

# Experimental Analysis on Concrete as Partial Replacement of Eggshell & Cal-Sil Powder

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**Abstract**— The aim of this project is to prevent the pollution of environment by the improper disposal of the Eggshell waste, a remain from eggshells domestic waste such as schools, restaurant, bakeries, homes and fast food hotels, by using it as an additive material inform of ash & powder in conventional concrete with grade M20 since it is normally used in construction sites.

This project concentrates on mix design, material testing of ingredients of concrete such as cement, fine aggregate, coarse aggregate and eggshell powder and eggshell ash and cal-sil powder. Concrete cubes and cylinders with various trail percentages of eggshell powder, eggshell ash, cal-sil powder are casted.

Cal-sil powder is the new methodology that the producing calcium silicate from wastes, Calcium silicate gives the good bonding between the aggregate and cement paste, so it is produced by the mixture of glass powder & egg shell ash.

All the results obtained are compared with the conventional ones and the results are consolidated.

**Keywords**— Cal-Sil powder, eggshell ash, egg shell powder, compressive strength, split tensile strength.

## 1. INTRODUCTION

Throughout the world, concrete is being widely used for the construction of most of the buildings, bridges etc. Hence, it has been properly labeled as the back bone to the infrastructure development of a nation. To meet this rapid infrastructure development a huge quantity of concrete is required. Unfortunately, India is not self-sufficient in the production of cement, the main ingredient of concrete and the demand for exceeds the supply and makes the construction activities very costlier. Hence, currently, the entire construction industry is in

search of a suitable and effective the waste product that would consider minimizes the use of cement and ultimately reduces the construction cost.

A large number of food plants are constantly accumulating substantial quantities of eggshell waste. This natural solid waste, although non-hazardous, is directly disposed in the environment. As a consequence, a huge problem of pollution is generated.

A Portland cement is composed of major oxides: lime (CaO), Silica (SiO<sub>2</sub>), Alumina (Al<sub>2</sub>O<sub>3</sub>) and Iron (Fe<sub>2</sub>O<sub>3</sub>).The lime gives the strength to concrete, Eggshell is rich in the lime so it is used as the replacement of binder in concrete. In construction, concrete is a composite building material made from the combination of aggregate and a cement binder. The most common form of concrete consists of Portland cement, mineral aggregates (generally gravel and sand) and water.

Concrete does not solidify from drying after mixing and placement; the water reacts with the cement in a chemical process known as hydration. This water is absorbed by cement, which hardens, gluing the other components together and eventually creating a stone-like material. When used in the generic sense, this is the material referred to by the term concrete. This project is about the effective use of the material eggshell as an additive in conventional concrete.

India is second largest Eggshell powder has not being in use as a stabilizing material and it could be a good replacement for industrial lime, since its chemical composition is similar to that of lime. Chicken eggshell is a waste material from domestic sources such as poultries, hatcheries, restaurants, bakeries, homes and fast food joints. Eggshell waste falls

within the category of waste food; they are materials from the preparation of foods and drinks. In recent years, special attention to public health, contamination of waste resources and polluting the environment.

**2. BACKGROUND AND RELATED WORK**

Earlier works on the combination concrete conducted by scholars have led us to the point that the egg shell powder can be used as a supplement for industrial lime. In their article "Effect of Eggshell powder on the stabilizing potential of Lime on an Expansive clay soil" by O.O. Amu, A.B. Fajobi and B.O. Oke Department of Civil Engineering, Obafemi Awolowo University. There were also studies on using Eggshell powder in wall tile materials. Eggshell powder is rich in  $CaCO_3$ . Based on the researches conducted by M. N. Freire, J. N. F. Holanda in their article "Characterization of avian eggshell waste aiming its use in a ceramic wall tile paste". Opine that the eggshell waste rich in  $CaCO_3$  can be used as an alternative raw material in the production of wall tile material.

**3. MATERIALS USED AND PROPERTIES:**

**3.1 Cement:**

Ordinary Portland cement of grade 43 is used in this project as per IS8112-1989. The properties of cement used are

Specific gravity	3.12
Fineness modulus	3.2%
Initial setting time	34mins
Final setting time	350mins

**3.2 Fine aggregate:**

The river sand (Natural) has been used in this project as per IS383-1970. The properties of the fine aggregate are

Specific gravity	2.63
Fineness modulus	2.69%
Water absorption	0.51%

**3.3 Coarse aggregate:**

The coarse aggregate size of 20mm angular is used in this project. The properties of the coarse aggregate are

Specific gravity	2.63
Fineness modulus	2.69%
Water absorption	0.51%

**3.4 Eggshell ash:**

Eggshells are collected from government schools, hotels etc. and dried in sunlight. The Collected eggshells are ignited with kerosene and the eggshell ash has been collected.



Fig 1: Preparation Of Eggshell Ash

The properties of the eggshell ash are

Specific gravity	2.75
Fineness modulus	6.7%

**3.5 Egg shell powder**

Egg shell which is collected from government schools, hotels and dried in sunlight. Collected eggshells are powdered by the grinder.



Fig 2: Preparation Of Eggshell Powder

The properties of eggshell powder are

Specific gravity	3
Fineness modulus	5.9%

**3.6 Cal-Sil Powder**

The eggshell is collected from government schools, hotels etc. Collected eggshells are ignited with kerosene and eggshell ash is prepared. The glass wastes are broken and glass powder is prepared. The eggshell ash and glass powder is mixed. Mixed powder is kept in oven at above 350 deg.cel.

The properties of cal-sil powder are

Specific gravity	2.67
Fineness modulus	5.9%



Fig 3: Preparation Of Glass Powder

**3.7 Water**

In this project, the ordinary portable water is used for both mixing and curing.

#### 4. MIX DESIGN

##### 4.1 DESIGN FOR MIX CONCRETE

Characteristics compressive strength = 20N/mm<sup>2</sup>

Required in field after 28 days

Maximum size of aggregate = 20 mm (angular)

Degree of workability = 0.9

Degree of quality control = Good

Type of exposure = Mild

Grade of concrete- M20

##### 4.2 TARGET STRENGTH

Target strength,  $F_t = f_{ck} + t_s$

$$= 20 + (1.65 \times 4)$$

$$= 26.6$$

##### 4.3 WATER CONTENT:

Water-cement ratio=0.5

Estimated water content=186+186 x 3/100

$$= 191.6 \text{ kg/m}^3$$

##### 4.4 CEMENT CONTENT:

Cement content=191.58/0.5=383.2 kg/m<sup>3</sup>

##### 4.5 FINE AGGREGATE CONTENT:

$$V = w + c / s_c + 1/p + f_a / s_{fa} \times 1/100, V = 0.98$$

$$\text{Fine aggregate} = 727 \text{ kg/m}^3$$

Water	Cement	Fine Aggregate	Coarse Aggregate
191.61 kg/m <sup>3</sup>	383 kg/m <sup>3</sup>	727 kg/m <sup>3</sup>	1103 kg/m <sup>3</sup>
0.5	1	1.5	3.3

##### 4.6 COARSE AGGREGATE CONTENT:

Coarse aggregate=1-p/p x fa x sca/sfa

$$= 1 - 0.33 / 0.33 \times 586.2 \times 2.75 / 2.68$$

$$= 1103 \text{ kg/m}^3$$

TABLE 1: MIX DESIGN

##### 4.7 Mix Proportion

Cement is replaced by egg shell ash at 0%, 5%, 10%, 15% and fine aggregate is replaced by eggshell

Powder at 0%, 5%, 10%, 15% and cement is replaced by cal-sil powder at 5%, 10%, and 15%.

#### 5. CASTING OF SPECIMENS

The concrete is mixed as per mix design for the all concrete. The mixture is casted in cubes has dimension of 150mm x 150mm x 150mm and cylinder has dimension of 150mm diameter and 300mm height. The moulds were casted and compacted on table vibrator. Demoulding was done after 24 hours of casting and specimens are cured in water tank.



Fig 4: Casting Of Concrete

Percentage	Eggshell ash concrete	Eggshell powder concrete	Cal-sil concrete
5	30.67	31.11	32.00
10	30.00	30.22	31.11
15	28.67	27.56	30.22

#### 6. TESTING OF SPECIMEN

##### 6.1 Compressive strength of concrete

The casted concrete is cured in tank which consists full of water for 28 days, the concrete is tested in CTM. The tests are done for 7days and 28 days as shown in fig.



Fig 4: Compressive Test In Ctm

**6.2 SPLIT TENSILE STRENGTH**

The casted concrete is cured in tank which consists full of water for 28 days, the concrete is tested in UTM. The tests are done for 28 days.



Fig 5: Split Tensile Strength Test In Utm



Fig 6: Split Tensile Strength Test

**7.RESULTS AND COMPARISION**

Chart 1 represents the comparison of compressive strength of the eggshell ash concrete , eggshell powder concrete , cal-sil concrete in 7 days.

Percentage	Eggshell ash concrete	Eggshell powder concrete	Cal-sil concrete
5	21.11	20.44	21.77
10	16.66	17.77	19.33
15	14.44	17.33	18.22

TABLE 2: COMPRESSIVE STRENGTH IN 7DAYS

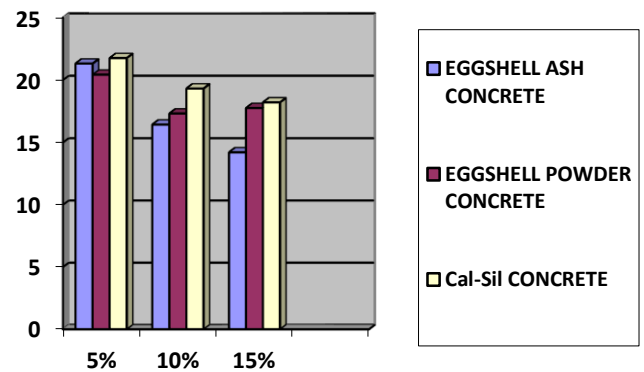


Chart 1: Compressive Strength In 7days

Chart 2 represents the comparison of compressive strength of the eggshell ash concrete, eggshell powder concrete, cal-sil concrete in 28 days.

Percentage	Eggshell ash concrete	Eggshell powder concrete	Cal-sil concrete
5	1.33	1.29	1.32
10	1.29	1.29	1.34
15	1.34	1.33	1.39

TABLE 3: COMPRESSIVE STRENGTH IN 28 DAYS

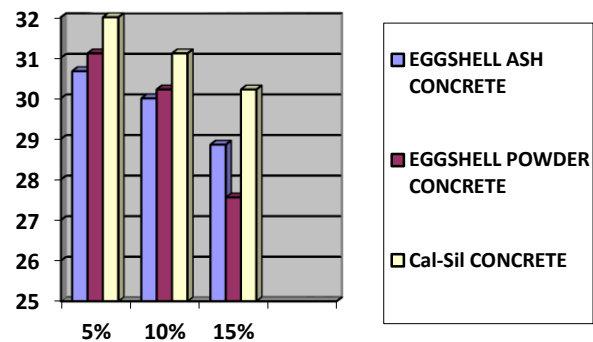


Chart 2: Compressive Strength In 28 Days

Chart 3 represents the comparison of split tensile strength of the eggshell ash concrete , eggshell powder concrete , cal-sil concrete in 28 days.

TABLE 4: SPLIT TENSILE STRENGTH IN 28DAYS

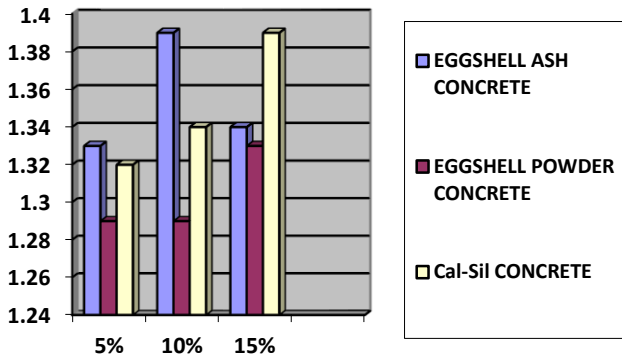


Chart 3: Split Tensile Strength In 28days

### 8. CONCLUSION

Based on the above experimental analysis the below conclusion has been drawn,

- Based on the results of these works it can be concluded that egg shell ash mixed cubes has equal strength with that of conventional concrete cubes in certain categories.
- M20 cubes takes equal load compared to conventional concrete, and It is equal grade concrete’s load carrying capacity is slightly decreased.
- The Cost of the construction has been reduced by adding the waste egg shells to the materials of construction.
- The pollution in landfill by the decomposition of the egg shell has been reduced
- The compressive strength & split tensile strength of 5% eggshell ash concrete, eggshell powder concrete , Cal-Sil concrete is higher than the all results in this experimental analysis.

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