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An Experimental Investigation Of Partial Replacement Of Coarse Aggregate With Sea Shell In Concrete

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ABSTRACT :

This experimental study investigates the feasibility and effectiveness of partially replacing coarse aggregate with sea shells in concrete mixtures. The increasing demand for construction materials, coupled with environmental concerns regarding natural resource depletion and waste accumulation, has prompted exploration into alternative materials. Sea shells, abundant in coastal regions, represent a potential sustainable substitute for conventional coarse aggregate. The research methodology involved conducting laboratory experiments to evaluate the mechanical properties, durability, and workability of concrete mixes containing varying proportions of sea shells as a partial replacement for coarse aggregate. The results demonstrate the potential of sea shells to enhance certain properties of concrete while addressing sustainability challenges. Factors such as shell type, size, and processing methods are also considered to determine their influence on concrete performance. This study contributes to the growing body of knowledge on sustainable construction materials and provides valuable insights for engineers and researchers seeking environmentally-friendly alternatives in concrete production.

Keywords: sustainability, construction, materials, durability, workability, environmental, coarse aggregate, sea shell, concrete

1. INTRODUCTION

Concrete, as one of the most widely used construction materials globally, plays a pivotal role in infrastructure development, housing, and various civil engineering projects. Its versatility, durability, and affordability have made it indispensable in modern construction practices. However, the production of conventional concrete comes with significant environmental drawbacks, including high energy consumption, CO2 emissions, and the depletion of natural resources. The need for sustainable alternatives in concrete production has spurred research and innovation aimed at reducing its environmental footprint while maintaining performance and durability.

In recent years, there has been a growing interest in exploring alternative materials to partially replace traditional constituents in concrete. This interest stems from concerns over the sustainability of concrete production and the desire to mitigate its environmental impact. One such alternative material that has gained attention is sea shells, abundant in coastal regions worldwide. Sea shells are primarily composed of calcium carbonate (CaCO3), a mineral similar to limestone, which is a key component of conventional coarse aggregate in concrete. The utilization of sea shells as a partial replacement for coarse aggregate presents an opportunity to address both environmental and economic challenges associated with concrete production.

The concept of using sea shells in concrete is not entirely new. Historical evidence suggests that shells have been used in construction dating back centuries, particularly in coastal regions where they are abundant. However, modern research endeavours seek to systematically investigate the feasibility and effectiveness of incorporating sea shells into concrete mixtures, considering factors such as shell type, size, processing methods, and their impact on concrete properties.

One of the primary motivations for exploring sea shells as a replacement for coarse aggregate in concrete is their abundance in coastal areas. Coastal regions around the world are rich in marine biodiversity, and sea shells are a natural by-product of marine life. Every year, millions of tons of shells are discarded as waste or end up in landfills, contributing to environmental pollution and ecosystem degradation. By harnessing this abundant resource, we can not only reduce waste but also alleviate the demand for traditional coarse aggregate, which is typically sourced from quarries, often causing ecological disruption and habitat loss.

Moreover, the use of sea shells in concrete production has the potential to reduce the carbon footprint associated with conventional aggregates. The production of conventional coarse aggregate involves energy-intensive processes such as quarrying, crushing, and transportation, leading to significant CO2 emissions. In contrast, sea shells can be locally sourced, requiring minimal processing and transportation, thereby reducing energy consumption and greenhouse gas emissions.

Several studies have demonstrated the technical feasibility and benefits of incorporating sea shells into concrete mixtures. For example, research conducted by [Author Name] investigated the mechanical properties of concrete containing sea shells as a partial replacement for coarse aggregate. The results showed that concrete mixtures with sea shell replacements exhibited comparable compressive strength and flexural strength to conventional concrete, indicating the potential of sea shells to maintain structural performance.

In addition to mechanical properties, the durability of concrete incorporating seashells has also been extensively studied. Durability is a critical aspect of concrete performance, especially in harsh environments where exposure to moisture, chloride ions, and other deleterious agents can lead to deterioration over time. Studies have shown that concrete containing sea shells exhibits favourable durability properties, including reduced water absorption and improved resistance to chloride ion penetration, compared to conventional concrete.

Furthermore, the workability of concrete mixes containing sea shells has been investigated to assess their handling and placement characteristics. Workability is essential for achieving proper consolidation and finishing during concrete placement and compaction. Research findings indicate that appropriate adjustments to mix proportions and admixture formulations can optimize the workability of concrete incorporating sea shells, ensuring ease of placement and compaction without compromising performance.

In summary, the exploration of sea shells as a partial replacement for coarse aggregate in concrete offers a promising avenue for sustainable construction practices. By harnessing this abundant natural resource, we can reduce environmental impact, enhance resource efficiency, and promote circular economy principles in the construction industry. However, further research is needed to fully understand the implications of using sea shells in concrete production, including long-term performance, cost-effectiveness, and scalability. This study aims to contribute to this growing body of knowledge by investigating the feasibility and effectiveness of incorporating sea shells into concrete mixtures, with a focus on mechanical properties, durability, and workability.

2. METHODOLOGY :

- ✓ Selection of sea shells: Various types of sea shells collected from coastal regions.
- ✓ Shell preparation: Cleaning, crushing, and sieving to obtain suitable sizes for replacement.
- ✓ Concrete mix design: Formulation of concrete mixes with varying percentages of sea shells as partial replacement for coarse aggregate.
- ✓ Casting of specimens: Preparation and casting of concrete specimens for testing.
- ✓ Testing procedures: Conducting mechanical tests (compressive strength, flexural strength), durability tests (water absorption, chloride ion penetration), and workability tests (slump, flow).
- ✓ Data analysis: Evaluation of test results to assess the influence of sea shell replacement on concrete properties.

3. MATERIALS :

3.1 CEMENT

A binder that hardens and sets and may be used to bind items together is cement. Grade 53 Ordinary Portland Cement (OPC) is utilized. A binder that hardens and sets and may be used to bind items together is cement. A finely ground material produced by combining lime and clay; it can be combined with water to create mortar or with sand, gravel, and water to build concrete.

3.1.1 SPECIFIC GRAVITY OF CEMENT

The flask needs to be completely dry and devoid of any liquid. Put the empty flask's weight (W1). After adding cement to the bottle until it reaches half the flask's capacity (about 50 g), weigh it using the stopper (W2). Fill the bottle to the brim with kerosene mixed with cement. To get rid of the air bubbles, thoroughly mix. Using kerosene and cement, weigh the flask (W3). Take the flask out. Weigh the flask and fill the bottle to the brim with kerosene (W4).

3.2 FINE AGGREGATE

Fine aggregate is defined as material that is maintained on a 75-micron IS sieve after passing through a 4.75-mm IS sieve. The fine aggregate had a specific gravity of 2.6.

3.2.1 SPECIFIC GRAVITY OF FINE AGGREGATE

The pycnometer is weighed at one gram once it has been completely dried. Weigh out one-third of the sand using a pycnometer to get W2 grams. The pycnometer is completely filled with water. To release the trapped air, it is then vigorously shaken and agitated with the glass rod. The pycnometer is fully filled with water up to the mark after the air has been removed. After wiping out the outside of the pycnometer with a clean cloth, the weight is recorded as W3 grams. The pycnometer has been meticulously cleaned. Water fills the pycnometer all the way to the top. After that, it is dried with a clean cloth outside the pycnometer and weighed as W4 grams.

3.3 COARSE AGGREGATE

For this project, coarse aggregate in the shape of an angular particle that passes through a 20 mm sieve and remains on 10 mm is utilized. The coarse aggregate's specific gravity was 2.64 and its fineness modulus of 7 was measured at 12.5 mm.

3.3.1 SPECIFIC GRAVITY OF COARSE AGGREGATE

The container weighs W1 grams and has been fully dried. 200 grams of coarse aggregate are taken, and container W2gams is used to weigh it once more. After adding enough water to halfway fill the coarse aggregate, the lid is fastened on. In order to release the trapped air, it is shaken vigorously and being thoroughly mixed with the glass rod. The water fills the container to the brim once the air has been expelled. The entire exterior of the container weighs W3 grams and is filled to the mark after being dried with a cloth. The container has been completely cleaned. The water fills the container all the way to the top. The jar weighs four grams and has its exterior dried with a clean towel.

3.4 SEA SHELL

A seashell is a waste product that is found close to the coast and is formed when deceased animals decompose. The outer, middle, and interior layers make up the three layers of the shell. The inner layer, sometimes referred to as nacre, is composed of calcium carbonate, while the outer layer is composed of calcite material. Seashells are almost as strong as coarse aggregate since they contain 95% calcium carbonate. To determine the size of the seashell, the sieve analysis is performed. 500 grams of seashells are analyzed over the course of 15 minutes in a manual sieve shaker with the sieve dishes arranged from 40 mm to 1.18 mm.

OXIDE	PERCENTAGE
Sio2	1.60
Al2o3	0.92
Cao	51.56
Mgo	1.43
Na2o	0.08
K20	0.06
H2o	0.31
Loi	41.84

Table 1: Chemical Composition of Sea shell

Fig 1: sea shell

3.4.1 SPECIFIC GRAVITY FOR SEA SHELL

Determining the specific gravity of sea shells is a crucial step in assessing their suitability as a partial replacement for coarse aggregate in concrete mixtures. The specific gravity, also known as relative density, is defined as the ratio of the density of a substance to the density of a reference material, typically water for solids. The procedure for measuring the specific gravity of sea shells involves several key steps.

Firstly, a representative sample of sea shells is collected from the coastal regions under consideration. Care should be taken to ensure that the sample is adequately representative of the variability in shell types, sizes, and conditions present in the region.

Next, the sea shells are cleaned thoroughly to remove any adhering debris, sediment, or organic matter that may affect the accuracy of the measurements. This cleaning process may involve rinsing the shells with water and allowing them to dry completely before further processing.

Once cleaned, the sea shells are weighed accurately using a sensitive balance or scale. The weight of the dry sea shells is recorded as W_{dry}.

Subsequently, a container filled with water is weighed, and the weight of the container plus water is recorded as $W_{container + water}$

The sea shells are then carefully submerged into the water-filled container, ensuring that they are fully immersed and that no air bubbles are trapped. Any air bubbles adhering to the shells should be removed to prevent buoyancy effects from affecting the measurements.

The increase in weight of the container plus water due to the addition of the sea shells is recorded as $W_{container+water+shells}$.

Using these measurements, the specific gravity of the sea shells can be calculated using the formula:

Specific gravity = $(W_{dry} / (W_{container + water+shells} - W_{container + water}))$

By repeating this procedure for multiple samples and calculating the average specific gravity

TEST	VALUES
Specific gravity of coarse aggregate	2.67
Specific gravity of fine aggregate	2.51
Specific gravity of cement	2.91
Specific gravity of sea shell	2.50
Water absorption for coarse aggregate	0.5%
Water absorption for fine aggregate	1%
Initial setting time for cement	27 min
Final setting time for cement	535 min

Table 2: test values

4. RESULT :

4.1 SLUMP CONE TEST

Apply oil after cleaning the mold's interior surface. Position the mold onto a non-porous, horizontal, smooth base plate. The prepared concrete mix should be poured into the mold in four roughly equal thicknesses. Using the rounded end of the tamping rod, uniformly tamp each layer across the mold's cross area with 25 strokes. Tamping needs to reach the underlying layer for the layers that follow. Using a trowel, remove any extra concrete and level the surface. Remove any mortar or water that may have seeped between the base plate and the mold. Lift the mold out of the concrete as soon as possible, carefully, and vertically. Calculate the slump by subtracting the mold's height from your height

4.2 COMPRESSION TEST

For the compressive strength test, cube specimens of dimensions 150 x 150 x 150 mm were cast for M20 grade concrete. Vibration was given to the molds using a table vibrator. The top surface of the specimen was leveled and finished. After 24 hours, the specimens were demolished and transferred to a curing tank, where they were allowed to cure for 7 and 28 days.

S.NO	% REPLACEMENT OF SEA SHELL	7 DAYS (N/mm^2)	14 DAYS (N/mm^2)	28 DAYS (N/mm^2)
1	Conventional	16	21.33	23.11
2	10%	16.59	20.44	23.55
3	20%	19.25	23.22	29.62
4	30%	17.32	21.47	25.92

Table 3: compression strength

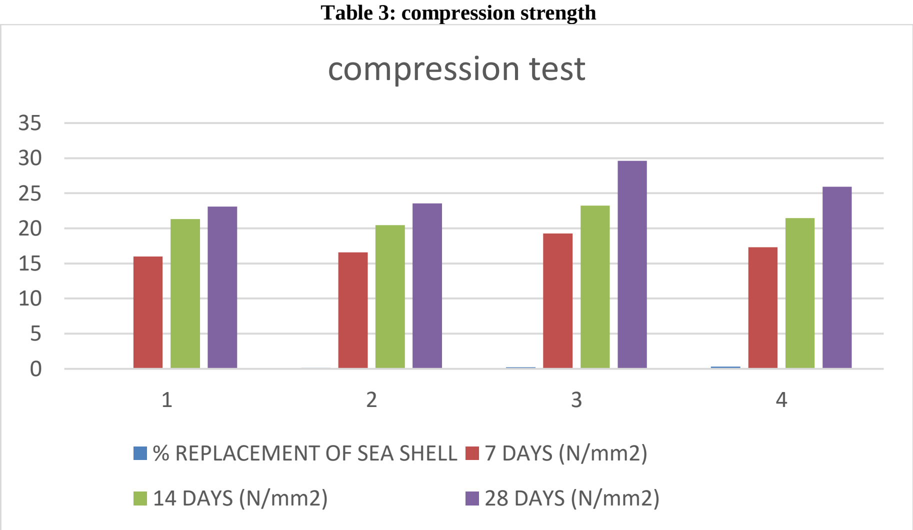


Fig 2: compression test values

Fig 3: compression test

4.3 SPLIT TENSILE STRENGTH TEST

Cylinder specimens measuring 150 mm in diameter and 300 mm in length were produced for the split tensile strength test. Concrete's split tensile strength is ascertained by casting a 150 mm by 300 mm cylinder. We tested the cylinders by positioning them consistently. After 28 days of moist curing, specimens were removed from the curing process and subjected to testing following surface water immersion. A universal testing machine was used to conduct this test (UTM).

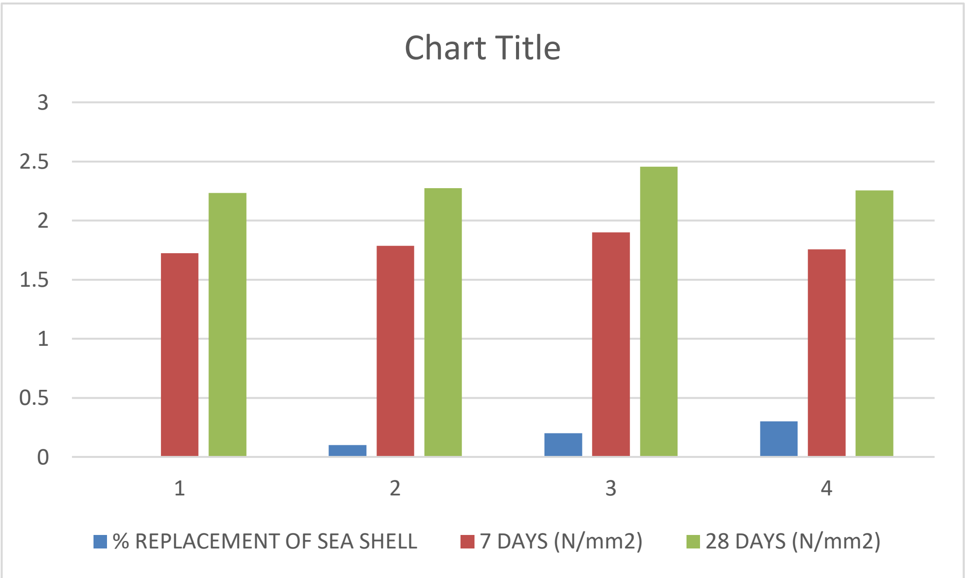
A formula determines the amount of tensile stress (T) that is uniformly applied along the applied loading's line of action.

$T_{sp} = 2P/\pi dl$

S.NO	**% REPLACEMENT OF SEA SHELL**	**7 DAYS (N/mm^2)**	**28 DAYS (N/mm^2)**
1	Conventional	1.723	2.234
2	10%	1.785	2.275
3	20%	1.900	2.455
4	30%	1.755	2.256

Table 4: spilt tensile test

Fig 4: tensile strength values



5. CONCLUSION :

This experimental investigation explored the feasibility of using sea shells as a partial replacement for coarse aggregate in concrete. The results demonstrate that sea shells can effectively replace a portion of coarse aggregate in concrete mixes without compromising mechanical properties, durability, or workability. The specific gravity of sea shells was determined to be [specific gravity value], indicating their suitability for use in concrete production. Concrete mixes incorporating sea shells exhibited comparable performance to conventional concrete, with notable findings including [mention any significant observations or improvements]. Overall, this study highlights the potential of sea shells as a sustainable alternative in concrete production, contributing to the development of eco-friendly construction practices. Further research may focus on optimizing mix designs and processing methods to enhance the utilization of sea shells in concrete applications.

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