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Experimental Study on Strengthening Of Concrete by Replacing Seashell and Flyash

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ABSTRACT
This paper reports the exploratory study on the suitability of the cockle shells as partial replacement for in concrete. In developing countries where concrete is widely used, the high and steadily increasing cost of concrete has made construction very expensive. The high cost of conventional building materials is a major factor affecting housing delivery in world. This has necessitated research into alternative materials of construction and analyzing tensile and compressive strength characteristics of concrete produced using by sea shells as substitutes for conventional coarse aggregate with partial replacement using M30 grade concrete. The main objective is to encourage the use of these products as construction materials in low-cost building. In this project, cement is partial replacement with Fly ash of about 5%, 10%, 15%. The coarse aggregate is partial replacement with 5%, 10%, and 15% by sea shell. Hardened concrete properties such as compressive strength of the concrete on 7, 14, & 28 days has been achieved. A comparative study was also done based on the obtained results and the variations were plotted.
Keywords: sea shell, partial coarse aggregate replacement, concrete, workability, compressive strength.

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I. INTRODUCTION

Civil engineering practice and construction works in Nigeria depend to a very large extent on concrete. Concrete is one of the major building materials that can be delivered to the job site in a plastic state and can be molded insitu or precast to virtually any form or shape. Its basic constituents are cement (binding material), fine aggregate (sand), coarse aggregate (granite chippings) and water.

Hence, the overall cost of concrete production depends largely on the availability of the constituents. In Nigeria, a 50kg bag of cement is sold at almost uniform price with slight deviations in every state of the federation and fine aggregates are readily available. However, the cost of concrete is directly proportional to the cost of crushed stones or local gravels, which increases from the north to the south. Cost of construction in the Niger Delta areas especially the south-south zone is highest. Thus, alternatives lightweight options are adopted for non-load bearing walls and non-structural floors in buildings.

Different alternative waste materials and industrial byproducts such as fly ash, bottom ash, recycled aggregates, foundry sand, china clay sand, crumb rubber, glass were replaced with natural aggregate and investigated properties of the concretes. The basic constituents of concrete are cement, water and aggregate (and selected additives). Cement is produced by heating limestone and clay to very high temperatures in a rotating kiln. Cement is produced by grinding the resulting clinker to a fine powder. Water reacts chemically with cement to form the cement paste, which essentially acts as the "glue" (or binder) holding the aggregate together. The reaction is an exothermic hydration reaction. The water cement ratio is an important variable that needs to be "optimized". High ratios produce relatively porous concrete of low strength, whereas too low a ratio will tend to make the mix unworkable. Aggregates are usually described as inert "filler" material of either the fine (sand) or coarse (stone) variety. Aggregate tends to represent a relatively high volume percentage of concrete, to minimize costs of the material. Seashell is also known simply as a shell, is a hard, protective outer layer created by an animal that lives in the sea. The shell is part of the body of the animal. Empty seashells are often found washed up on beaches by beachcombers. The shells are empty because the animal has died and the soft parts have been eaten by another animal or have rotted out. The term seashell usually refers to the exoskeleton of an invertebrate (an animal without a backbone). Most shells that are found on beaches are the shells of marine molluscs, partly because many of these shells endure better than other seashells. Seashells have been used by humans for many different purposes throughout history and pre-history. However, seashells are not the only kind of shells; in various habitats, it is possible to find shells from freshwater animals such as freshwater mussels and freshwater snails, and it is also possible to find the shells of land snails. **Fly ash** is also known as flue-ash, is one of the residues generated in combustion, and comprises the fine particles that rise with the flue gases. Ash which does not rise is termed bottom ash. In an industrial context, fly ash usually refers to ash produced during combustion of coal.

II. EXPERIMENTAL INVESTIGATIONS

2.1 MATERIALS

2.1.1 Cement: In this experimental investigation Ordinary Portland cement of 53 grade is used The properties of Cement are as follows in table 2.1:

TABLE 2.1. PROPERTIES OF CEMENT

S.No	Property	Value
1.	Specific Gravity	3.15
2.	Initial Setting Time	85minutes
3.	Standard Consistency	32%
4.	Fineness	1.75

2.1.2 Fine Aggregate: Natural river sand with fraction passing through 4.75mm sieve and on 150μm sieve was used and tested as per IS: 2386-1983. The important properties tested for the aggregate are given below in the table 2.2

TABLE 2.2 PROPERTIES OF FINE AGGREGATE

S.No	Property	Value
1.	Specific Gravity	2.66
2.	Fineness modulus	2.73
3.	Water absorption	1.24

2.1.3 Coarse Aggregate: crushed granite coarse aggregate of size 15.5mm was used and tested as per IS:2386-1983.The important properties tested for coarse aggregates are given below in the table 2.3

TABLE2.3 PROPERTIES OF COARSE AGGREGATE

S.No	Property	Value
1.	Specific Gravity	2.74
2.	Water absorption	0.54

2.1.4 seashell

Seashell is also known simply as a shell, is a hard, protective outer layer created by an animal that lives in the sea. Seashell consists of three layers outer, intermediate and inner layer. Outer layer is made up of calcite material whereas inner layer is otherwise known as nacre which is made up of calcium carbonate. since 95% of calcium carbonate present in seashell; it has the strength nearly equal to coarse aggregate**.**The properties of sea shell shown in the table 2.4

Figure 2.1 sea shell

TABLE 2.4.PROPERTIES OF SEA SHELL

S.No	Properties and composition	Value
1.	Specific gravity	2.34
3.	Absorption (%)	0.1
4.	Moisture Content (%)	Nil
5.	Impact value	52.8

2.1.5 flyash

Fly ash is generally captured by electrostatic precipitators or other particle filtration equipment before the flue gases reach the chimneys of coal-fired power plants, and together with bottom ash removed from the bottom of the furnace is in this case jointly known as coal ashdecomposition. The properties of fly ash is shown in the table 2.5

Figure 2.2 fly ash

TABLE 2.5. PROPERTIES OF FLY ASH

S.No	Properties and composition	Value
1.	Specific Gravity	2.72
2.	Bulk Density(kg/m3)	1741
3.	Water absorption	1.73

III. MIX PROPORTIONS

Mix design is carried out as per EFNARC Specifications which satisfied the workability test methods on concrete. The MIX PROPORTIONS of SCC as shown in the table 2.5.

TABLE 2.5. MIX PROPORTIONS

Cement	385 kg/m^3
Fine aggregate	736 kg/m^3
Coarse aggregate	1137 kg/m^3
water	186 kg/m^3

IV. WORKABILITY TEST METHODS

5.1.1 Slump Flow Test: The slump flow is used to assess the horizontal free flow of Self Compacting Concrete in the absence of obstruction. This method is based on the test method for determining the slump.

V. SPECIMEN PREPARATION

Concrete cubes specimens (150 mm x 150 mm x150mm) for 45cubes were casted for computing compressive strength. The cylindrical specimens (diameter- 150 mm and length- 300 mm) for 30cylinders were casted to determine spilt tensile strength of concrete. The prism specimens (150 mm x 150 mm x150mm) for 30prisms were casted for computing flexural strength. All the specimens were cured for a period of 28 days before test.

VI. RESULTS AND DISCUSSIONS

After a detailed study we have obtained the following results for compression, split tensile strength and flexural strength.

6.1COMPRESSIVE STRENGTH

The specimen is tested by compression test machine after 7 days, 14 days and 28 days curing. Load should be applied gradually at the rate of 140kg/cm^2 per minute till specimens fails. Load at the failure divided by area of specimen gives the compressive strength of concrete.

TABLE 6.1 RESULTS FOR COMPRESSIVE STRENGTH

Sl.No.	% of FA & SS	Compressive strength N/mm^2		
		7D	**14D**	**28D**
1.	Nominal Mix	22.1	27.9	33.1
2.	5% FA & 5% SS	23.9	30.4	36.3
3.	10% FA & 10% SS	24.6	31.7	37.8
4.	15% FA & 15% SS	24.9	31.5	35.4

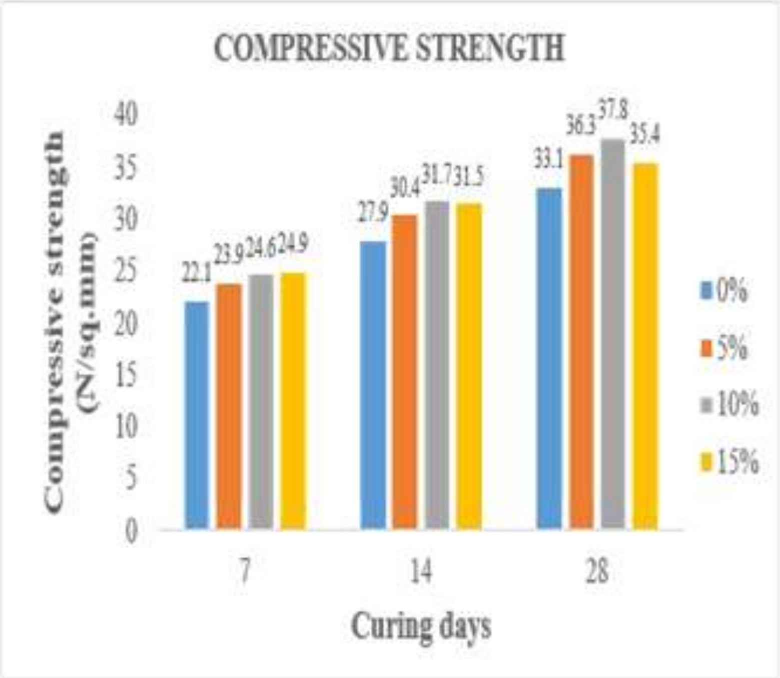


Figure 6.2 compressive strength for various proport

6.2 SPLIT TENSILE STRENGTH

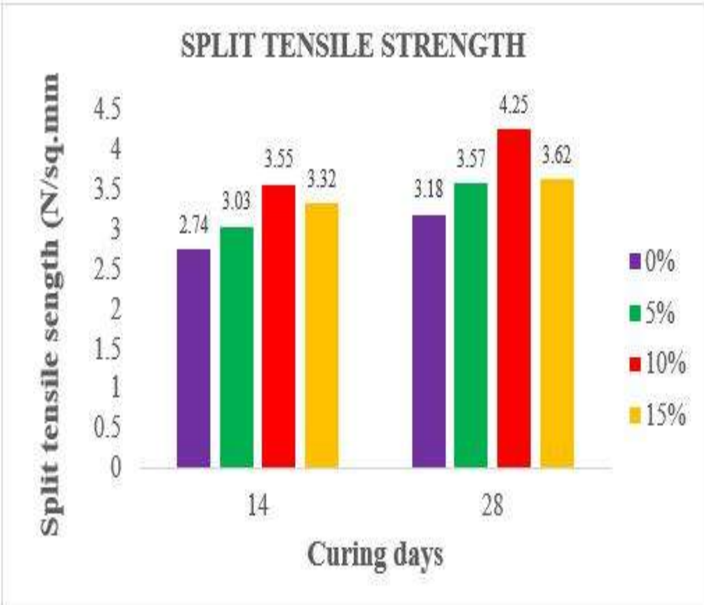
The tensile strength of concrete is one of the basic and important properties. Splitting tensile strength test on concrete cylinder is a method to determine the tensile strength of concrete. The concrete is very weak in tensile due to its brittle nature and is not expected to resist the direct tension. The concrete develops cracks when subjected to tensile forces. Thus, it is necessary to determine the tensile strength of concrete to determine the load at which the concrete members may cracks.

Figure 6.3 split tensile testing machine

TABLE 6.2 RESULTS FOR SPLIT TENSILE STRENGTH

Replacement Details	**14 days (N/mm^2)**	**28 days (N/mm^2)**
Nominal Mix	2.74	3.18
5% FA & 5% SS	3.03	3.57
10% FA & 10% SS	3.55	4.25
15% FA & 15% SS	3.32	3.62

Figure 6.4 split tensile strength for various proportions of SF and RHA



6.1 FLEXURAL STRENGTH

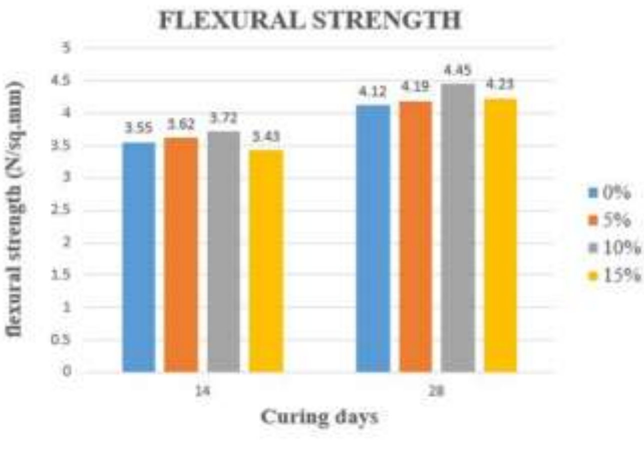
"Flexural strength is one measure of the tensile strength of concrete. It is a measure of an unreinforced concrete beam or slab to resist failure in bending. It is measured by loading 100mm x 100mm x 500mm concrete beam".

Figure 6.4 flexural testing machine

TABLE 6.3 TEST RESULTS FOR FLEXURAL STRENGTH

[1] Replacement Details [2]	**14 days (N/mm^2)**	**28 days (N/mm^2)**
Nominal Mix	3.55	4.12
5% FA & 5% SS	3.62	4.19
10% FA & 10% SS	3.72	4.45
15% FA & 15% SS	3.43	4.23

Figure 6.4 flexural strength for various proportions



VII. CONCLUSIONS

COMPRESSIVE STRENGTH

- For 5% replacement of cement and coarse aggregate, the compressive strength has increased to about 36.3 N/mm^2 from 33.1 N/mm^2 when compared to conventional concrete.
- For 10% replacement of cement and coarse aggregate, the compressive strength has increased to about 37.8 N/mm^2 from 33.1 N/mm^2 when compared to conventional concrete.
- For 15% replacement of cement coarse aggregate, the compressive strength has increased to about 35.4 N/mm^2 from 33.1 N/mm^2 when compared to conventional concrete

SPLIT TENSILE STRENGTH

- For 5% replacement of cement and coarse aggregate, the split tensile strength has increased to about 3.57 N/mm2 from 3.18 N/mm2 when compared to conventional concrete.
- For 10% replacement of cement and coarse aggregate, the split tensile strength has decrease to about 4.25 N/mm2 from 3.18 N/mm2 when compared to conventional concrete.
- For 15% replacement of cement coarse aggregate, the split tensile strength has increased to about 3.62 N/mm2 from 3.18 N/mm2 when compared to conventional concrete.

FLEXURAL STRENGTH

- For 5% replacement of cement and coarse aggregate, the flexural strength has decreased to about 4.19 N/mm^2 from 4.12 N/mm^2 when compared to conventional concrete.
- For 10% replacement of cement and coarse aggregate, the flexural strength has increased to about 4.45 N/mm^2 from 4.12N/mm^2 when compared to conventional concrete.
- For 15% replacement of cement and coarse aggregate, the flexural strength has increased to about 4.23 N/mm^2 from 4.12 N/mm^2 when compared to conventional concrete.

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