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# STRENGTH AND DURABILITY PROPERTIES OF CONCRETE USING GROUNDNUT SHELL AS FINE AGGREGATE

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***Abstract***: *This report presents experimental study on effect of replacement of fine aggregate by Groundnut shell (GS). GS is used in concrete to minimize the demand of fine aggregate. The groundnut shells are available as agricultural waste in large amount every year. The groundnut shells were replaced in various percentages as 5%, 10%, 15% and 20% by weight of fine aggregate. The strength and durability properties of concrete were tested and compared with the conventional concrete. By comparing these test results 5% replacement of groundnut shell shows better results than the conventional concrete for both strength and durability tests.*

***Index Terms*** **– Groundnut shell, strength, durability.**

## 1. INTRODUCTION

Industrial development across the world created demand for the construction materials like cement, fine aggregate and coarse aggregate. Huge amount of groundnut shells were disposed as agricultural wastes in the agricultural farm every year. These agricultural wastes are either burnt or dumped in the lands. By burning of these wastes the environment gets polluted. So many investigations were carried out to utilize these agricultural groundnut shell wastes. In this study the groundnut shells were utilized for the replacement of fine aggregate of various percentages. The concrete thus obtained shows better strength and durability properties.

## 2. Literature review

**Alabadan, B. A.,et al. (January-June 2005),** the paper on partial replacement of ordinary Portland cement (OPC) with Bambara groundnut shell ash (BGSA) in concrete. The ash contained 10.91% CaO, 2.16% $Fe_2O_3$, 4.72% MgO, 33.36% $SiO_2$, 1.75% $Al_2O_3$, 16.18% $K_2O$, 9.30% $Na_2O$, 6.40% $SO_3$, 6.02% $CO_3$ and 9.20% $HCO_3$. 10%, 20%, 30%, 40% 50% and 0% ash was used in the mix to replace cement. The strength of cement/ash concrete increased with curing period but decreased with increasing ash percentage. The highest strength was 31.24N/mm$^2$ and 20.68N/mm$^2$ at 28 days for 0% and 10% ash respectively. Substitution of cement with ash in concrete formation was relatively possible not exceeding 10%.Though the strength of OPC/BGSA concrete was lower than that of 100% cement; it can be used for light load bearing elements.

**B.A. Alabadan et al., (2006)** estimates the Potentials of Groundnut Shell Ash as Concrete Admixture, Pozzolanic materials have long demonstrated their effectiveness in producing high-performance concrete. Artificial pozzolana such as rice husk ash have gained acceptance as supplementary cementing materials in many parts of the world. This work evaluates the potentials of groundnut shell ash (GSA) as a partial replacement for ordinary Portland cement (OPC) in concrete. Chemical analysis of the ash was carried out to ascertain whether it possesses pozzolanic or cementing properties and the partial replacement of OPC by GSA was varied from 0% to 70% in the concrete**.**

**T.S.Ketkukah and E.E.Ndububa (2006)** studied Groundnut Husk Ash as a partial replacement of cement in mortar. This paper examines some properties of Ordinary Portland Cement (OPC) and Groundnut Husk Ash (GHA) mortar. The GHA was used as a partial replacement of OPC. The replacement levels of 0%, 2%, 4%, 6%, 8% and 10% ash were used. The chemical analysis of the ash carried out ascertained its pozzolanic properties. The initial and final setting times of the paste were 95 minutes and 11 hours respectively. The density and water absorption capacity of the mortar decreased as the percentage of ash increased. OPC/GHA mortar is recommended for production of sandcrete blocks in hot weather climate.

**Nwofor, T.C., and Sule, S.,(2012),** this paper is based on the use of considerable volume of groundnut shell ash as the partial replacement for cement in concrete production. A total of 100 specimens of the GSA/OPC concrete were cured in cubes of 100mm dimension for 7, 14, 21 and 28 days and the compressive strength and density determined. The utilization of ground nut shell ash

reduces the environmental problems and also replacement level of (0-40%) gives high compressive strength. A percentage replacement of 10% is suggested for sustainable construction, especially in mass concrete constructions.

**Mahmoud,H.,(November 2012),** the paper investigates the production of sandcrete blocks using groundnut shell ash (GSA) as cement replacement was investigated. Six number sandcrete blocks were cast for each replacement levels (0, 10,20,30,40, and 50 percentage) with GSA. The blocks were cured and crushed at 7, 14, 21, and 28 days. The results show that the compressive strength ranges from 4.50 N/mm$^2$ to 0.26N/mm$^2$.The optimum replacement level was achieved at 20% with a corresponding strength of 3.58 N/mm$^2$.

## 3. MATERIALS USED:

### 3.1 Cement

Cement is the most important material in building construction. Cement acts as a binding material. Ordinary Portland cement is the best suited for use in general concrete construction. It is available in three grades of 33 grades, 43 grades and 53 grades. The cement used in this report is ordinary Portland cement of grade 53.

### 3.2 Fine Aggregate

Natural sand is available from local river beds or pits. An examination should be made on the fineness of the available sand and depending on its fineness; it should be used for the construction purposes. Mostly river sand which is founded by gradation test is used in this project work.

### 3.3 Coarse aggregate

Coarse aggregate is used for making concrete. They may be in the form of irregular broken stone or naturally occurring gravel. Material which are large to be retained on 4.75mm sieve size are called coarse aggregates. Its maximum size can be up to 63mm.

### 3.4 Groundnut shell

Groundnut shells were obtained from nearby farms. It is washed and the soil, dust particles are removed from it. It is dried until the moisture is reduced. After that it is crushed into the size of 4.74mm by mechanical process. The groundnut shell fulfills the fine aggregate properties.

### 3.5 Water

Water is an important ingredient of concrete as it actively participates in chemical reaction with cement. Clean potable water confirming to IS: 456-2000 was used; the water used in the preparation of mortar should not necessarily be distilled water. But it must be free from all acids, dusts and other dissolved matters.

## 4. CONCRETE MIX DESIGN:

In this study M30 concrete was used, the concrete mix design for standard conventional concrete is done by using IS 10262:2009.

**MIX PROPORTION**

| | |
|---|---|
| Cement | = 465kg/m$^3$ |
| Water | = 186 liters/m$^3$ |
| Fine aggregate | = 630.56kg/m$^3$ |
| Coarse aggregate | = 1176.42kg/m$^3$ |
| Chemical admixture | = 1.75kg/m$^3$ |
| Water cement ratio | =0.40 |
| **M30mixratio** | **= 1: 1.35: 2.52:0.40** |

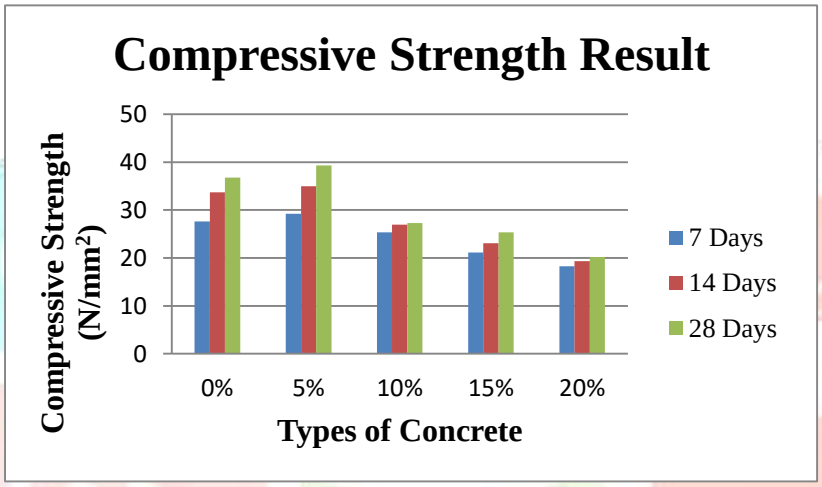
## 5. TESTS on Hardened Concrete

### 5.1 Compressive strength test:

The mould size of 150×150×150mm was used for casting the cube specimens. The cube specimens were immersed in water of 7, 14 and 28 days. After the curing period the compressive strength were calculated.

Table -1 Compressive Test Results

| TYPES OF CONCRETE | COMPRESSIVE Strength IN N/mm2 | | |
|---|---|---|---|
| | 7DAY | 14DAY | 28DAY |
| Conventional | 27.58 | 33.68 | 36.75 |
| Concrete with 5% GS | 29.21 | 34.93 | 39.30 |
| Concrete with 10% GS | 25.36 | 26.93 | 27.31 |
| Concrete with 15% GS | 21.13 | 23.04 | 25.31 |
| Concrete with 20% GS | 18.27 | 19.32 | 20.18 |



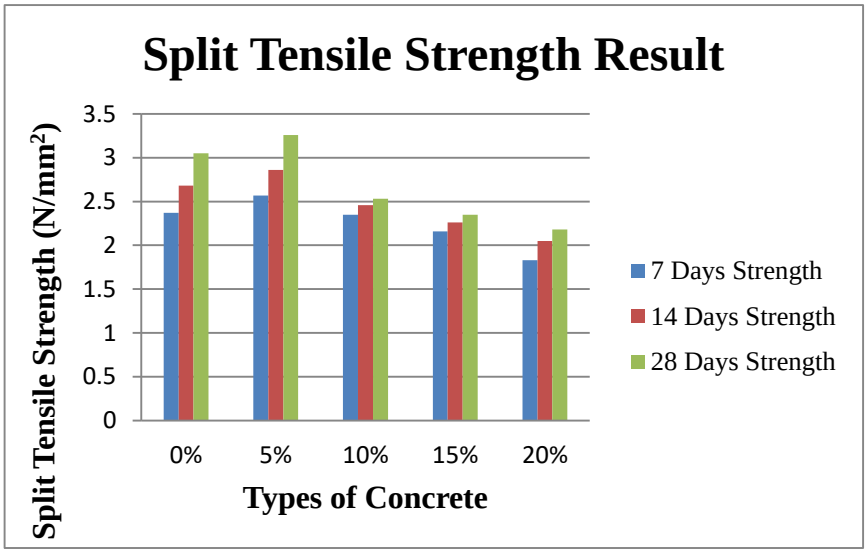

Graph -1 Comparing Test Results of 7, 14, 28 days.

**5. 2 Split Tensile Strength Test**

The split tensile strength test has been carried out and results are as follows.

Table -2: Split Tensile Test Results

| TYPES OF CONCRETE | COMPRESSIVE IN N/mm2 | | |
|---|---|---|---|
| | 7DAY | 14DAY | 28DAY |
| Conventional | 2.37 | 2.68 | 3.05 |
| Concrete with 5% GS | 2.57 | 2.86 | 3.26 |
| Concrete with 10% GS | 2.35 | 2.46 | 2.53 |
| Concrete with 15% GS | 2.16 | 2.26 | 2.35 |
| Concrete with 20% GS | 1.83 | 2.05 | 2.18 |




Graph -2 Comparing Test Results of 7, 14, 28 days.

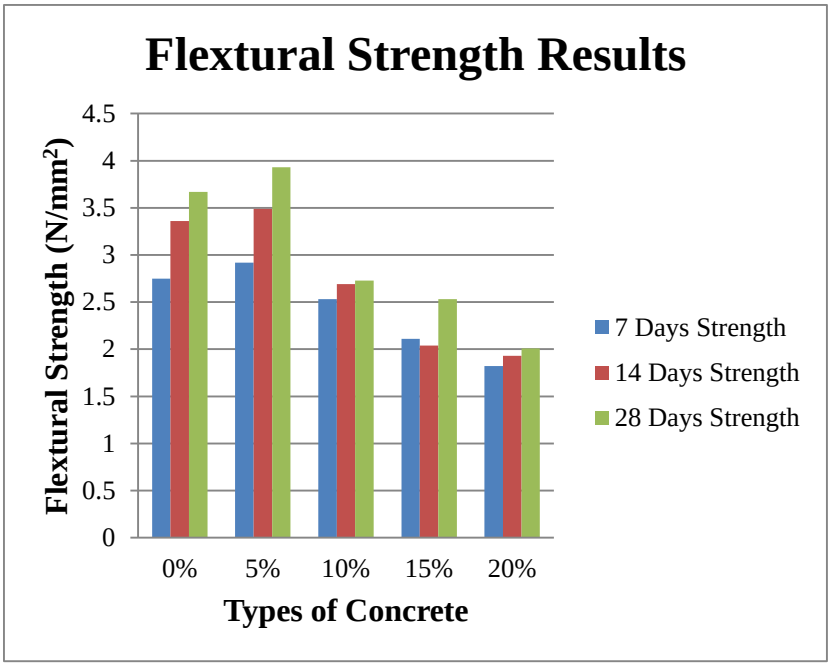
**5.3 Flexural Strength Test**

The flexural strength test has been carried out and results are as follows.

Fig -2: Beam after Load Applied

Table 3- Flexural Test Results of 7, 14,28 days.

| TYPES OF CONCRETE | FLEXURAL STRENGTH N/mm2 | | |
|---|---|---|---|
| Conventional concrete | 2.75 | 3.36 | 3.67 |
| Concrete with 5% GS | 2.92 | 3.49 | 3.93 |
| Concrete with 10% GS | 2.53 | 2.69 | 2.73 |
| Concrete with 15% GS | 2.11 | 2.04 | 2.53 |
| Concrete with 20% GS | 1.82 | 1.93 | 2.01 |




Graph -3 Comparing Flexural Values of Test

**6. Durability Test:**

**6.1 Acid Test**

Tests were carried out according to ASTM G20-8 to obtain weight loss of different type of concrete. Acid test results are shown in Table 4. From result it will be observed that 60 days Hydrochloric acid attack to the concrete increases the weight loss on various proportions of concrete with GS compared to conventional concrete.

Table -4 Test Results for Acid Attacks of various percentages of GS

| TYPES OF CONCRETE | Average weight before(kg) | Average weight after(kg) | Loss(kg) | Loss% |
|---|---|---|---|---|
| Conventional concrete | 8.685 | 8.865 | 0.020 | 0.23% |
| Concrete with 5% GS | 8.653 | 8.618 | 0.035 | 0.40% |
| Concrete with 10% GS | 8.640 | 8.593 | 0.047 | 0.54% |
| Concrete with 15% GS | 8.623 | 8.568 | 0.055 | 0.63% |
| Concrete with 20% GS | 8.610 | 8.548 | 0.062 | 0.72% |

**6.2 Rapid Chloride Penetration Test (RCPT)**

The test was conducted as per ASTM–C 1202–97. Test result of RCPT for various type of concrete is shown in Table 5. From result it will be observed that conventional concrete value and various proportions of concrete with GS values get increased, because of the porous nature of groundnut shells.

Table -5 RCPT Tests Values

| TYPES OF CONCRETE | Charge Passed In Coulombs |
|---|---|
| Conventional concrete | 2895 |
| Concrete with 5% GS | 2900 |
| Concrete with 10% GS | 3180 |
| Concrete with 15% GS | 3292 |
| Concrete with 20% GS | 3374 |

## 7. CONCLUSION:

The following are the conclusions drawn from the study.

The optimum percentage replacement of fine aggregate by groundnut shell is 5% for compressive test of M30 grades of concrete, where compressive strength of concrete with 5% GS replacement is 39.30N/mm$^2$ which is greater than conventional concrete 36.75N/mm$^2$.

The Optimum replacement of fine aggregate by groundnut shell for Tensile strength is 5% for M30 grade of concrete where tensile strength at 5% GS is 3.26N/mm$^2$ which is greater than conventional concrete 3.05N/mm$^2$

The Optimum replacement of fine aggregate by groundnut shell for Flexural strength is 5% for M30 grade of concrete where flexural strength at 5% GS is 3.93N/mm$^2$ which is greater than conventional concrete 3.67N/mm$^2$.

The durability tests like acid test and rapid chloride penetration test shows that the loss percentages and charges passed to the concrete specimen gets increased with the increasing percentages of groundnut shells, due to the porous nature of the groundnut shells.

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