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# An Experimental Study on Partial Replacement of Cement with Eggshells Powder and Aggregates with Coconut Shells

**M.Murali Krishna [1], P.NageswaraRao [2]**

*[1] P.G student, Department of civil engineering, A.S.R.College Of Engineering & Techonology, Tanuku, (AP)*
*[2]Assistant Professor,Department of civil engineering. A.S.R.College of Engineering & Techonology, Tanuku,(AP).*

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**Abstract :** In the construction, the cost of building materials are rising day by day, use of alternative material is a partial replace of coarse aggregate in solving part of natural aggregate and partial replacement of cement. The waste materials are used such as coconut shells, eggshells powder, cockle shell, periwinkle shell, foundry sand etc. So here in our project we will use coconut shells waste as replacement of coarse aggregate and eggshells powder as replacement of cement by different percentage for making concrete of different grade like M-20 with a ratio of proportion (1:1.5:3). Concrete made from coconut shells waste as coarse aggregate and eggshells powder as cement will be studied for compressive strength, tensile strength, and flexural strength, the percentage replacement will be 0%, 5%, 10%, and 15% with natural coarse aggregate. 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 of). The shell itself is about 95% CaCo3 (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. So replacement both eggshells powder and coconut shells in concrete. Then prepare cubes, cylinder and test the cubes by experimentally like compression test, finally slump test, tensile strength test, split tensile strength test and flexural strength test will be conducted to obtain the results. The use of eggshells powder and coconut shells in concrete reduces the cost of raw materials with high strength durability and light weight of concrete. A large number of trial mixes are required to select desired optimum replacement of aggregate by coconut shells and cement by eggshells powder waste material. So in our concept of the project is replacing the coconut shells and eggshells powder on concrete to achieve the required strength of concrete.

## 1.INTRODUCTION;

Concrete is the most commonly used building material in the world. Its huge popularity is a consequence of several advantages, such as general availability, wide applicability and low cost. These advantages are also accompanied by a great environmental burden. The billions of tons of raw materials mined and processed each year leave a mark on the environment. Furthermore, during the production of Portland cement large quantities of CO2 are released into the atmosphere and enormous amount of energy are required. Portland cement is one of the most important ingredients of concrete. The environmental load of concrete can be reduced by the partial replacement of Portland cement with other cement alternatives or additives. These cement replacing materials could be fillers or waste products. Among them, eggshell powder and coconut shell waste has been proposed to be a promising cement and aggregate replacement. Large amounts of coconut shell waste which are most important natural fillers are produced in tropical countries like Malaysia, Thailand and Srilanka. As well as eggshell are generally available from the local areas such as hotels, restaurants .The traditional method of the disposal of the waste is by landfilling. Scarcity of land makes it necessary to find other possibilities to use this waste. Recycling of this eggshell and coconut shell waste is the best solution and will be beneficial for the environment and interesting for the government, since the environmental impact of new materials and the costs for disposing those waste products will be reduced.

This study focuses on eggshell powder and coconut shell as partial replacement of cement and aggregates.

## 2. MATERIALS;

### 2.1 Portland cement;

Portland cement is a rapid- curing binder which was first fabricated in Great Britain in the early
19th century. The name Portland is derived from the Portland formation, a layer of rocks with the same properties, from which Portland stone was mined. Portland stone is a white sandy limestone. The mineral compounds of Portland cement are always the same, but the proportions can be different.

**Table 1: chemical composition of cement**

| Oxides | Percentage content |
|---|---|
| CaO | 60-67 |
| $SiO_2$ | 17-25 |
| $Al_2O_3$ | 3.0-8.0 |
| $Fe_2O_3$ | 0.5-6.0 |
| MgO | 0.1-4.0 |
| Alkalies ($K_2O$,$Na_2O$) | 0.4-1.3 |
| $SO_3$ | 1.3-3.0 |

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### 2.2 Egg shell waste (cement replacement);

The eggshell wastelands in the poultry manufacturing have been highlighted because of its recovery potential. Eggshell waste is available in huge amounts from food processing, egg breaking and shading industries. The food indulgence industry is in need for investigations to find other methods for processing and using eggshell waste in an ecological friendly way. Eggshell consist of several growing layers of caco3 and it is a poultry waste to replace cement can have benefits like minimizing use of cement ,conserves natural lime and utilizing waste materials

Figure 1: eggshells

Table 2: Chemical composition of eggshell powder

| OXIDE CONTENTS | PERCENTAGE(%) |
|---|---|
| Cao | 50.09 |
| Sio2 | 0.09 |
| Al2o3 | 0.03 |
| Mgo | 0.01 |
| Fe2o3 | 0.02 |
| Na2o | 0.19 |
| P2o5 | 0.24 |
| Sro | 0.13 |
| Nio | 0.001 |
| So3 | 0.57 |
| Cl | 0.219 |

### 2.3 Coconut shells (Aggregates replacement)

The budding if waste coconut shells are used as a alternative for coarse aggregate in concrete. After the coconut is tattered out, the shell is regularly discharged. The bulk density of coconut shell is about 500 -600 kg/m3, producing concrete of about less than 2000kg/m3 in density, which makes that light weight. the coconut shell concrete straight forward attains the strength around 17 N/mm2.for the past 10 years light weight concrete getting a maximum hold in the construction industry.

**EXPERIMENTAL METHODOLOGY**

### 3. Mix Design;

Ft = FCK + 1.65.S

Ft = target average compressive strength at 28 days FCK = characteristics compressive strength at 28 days S = standard deviation.

Mass of fine aggregate is calculated from below formula:

V = [W+(C/G C) +( 1/(1-P)*(F* A/ Gf)]*(1/1000). Similarly mass of coarse aggregate is calculated from below formula:

v = [W+(c/GC)+1/(1-p)*((F-A)/Gf]*(1/1000)

Where;

V = absolute volume of concrete, m3

W = mass of total water, Kg/m3

C = mass of cement, Kg/m3

GC= specific gravity of cement

P = ratio of the aggregate to total aggregate by absolute volume

F.A, C .A = total masses of fine aggregate and coarse aggregate, Kg/m3

Gf, Gca = specific gravity of standard surface – dry sand and coarse aggregate.

### 3.1 Details of mix design as per IS: 10262-2009

**Design specifications:**

Characteristic compressive strength at 28 days (F c k ) = 20 N/mm2 (M20) Maximum size of aggregate = 20mm

Degree of workability (assumed) = 0.94

Degree of quality control (assumed) = good

Assumed type of exposure = mild

Test data for materials: Cement used = OPC 53 grade Specific gravity of cement = 3.09

Specific gravity of coarse aggregate = 2.89

Specific gravity of fine aggregate = 2.41 (zone III)

Standard deviation for M20 grade and good degree of control (s) = 4

(S is taken as greater of two values given in IS: 456-2000 and IS: 10262-2009)

Target average compressive strength at 28 days, Fc k = F c k + K.S = 20 + (1.65*4)

= 26.6 M Pa

1. **Selection of water-cement ratio:**

From fig 11.09 the water cement ratio required for target mean strength of 26.6Mpa is 0.50

W/C=0.50

Required sand content as the % of total aggreagate by absolute volume

35-3.5=31.5

Required water content=186+(186*(3/100))

= 191.6

Water cement ratio = 0.50

Water content = 191.6 Kg/m3

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Cement content, C = (water content) / (W/C ratio) = 191.6/0.50 = 383 Kg/m3
For 20mm max.
Size of aggregate entrapped air % of volume of concrete = 2%.

**2.Fine aggregate content:**

Volume V = [W+(C/S C) + 1/P*(F a / S f a)]*(1/1000) Where,
V = absolute volume = (1-0.02) = 0.98
W = water content = 191.6 Kg/m3
C = cement content = 383 Kg/m3
S c = specific gravity of cement = 3.09
P = ratio of F.A to total aggregate by absolute volume
= sand content required by total absolute volume
= 31.5/100 = 0.315
f a = fine aggregate, Kg/m3
S f a = specific gravity of fine aggregates = 2.43
V = [W+(C/S C) + 1/P*(F a / S f a)]*(1/1000)
0.98 = [191.6 + (383/3.09 + (F a /[0.315*2.43])] F a = 507.69Kg/m3
= 508kg/m3
Weight of coarse aggregate:
C a = [(1-P)/P]* f a *(S c a / S f a)]
= [(1-0.315))/0.315]* 508 * (2.69/2.43)]
= 1222.89Kg/m3
Cement: fine aggregate: coarse aggregate
383: 508 : 1223
1: 1.32: 3.19
Hence the final mix proportion = water: cement: F.A: C.A
= 0.50: 1: 1.32: 3.19

**4.TESTS ON MATERIALS;**

**1.CEMENT:**

**1.1 FINENESS TEST:**

| S.no | MATERIAL | FINENESS |
|---|---|---|
| 1. | Cement | 98% |
| 2. | Eggshell powder | 100% |

**1.2 INITIAL & FINAL SETTING TIME:**

| S.no | Setting time | Cement | Replaced cement(5%) | Replaced cement(10%) | Replaced cement(15%) |
|---|---|---|---|---|---|
| 1 | Initial setting time | [illegible] | [illegible] | [illegible] | [illegible] |
| 2 | Final setting time | [illegible] | [illegible] | [illegible] | [illegible] |

**1.3 SOUNDNESS OF CEMENT:**

| S.no | CEMENT | REPLACED CEMENT(5%) | REPLACED CEMENT (10%) | REPLACED CEMENT (15%) |
|---|---|---|---|---|
| 1 | 10mm | 4mm | 2mm | 1.5mm |

**1.4 SPECIFIC GRAVITY OF CEMENT:**

| S.no | CEMENT | EGGSHELLS POWDER |
|---|---|---|
| 1 | 3.10 | 1.20 |

**2.TESTS ON FINE AGGREGATES;**

**2.1 FINENESS MODULUS OF SAND:**

| S.no | Sand type | Range |
|---|---|---|
| 1 | Fine | 2.4 to 2.6 |
| 2 | Medium | 2.6 to 2.8 |
| 3 | Coarse | 2.8 and above |

**2.2 SPECIFIC GRAVITY OF SAND:**

Specific gravity = (W2-W1)/ ((W4-W1)-(W3-W2))=2.43

**2.3 SIEVE ANALYSIS OF FINE AGGREGATES:**

| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
|---|---|---|---|---|---|---|
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
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| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |

## 2.4 BULKING OF SAND:

| S.no | [illegible] | [illegible] | [illegible] | [illegible] |
|---|---|---|---|---|
| 1 | [illegible] | [illegible] | [illegible] | [illegible] |
| 2 | [illegible] | [illegible] | [illegible] | [illegible] |
| 3 | [illegible] | [illegible] | [illegible] | [illegible] |
| 4 | [illegible] | [illegible] | [illegible] | [illegible] |
| 5 | [illegible] | [illegible] | [illegible] | [illegible] |

## 3.TESTS ON COARSE AGGREGATES:

## 3.1 SPECIFIC GRAVITY:

| s.no | Coarse aggregate | Coconut shells |
|---|---|---|
| 1 | 2.78 | 1.285 |

## 3.2 SIEVE ANALYSIS OF COARSE AGGREGATES:

| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
|---|---|---|---|---|
| 1 | [illegible] | [illegible] | [illegible] | [illegible] |
| 2 | [illegible] | [illegible] | [illegible] | [illegible] |
| 3 | [illegible] | [illegible] | [illegible] | [illegible] |
| 4 | [illegible] | [illegible] | [illegible] | [illegible] |
| 5 | [illegible] | [illegible] | [illegible] | [illegible] |
| 6 | [illegible] | [illegible] | [illegible] | [illegible] |
| 7 | [illegible] | [illegible] | [illegible] | [illegible] |
| 8 | [illegible] | [illegible] | [illegible] | [illegible] |

## 3.3 ALOGATION INDEX FOR COARSE AGGREGATES:

| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
|---|---|---|---|---|
| 1 | [illegible] | [illegible] | [illegible] | [illegible] |
| 2 | [illegible] | [illegible] | [illegible] | [illegible] |
| 3 | [illegible] | [illegible] | [illegible] | [illegible] |
| 4 | [illegible] | [illegible] | [illegible] | [illegible] |

## 3.4FLAKINESS INDEX FOR COARSE AGGREGATES:

| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
|---|---|---|---|---|
| 1 | [illegible] | [illegible] | [illegible] | [illegible] |
| 2 | [illegible] | [illegible] | [illegible] | [illegible] |
| 3 | [illegible] | [illegible] | [illegible] | [illegible] |
| 4 | [illegible] | [illegible] | [illegible] | [illegible] |
| 5 | [illegible] | [illegible] | [illegible] | [illegible] |

## 4.TESTS ON FRESH CONCRETE:

## 4.1 SLUMP CONE TEST:

| s.no | Material | Slump(cm) |
|---|---|---|
| 1 | Concrete (0%) | 26 |
| 2 | Concrete (5%) | 25 |
| 3 | Concrete (10%) | 30 |
| 4 | Concrete (15%) | 30 |

## 4.2 COMPACTION FACTOR TEST:

| s.no | materials | Compaction value |
|---|---|---|
| 1 | Concrete (0%) | 0.84 |
| 2 | Concrete (5%) | 0.80 |
| 3 | Concrete (10%) | 0.75 |
| 4 | Concrete (15%) | 0.73 |

## 4.3 VEE-BEE TEST:

| s.no | Materials | Vee-bee time(sec) |
|---|---|---|
| 1 | Concrete(0%) | 11.83 |
| 2 | Concrete (5%) | 16 |
| 3 | Concrete (10%) | 18 |
| 4 | Concrete (15%) | 20 |

## 5. TESTS ON THE HARD CONCRETE:

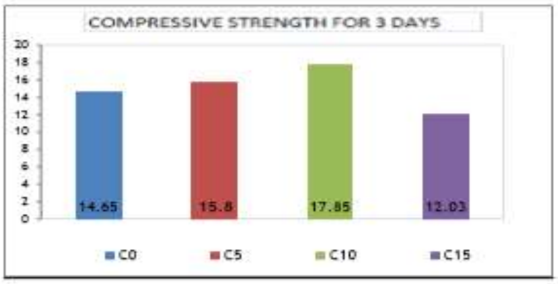
## 5.1COMPRESSION STRENGTH TEST:

| NO.OF DAYS | CONCRETE N/mm^2 | REPLACED CONCRETE(5%) N/mm^2 | REPLACED CONCRETE (10%) N/mm^2 | REPLACED CONCRETE (15%) N/mm^2 |
|---|---|---|---|---|
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |

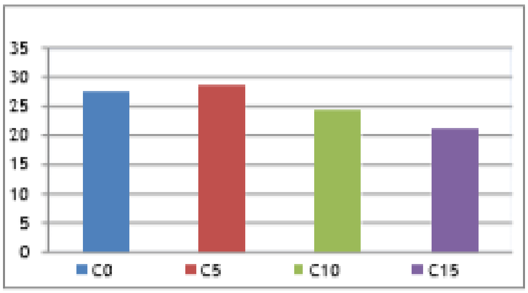
## 5.2 SPLIT TENSILE TEST:

| NO.OF DAYS | CONCRETE N/mm^2 | REPLACED CONCRETE(5%) N/mm^2 | REPLACED CONCRETE (10%) N/mm^2 | REPLACED CONCRETE (15%) N/mm^2 |
|---|---|---|---|---|
| 3 DAYS | 13.6 | 14.2 | 15.8 | 13.0 |
| 7DAYS | 14.4 | 16.8 | 16.9 | 15.4 |
| 14 DAYS | 22.6 | 22.8 | 23.1 | 21.24 |
| 28 DAYS | 28.2 | 29.4 | 29.7 | 25.70 |

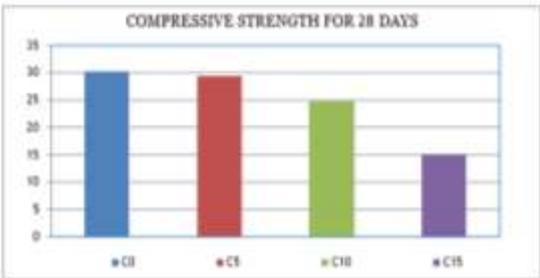
**6.GRAPHS:**

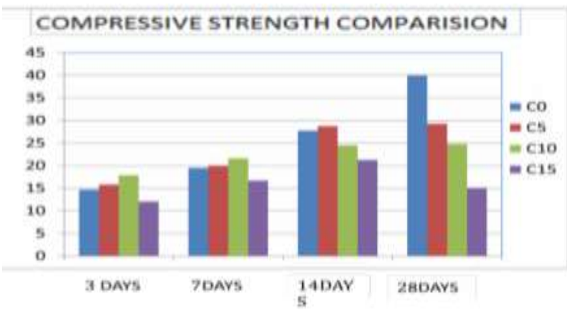



**Compressive strength for 14 days:**

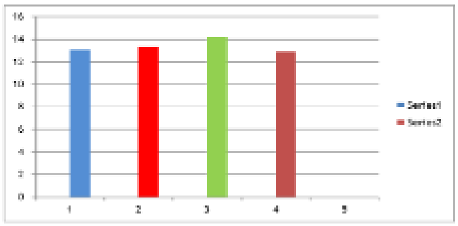



**COMPRESSIVE STRENGTH FOR 28 DAYS:**

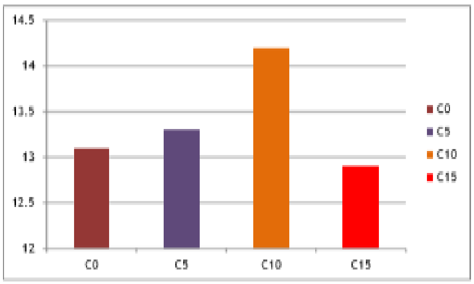


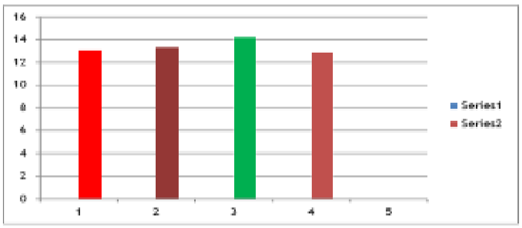

**Split tensile strength for 3 days**



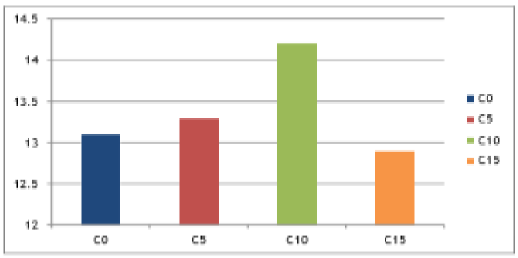
**Split tensile strength for 7 days**




**Split tensile strength for 14 days**




**Split tensile strength for 28 days**



## CONCLUSIONS

1. The eggshells powder of 2.2 grams of calcium in the form of calcium carbonate and 95% dry eggshells is calcium carbonate of 5.5 grams.

2. The specific gravity of the eggshells powder is 0.85 and the moisture content is 1.18 and surface area is 21.2 sq.m per gram.

3. Coconut shells exhibits more resistance against crushing, impact and abrasion.

4. By using coconut shells the aggregates provided volume at low cost comprising 66% to 78% of concrete.

5. By increasing percentage of coconut shells reduces compressive strength of concrete.

6. Using coconut shells on concrete is also termed as structural light weight concrete.
7. The specific gravity of coconut shells is low as compared to coarse aggregates and water absorption is higher for coarse aggregates.

8. The workability of concrete has decreased when compared with ordinary concrete.

9. The compressive strength of concrete is increased for 10% replacement whereas the compressive strength of partially replaced concrete is increased at 3 and 7 and gradually decreased from 14 and 28 days.

10. The replacement of cement with 15% the cubes act as a brittle material when compared to 5% and 10%.

11. The partially replaced act as a admixture which can reduce the setting time.

12. The optimum compressive strength is obtained 12% greater than normal concrete.

## REFERENCES

[1] K. Humphreys and M. Mahasenan, Towards a sustainable cement industry—sub-study 8: climate change, accessed on 12 January 2003.

[2] C. Thomark, Conservation of energy and natural resources by recycling building waste Resources, Conservation & Recycling, 33 (2001), pp. 113–130.

[3] D.Gowsika,et.al, ―Experimental Investigation Of Eggshells Powder as Partial Replacement With Cement in Concrete‖International Journal Of Engineering Trends and Technology (IJETT)- Volume 14 Number 2- August 2014.

[4] Praveen Kumar. R,et.al, ―Experimental Study on Partial Replacement of Cement with Eggshells Powder‖ International Journal of Innovation in Engineering and Technology (IJIET).

[5] Amarnath Yerramala ―Properties of Concrete with Eggshells Powder as Cement Replacement‖ The Indian Concrete Journal October (2014).

[6] Vishwas P.Kukarni and Sanjay Kumar B.Gaikwad 2013, Compared to Study on Coconut Shells Aggregate with Convensional Concrete International Journal ofEngineering and Technology 2 67-70.

[7] Gunasekaran K, Annadurai R and Kumar P S 2012, Long Term Study on Bond Strength of Coconut Shells Aggregate Concrete Journal of Construction and Building Materials 28 208-215.

## BIOGRAPHIES

M.Muraki Krishna,
P.G student,
ASR College of Engineering
Tanuku.

P.Nageswara Rao,
Assistant Professor,
ASR College of Engineering
Tanuku.