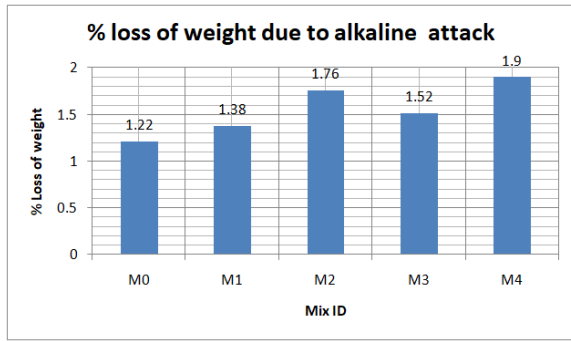


Percentage loss of weight due to acid attack

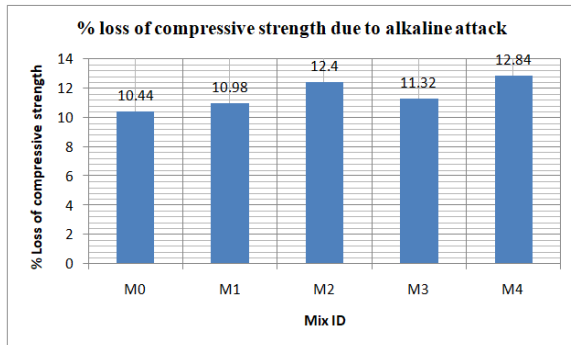


Percentage loss of strength due to acid attack

**Alkaline attack test**

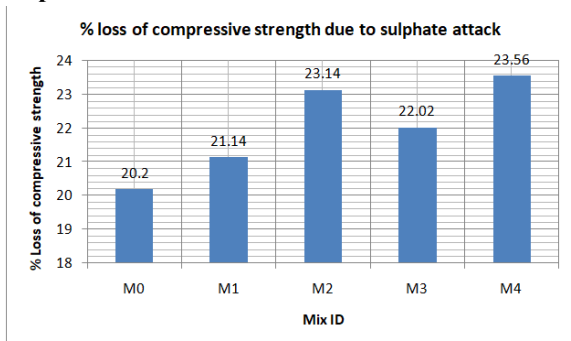


Percentage loss of weight due to alkaline attack



Percentage loss of strength due to alkaline attack

**Sulphate attack test**



Percentage loss of strength due to sulphate attack

**6. Conclusions**

From this study the following conclusions were made

1. By using fly ash, Rice husk ash and egg shell powder in concrete will reduces the cost of construction and increases the strength for certain percentage of replacement of cement.
2. The value of slump decreases with increase in the percentage of fly ash, Rice husk ash and egg shell powder from M0 Mix to M4 mix.
3. The value of compaction factor decreases with increase in the percentage of fly ash, Rice husk

ash and egg shell powder from M0 Mix to M4 mix.

4. The optimal value (maximum value) of compressive strength was observed at 5%FA+5%RHA+5%ESP (M2) for 7days, 14 days and 28 days. After 5%FA+5%RHA+5%ESP (M2) the compressive strength of concrete decreases.
5. The optimal value (maximum value) of split tensile and flexural strength was observed at 5%FA+5%RHA+5%ESP (M2) for 7days, 14 days and 28 days. After 5%FA+5%RHA+5%ESP (M2) the compressive strength of concrete decreases.
6. Addition of fly ash, Rice husk ash and egg shell has resulted in enhanced early strength and ultimate strength of concrete.
7. The partial replacement of cement results in reduction in the emission of green gases.
8. The easy availability of fly ash, Rice husk ash and egg shell and their lesser cost affects in cheaper economy.

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