# AN EXPERIMENTAL STUDY ON STRENGTH PROPERTIES OF TABBY CONCRETE WITH SEA SHELL COARSE AGGREGATE

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**Abstract:**

A type of concrete known as "tabby" is created by converting crushed oyster shells into lime by burning them and blending them with other materials, such as water and sand. Innovative materials made with natural resources have been developed in response to resource depletion and environmental damage concerns. Environmentally, the massive exploitation of natural aggregates causes depletion, while the manufacture of cement generates pollution. This scenario has an impact on the global ecological system. As civil engineers, we would like to replace the frequently used building materials of coarse aggregate and cement with seashells and oyster shell powder, respectively. Seashells and oysters are the dead remains of aquatic organisms. The rough texture of seashell makes it appropriate for partial coarse aggregate replacement, providing a cost-effective substitute for conventional materials like gravel. In this study, tests will be performed on normal concrete as well as seashell-concrete mixtures. The relative portion of coarse aggregate partially replaced with seashell ranges from 0%,5%, 10%, 15%, to 20%. Further, find the optimum % of sea shells(SS). Then with that optimum % of SS, the cement is replaced with oyster shell(OSP) powder in percentages of 0%, 10%, 20%, 30%, and 40%. The hardened and fresh characteristics of concrete will be examined, including compressive strength, flexural strength, tensile strength, and workability. The experimental investigation will be carried out with an M20 mix, and testing will be carried out in accordance with the prescribed methods by applicable IS codes. The M20 grading mix was designed using the IS: 10262-2009 standard results of this study help to understand how tabby concrete behaves, it might be recommended as a possible substitute construction material for low-cost house construction, particularly in coastal areas. Similarly, the study gives us the conclusion that 15% of sea shells(SS) and 20% of Oyster shells powder(OSP) replacement is optimum with an increase of compressive strength, Split tensile strength, and flexural strength by 15.8%, 25%, and 35.5% respectively for the 28 days curing period. Concrete's workability is also affected.

**Keywords:** Tabby concrete, Oyster shell powder, Sea shells, Ecological system, Aquatic organisms.

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# I. INTRODUCTION

## 1.1 GENERAL:

Concrete is made stronger by combining cement, fine and coarse aggregates, which is all mainly sourced from natural resources. The booming population, the spread of urbanization, and the rising standard of living as a result of technical developments have demanded a massive quantity of natural resources in the building sector, resulting in resource scarcity. Because of this shortage, researchers are motivated to utilize solid waste created by coastal, industrial, mining, household, and agricultural operations. As per statistics, India produced more than 600 Mega Tonnes of garbage from agro-based and coastal waste, posing a severe disposal challenge. In addition to addressing the problems of pollution, area congestion, and construction material prices, such wastes may be recycled to create sustainable building materials (Madurwar et al., 2013). Figure 1 depicts the majority of solid waste generated throughout India. According to Shafigh et al. (2014), a study regarding the use of agro-waste-waste as an aggregate substitute is still relatively new, and further studies are required to improve the concrete's hard as well as durability properties. Researchers also studied at the relationship between rating systems for green buildings and this kind of eco-friendly concrete.

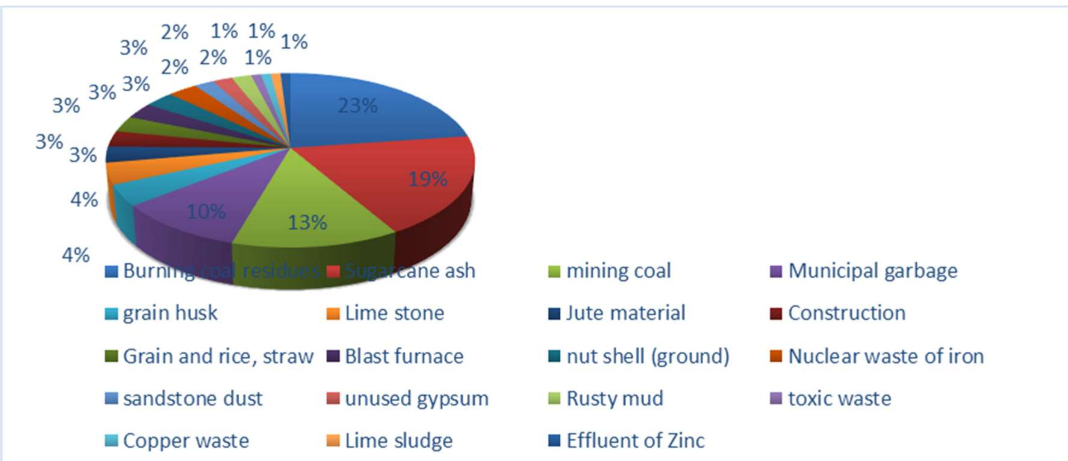


Figure 1: India's solid garbage production in its current situation. (Madurwar et al,,)

Recent research on sea shells has revealed a higher scope for their use as a concrete aggregate. The use of seashells not just to conserves materials for construction but also assists in resolving the issue regarding how to dispose of these waste products. A sea shell, commonly known as a shell, is a sea creature's hard, shield-like outer covering. The shells are portions of the animal's body. Dead mussels are frequently encountered washed up on beaches. The shells are identified as hollow since the animals expired in them and the sensitive portion of the shell was eaten by another animal or rotted away. Seashells may be found in abundance in the Bay of Bengal, Indian Ocean, and Arabian Ocean. Oyster shells, which contain substantial amounts of calcium carbonate, are occasionally utilized as soil conditioners in horticulture in some places. The shells are broken or crushed into minute pieces to achieve the intended effect of raising the pH and increasing the calcium content in the soil.

Current research is looking at using Coastal wastes like oyster shell powder and seashells are being studied as potential substitutes for cement and coarse aggregate in the production of concrete. This research looks at the manufacture and characterization of oyster shell powder, and seashells, and assesses the quality of building materials including cement, sand, and coarse aggregate. In addition, the experimental research of fresh and cured concrete qualities was measured and discussed.

Figure 2: Sea shells at Chennai beach.

**1.2 SCOPE OF THE WORK:**

The purpose of this work will be to investigate and assess the impact of replacing Cement (OPC) with oyster shell powder(OSP) in the proportion of 0, 10, 20, 30, and 40%, and coarse aggregate with sea shells (SS) in the proportion of 0, 5, 10, 15, and 20% in concrete. 150x150x150mm standard-sized cubes are cast, and their compressive strength was tested after 7 and 28 days. Standard 300mm-height, 150mm-diameter cylinders are cast, and their split tensile strength was evaluated after 7, and 28 days. Similarly, standard beams or prisms of 500x100x100mm are cast and tested for flexural strength after 7 and 28 days. Five distinct mixes of Sea Shells with varying proportions 0, 5, 10, 15, and 20% were tested to analyze the strength characteristics in terms of Compressive Strength, Flexural Strength, and Split Tensile Strength to find the optimal proportion of sea shells in concrete and keep it at that proportion. Now cement is replaced with oyster shell powder (OSP) (0, 10, 20, 30, and 40%). The same kind of aggregate is used in each mix, along with river sand, aggregate made of crushed granite, and the specific ratio from fine aggregate to aggregate.IS 10262-2009 Code methodology is used to calculate the proportional amounts of cement, coarse aggregate, sand, and water. In this work, M20 is taken as the standard blend. Six cubes, six cylinders, and six prisms are cast for each mix and tested for hardened properties.

**1.3 OBJECTIVES OF RESEARCH:**

The following are the key goals of this investigation:

a) To figure out the appropriate mix ratio for the partial substitution of coarse aggregate and cement with sea shells and oyster shell powder by the sampling specimen's strength-to-weight ratio.

b) Figuring out the flexural strength, split tensile strength, and compressive strength of the specified material in order to evaluate the possibility of partial concrete substitution.
c) Using the test results as a reference, recommending the addition of oyster shell powder and sea shell coarse aggregate in the most approximative portion.

## II. REVIEW OF LITERATURE

The mechanical properties of different sea shells, broken sea shell aggregates and oyster shell binders have all been studied recently by a number of scholars.

Gurikini Lalitha, C. Krishna Raju (2014) investigated the performance of M30 concrete with partial replacement of seashells and coconut shells. They came to the conclusion that the mixture of 10%, consisting of 5% coconut shells and 5% sea shells, had a consistently unfavorable effect on the concrete cubes' ability to withstand compression. The compressive strength of coconut shells (5%) and sea shells (5%) increased by 10% (5% + 5%) as compared to normal concrete.

Dr. Vaishali G. Ghorpade and Syed Talha Zaid (2014) conducted research on the subject of "Experimental Investigation of Snail Shell Ash (SSA) as Partial Replacement of Ordinary Portland Cement in Concrete". In this work, SSA proportions of 0%, 5%, 10%, 15%, and 20% were used in place of OPC. They come to the conclusion that a 5% replacement of OPC with SSA is ideal after observing increases in compressive strength of 7.50% and split tensile strength of 3.54% during a 28-days curing period. They also came to the conclusion that the workability of concrete is also impacted.

B.Ramakrishna and A.Sateesh (2016) have published a paper on the topic of Exploratory study on the use of cockle shells as partial coarse and fine aggregate replacement in concrete, by using the cockle shells to replace a proportion of the coarse and fine aggregates, which might minimize consumption of natural fine aggregate usage. For this research, seven different mix percentages of shells were employed to make various types of the concrete mix: 0%, 5%, 10%, 15%, 20%, 25%, and 30%. In this work, Tests for fresh and hardened properties were performed as per Indian standard code specifications. They came to the conclusion that adding crushed cockle shells to fine aggregate at a level of 10% and replacing natural coarse material at a level of 25% increased compressive strength. However, this substitution affected the workability of the concrete.

S. Subhashini, T. Manvitha, R. Yamuna Bharathi, S. Herald Lessly. the experimental study on the partial replacement of coarse aggregate by seashells and partial replacement of cement by fly ash examines the outcomes of the partial substitution of cement with fly ash and coarse aggregate with seashells. Investigation on conventional concrete and seashell-concrete mixes was carried out. The amount of seashells varies from 3% to 11% was used. Furthermore, fly ash was used to replace 25% of the cement. The ideal percentage of effective replacement in all 3 tests was found to be 7%, which corresponds to the maximum compressive strength, and 5%, which corresponds to the maximum split tensile and flexural strength values.

Olateju, O.T. His research describes an exploratory study on the suitability of the periwinkle shells as partial in concrete works. Periwinkle shells and crushed granite were examined and compared in terms of their physical and mechanical characteristics. In his study, different weight ratios of crushed granite to periwinkle shells 100:0, 75:25, 50:50, 25:75,0:100 are used as coarse aggregate, and a total of three hundred concrete cubes with dimensions of 150x150x150 mm were cast, tested, and their hardened characteristics were assessed.

Bin Wan Mohammad and Wan Ahmad (2017) This research examine a variety of seashell ash such as cockle, clam, oyster, mollusk, periwinkle, snail, and green mussel shell ash as partial cement replacement with the intention of creating a sustainable environment and reducing global warming problems. The findings show that between 4 and 5% of seashells perform better as a cement alternative. This study comes to the conclusion that it could be advantageous to produce sea shell ash as a partial cement alternative.

Shahnawaz Alam, Joonaith Veda, and ThavasumonyDhasan (2018), This study is concerned with the experimental analysis of the strength and durability of concrete by partially substituting fine aggregate with oyster shell. The crushed oyster shell was partially replaced with fine aggregate to investigate the possibility of reusing trash as construction materials. Using the results of this experimental work, it was determined that the mix proportion may be produced by substituting oyster shells for fine aggregate without reducing strength. Maximum compressive strength was achieved by substituting 20% oyster shell for fine aggregate. In comparison to nominal concrete, oyster shell replacement concrete performed better in terms of strength. As a result of the research, the concrete's strength was increased by substituting oyster shells for fine aggregate. Sand prices and demand are both rising significantly these days. This will reduce sand availability and lead to a sand shortage in the future. Furthermore, the results of the tests revealed that partial substitution of sand with oyster shells in concrete results in higher compression strength than regular concrete. As a result, the demand for sand might be minimized.

## III. EXPERIMENTAL INVESTIGATION

The primary goal of the exploratory work is to identify as well as evaluate the improved performance in hardened concrete induced by the replacement of cement with oyster shell powder (OSP) as well as coarse aggregate with sea shells (SS) waste, along with the order to determine the optimal proportion of OSP and SS replacement. This research focuses on the methodology that will be applied such as material characterization, concrete mix, and estimating the quantity of substances required for the specimens which might be going to be examined.

### 3.1 MATERIALS USED:

#### A. Cement:

Grade 53 ordinary Portland cement, as per, IS: 12269-1987, was utilized in this investigation. Throughout the investigation, the cement utilized was locally available Penna brand 53 Grade Ordinary Portland Cement. It was fresh and free of lumps. The cement’s physical characteristics as determined by different tests in accordance with Indian standard IS12269:1987. As indicated in the table, the various tests performed on cement include initial and ultimate setting time, as well as specific gravity.

Table 1: Cement's Physical Characteristics

| S.no | Property | Test result |
|---|---|---|
| 1 | Normal consistency | 29% |
| 2 | Specific gravity | 3.11 |
| 3 | Initial setting time | 65min |
| 4 | Final setting time | 550min |
| 5 | Soundness | 3mm |
| 6 | Fineness (sieve) | 95% |

**B. Fine Aggregate:**

The experiment employed naturally accessible river sand that passed through a 4.75mm IS mesh and conforms to grading zone II of IS: 383-1970. River sand fineness modulus and grain size distribution were determined using sieve analysis. The physical characteristics of fine aggregate are mentioned in the table and it can be transported from local suppliers.

Table 2: Fine aggregate physical characteristics

| S.no | Property | Test result |
|---|---|---|
| 1 | Specific gravity | 2.64 |
| 2 | Fineness modulus | 2.52 |
| 3 | Zone | II |
| 4 | Water absorption | 1% |

**C. Coarse Aggregate:**

The coarse materials utilized in this research are 20 mm natural stone coarse aggregates that are locally available. Laboratory tests on coarse aggregate were performed as per IS: 2386 (part III)- 1963 to determine the various physical properties and they can be shown in the table as follows.

Table 3: physical characteristics of Coarse aggregate

| S.no | Property | Test result |
|---|---|---|
| 1 | Specific gravity | 2.77 |
| 2 | Water absorption | 0.5% |

**D. Oyster shells Powder:**

Oyster shells are considered a good alternative to cement, because of their physical and chemical characteristics. Oyster shells have been proven to be useful in the construction industry. To conduct the experimental investigation, the oyster Shell powder capable of passing through a 90µm sieve of 50 kgs was transported from Astrra chemicals in Chennai. This powder was chemically analyzed to determine its chemical composition.

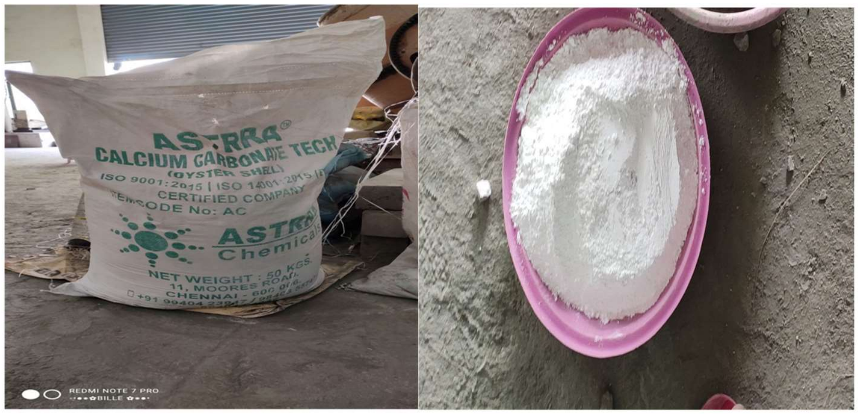


Figure 3: Oyster shell powder

The chemical analysis was carried out at Astrra Chemicals Limited in Chennai in accordance with standard procedures, and the lab reports were sent together with the oyster shell powder bag. The following is the chemical composition of oyster shell powder. Likewise, the specific gravity of oyster shell powder is 2.45.

Table 4: Oyster shell powder and cement chemical composition

| S.no | Component | Description | % in cement | Content in oyster shell powder |
|---|---|---|---|---|
| 1 | $SiO_2$ | Silica | 17-25 | 0.25% |
| 2 | $Al_2O_3$ | Alumina | 3-8 | 0.1% |
| 3 | Cao | Calcium Oxide | 60-67 | 92.56% |
| 4 | MgO | Magnesium Oxide | 0.1-4 | 0.43% |
| 5 | $Na_2O$ | Sodium Oxide | 0.2-1.3 | 0.8% |
| 6 | $K_2O$ | Potassium Oxide | 0.2-1.3 | 0.6% |
| 7 | $SO_3$ | Sulfur trioxide | 1-3 | 0.31% |
| 8 | LOI | Loss of Ignition | <3% | 41.84% |

**E. Sea shells:**

For this study, sea shells were transported from Thiruvalluvar Nagar beach, Chennai, and contained slightly more CaCO3 (90.18%) than limestone. Physical properties of sea shells include specific gravity of 2.36 and water absorption (0.60%).

Figure 4: Sea shells

**F. Water:**

Concrete must be mixed with clean water that has no dangerous quantities of oils. acids, alkalis, organic compounds, or other deleterious chemicals. The presence of these contaminants in the water may affect cement setting time, concrete strength, and reinforcing corrosion. In this investigation, we used portable tap water from the college campus water plant that met the IS456-2000 standards for casting concrete and curing the specimens.

**3.2 Mix proportions:**

To attain M20 grade strength, the concrete was designed in accordance with IS 10262-2009, and a water to cement ratio of 0.5 was employed. Five distinct mixes of Sea Shells with varying proportions 0%, 5%, 10%, 15%, and 20% were tested to analyze the strength characteristics in terms of Compressive Strength, Flexural Strength, and Split Tensile Strength. Find the optimal proportion of sea shells in concrete and keep it at that proportion. Now cement is replaced with oyster shell powder (OSP) (0%, 10%, 20%, 30%, and 40%). The same kind of aggregate is used in each mix, along with river sand, aggregate made of crushed granite, and the specific ratio from fine aggregate to aggregate. Six cubes, six cylinders, and six prisms are cast for each mix and tested for hardened properties. The table shows the designed proportions of the basic ingredients in concrete.

**Table 5: Mix proportions of different mixes**

| **Mix.ID** | **OPC (kg/m$^3$)** | **F.A (kg/m$^3$)** | **C.A(kg/m$^3$)** | **W/C** | **OSP (kg/m$^3$)** | **SS (kg/m$^3$)** |
|---|---|---|---|---|---|---|
| M0 (Conventional mix) | 340 | 610 | 1240 | 0.5 | 0 | 0 |
| M1 (0% OSP+5%SS) | 340 | 610 | 1179.2 | 0.5 | 0 | 53.18 |
| M2 (0%OSP+10%SS) | 340 | 610 | 1117.17 | 0.5 | 0 | 105.45 |
| M3 (0%OSP+15%SS) | 340 | 610 | 1055.10 | 0.5 | 0 | 158.17 |
| M4 (0%OSP+20%SS) | 340 | 610 | 993 | 0.5 | 0 | 210.9 |
| M3 (0%OSP+15%SS) | 340 | 610 | 1055.10 | 0.5 | 0 | 158.17 |
| M5 (10% OSP+15%SS) | 306 | 608.433 | 1051.156 | 0.5 | 34 | 157.58 |

| | | | | | | |
|---|---|---|---|---|---|---|
| M6 (20%OSP+15%SS) | 272 | 607.58 | 1049.69 | 0.5 | 68 | 157.36 |
| M7 (30%OSP+15% SS) | 238 | 605.04 | 1045.30 | 0.5 | 102 | 156.708 |
| M8 (40%OSP+15%SS) | 204 | 603.34 | 1042.37 | 0.5 | 136 | 156.26 |

**3.4 Casting of specimens:**

The moulds that were used to cast cubes, cylinders, and beams were carefully cleaned. A thin layer of oil was applied to the interior surface of the moulds to prevent concrete adherence and leakage. Then, using a tamping rod, the concrete was poured into the greased moulds (cubes, beams, and cylinders). Tests were conducted at 7, and 28 days of age


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Figure 5: Casting of cubes, cylinders, and prisms

**3.5 Curing:**

Curing is the process of creating an atmosphere conducive to the setting and hardening of concrete. From the time the specimens leave their moulds until they are shipped to the testing laboratory, the specimens are completely immersed in a pond of water with 50 mm of water over them. If possible, keep the temperature between 10°C and 25°C.

Figure 6: Curing of Specimens

**IV. RESULTS AND DISCUSSIONS**

**4.1. GENERAL:**

The tests were done on both freshly mixed and hardened concrete. The Fresh concrete mixture was tested for slump and workability. Hardened concrete tests include compressive strength, tensile strength, and Flexural strength tests are performed.

**4.2 FRESH PROPERTIES OF CONCRETE:**

Workability is tested in terms of slump cone and compaction factor test, which decrease as sea shells are replaced with coarse aggregate and oyster shell powder is replaced with cement, respectively. The slump cone and compaction factor test with % replacement is depicted in the graph below.

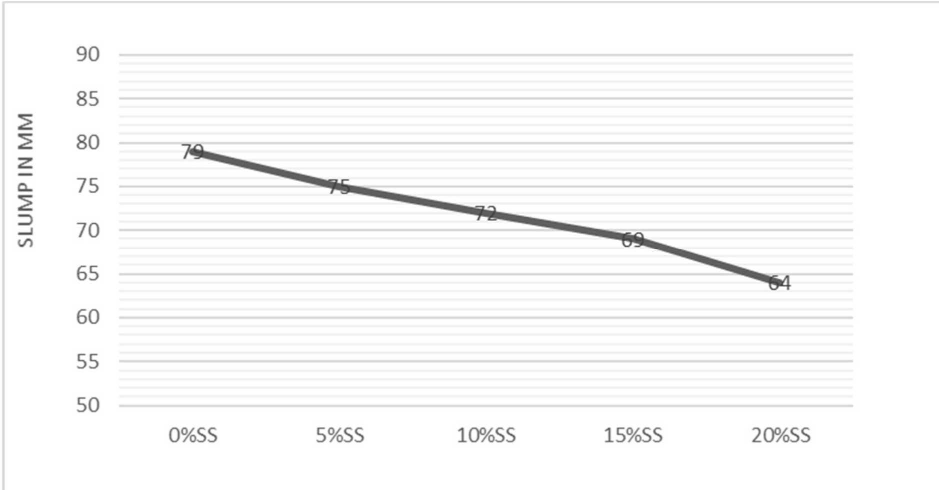



Figure 7: slump with different mixed proportions of SS.

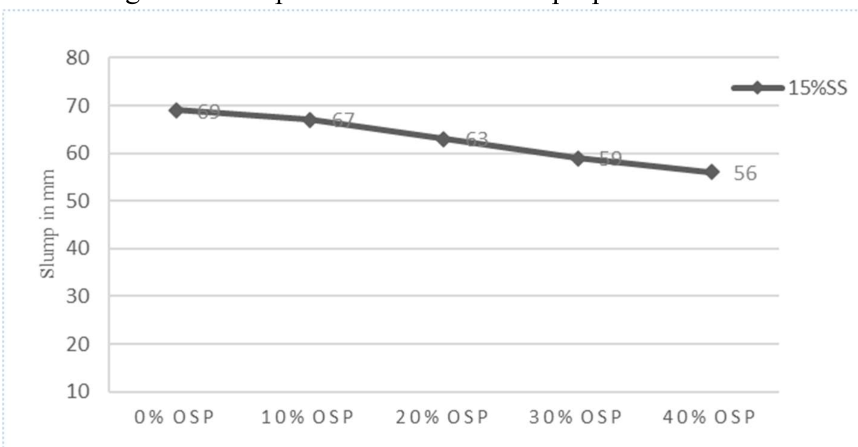



Figure 8: slump with different mixed proportions of OSP and SS.

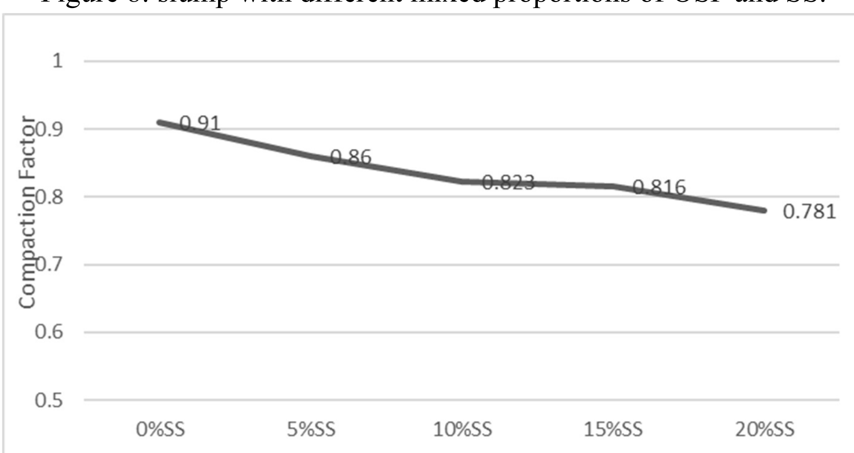



Figure 9: Compaction factor with different mixed proportions of SS.

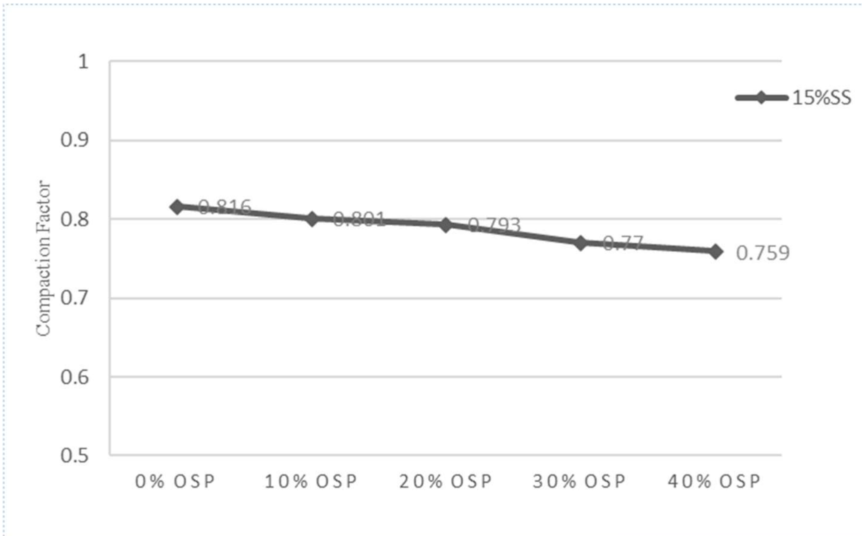



Figure 10: Compaction factor with different mixed proportions of OSP and SS.

The workability test results show that the workability decreases as the percentage of Seashells and oyster shell powder increases. The slump value for the nominal mix (M0) was around 79 mm, and it steadily dropped to 56 mm. In terms of compacting factor, the nominal mix (M0) demonstrated the highest workability. The dropping of workability is mainly due to the uneven form and surface structure or texture of sea shells. Furthermore, because the surface hydration of oyster shell powder is slightly slower than that of cement, the water needed for mixing is not instantly wasted. However, even with the use of sea shells, the workability obtained is sufficient for normal concrete works.

**4.3. HARDENED PROPERTIES OF CONCRETE:**

Testing hardened concrete is crucial for assessing and confirming the quality of cement concrete work. The test methodologies should be precise, simple, and easy to apply.

**A. Compressive strength test:**

It is a key property of hardened concrete. Seashell concrete's compressive strength development mostly depends on the type, size, shape, and proportion of sea shells utilized in concrete mixes. Similarly, oyster shell powder particle size and fineness. The compression testing equipment was used for the compressive test, and the failure load and cube compressive strength were evaluated 7, and 28 days after curing.

Table 6: Compressive strength test results

| Mix Id | 7 days | | 28 days | |
|---|---|---|---|---|
| | Average Ultimate Load (P) KN | Compressive strength(P/A) Mpa | Average Ultimate Load (P) KN | Compressive strength(P/A) Mpa |
| M0(Conventional mix) | 390 | 17.33 | 615 | 27.34 |
| M1(0% OSP+5%SS) | 484 | 21.5 | 640.6 | 28.47 |
| M2(0% OSP+10%SS) | 534 | 23.7 | 680.67 | 30.25 |

| | | | | |
|---|---|---|---|---|
| M3(0% OSP+15%SS) | 550 | 24.45 | 713.34 | 31.70 |
| M4(0% OSP+20%SS) | 403 | 17.92 | 589 | 26.17 |
| M3(0% OSP+15%SS) | 550 | 24.45 | 713.34 | 31.70 |
| M5(10% OSP+15%SS) | 553 | 24.56 | 717 | 31.87 |
| M6(20% OSP+15%SS) | 564 | 25.06 | 731 | 32.47 |
| M7(30% OSP+15%SS) | 503 | 22.35 | 666 | 29.58 |
| M8(40% OSP+15%SS) | 437 | 19.40 | 623 | 27.67 |

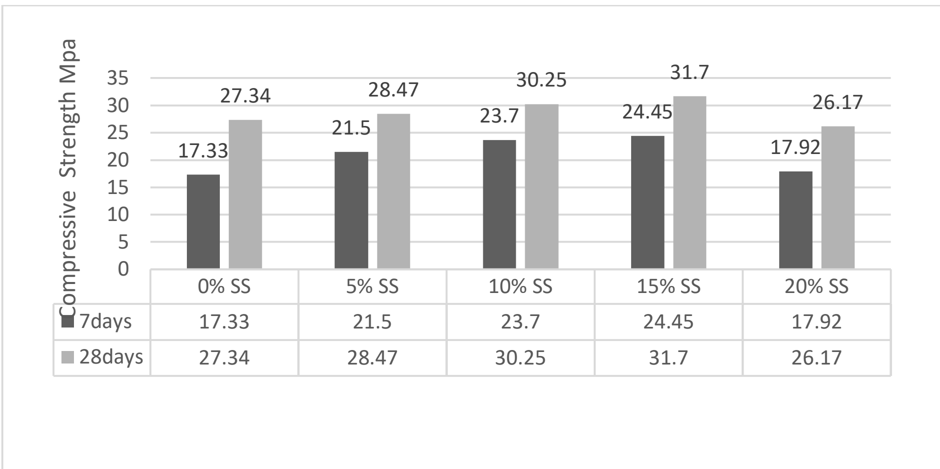
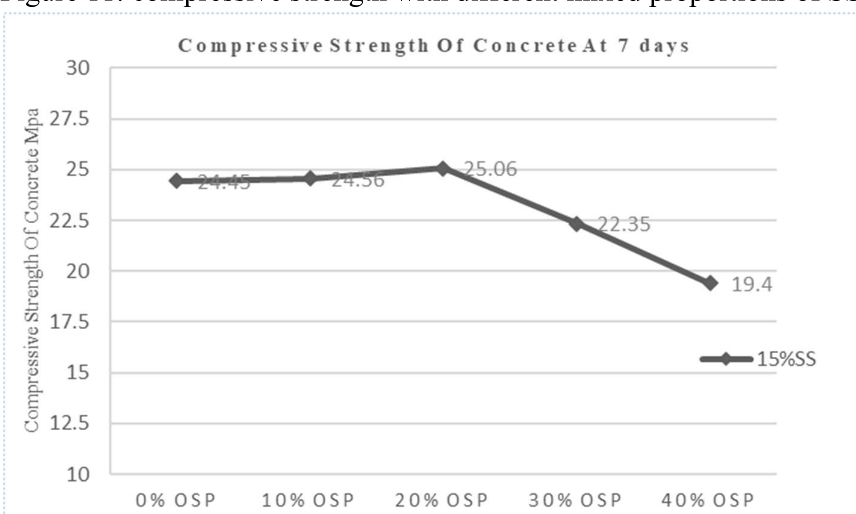



Figure 11: compressive strength with different mixed proportions of SS.



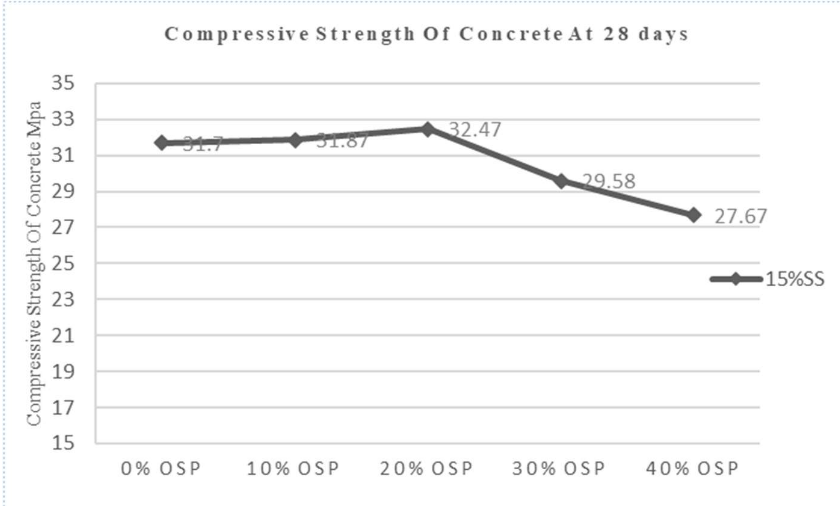



Figure 12: compressive strength with different mixed proportions of SS and OSP.

From the lab results, the compressive strength was maximum when coarse aggregate was replaced with sea shells at 15% and cement was replaced with oyster shell powder at 20%. The compressive strength increased when sea shells and oyster shell powder were added. In comparison to the control mix, the compressive strength of sea shells and oyster shell powder steadily increased up to 15% and 20%, respectively, and subsequently dropped. This study determined that 15%SS+20%OSP was the best combination. The increased void space in sea shells may lead to the formation of a high void ratio in the concrete. The increasing voids ratio in concrete affects the bond between the concrete ingredients, resulting in a reduction in the compressive strength of the concrete.

**B. Split tensile Strength test:**

The tensile strength of concrete can be determined by this indirect test. Concrete specimens were tested for splitting tensile strength on cylinders 150 mm in diameter and 300 mm in height after 7 and 28 days of water curing. IS 5816-1999 was used to conduct the test. A splitting tensile strength test was conducted on cylindrical specimens positioned horizontally on the compression testing machine. The load was applied till failure, and the splitting tensile strength values are graphed in the below Figures.

**Table 7: Split tensile strength results**

| Mix Id | 7 Days | | 28 days | |
|---|---|---|---|---|
| | Average Ultimate Load(P)KN | Split Tensile strength (Mpa) | Average Ultimate Load (P) KN | Split Tensile strength (Mpa) |
| M0(Conventional mix) | 180 | 2.54 | 216 | 3.05 |
| M1(0% OSP+5%SS) | 186 | 2.63 | 227.34 | 3.22 |
| M2(0% OSP+10%SS) | 198 | 2.81 | 240.3 | 3.40 |
| M3(0% OSP+15%SS) | 220 | 3.02 | 253 | 3.57 |
| M4(0% OSP+20%SS) | 175 | 2.47 | 191.34 | 2.70 |

| | | | | |
|---|---|---|---|---|
| M3(0% OSP+15%SS) | 220 | 3.02 | 253 | 3.57 |
| M5(10% OSP+15%SS) | 227 | 3.21 | 266 | 3.76 |
| M6(20% OSP+15%SS) | 247 | 3.49 | 285.34 | 4.03 |
| M7(30% OSP+15%SS) | 207 | 2.92 | 243 | 3.43 |
| M8(40% OSP+15%SS) | 155 | 2.18 | 221 | 3.12 |

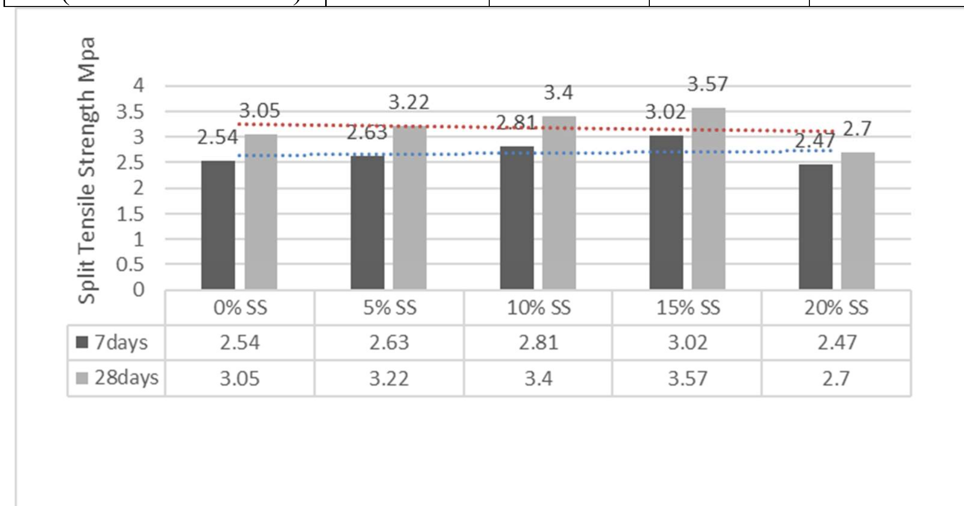
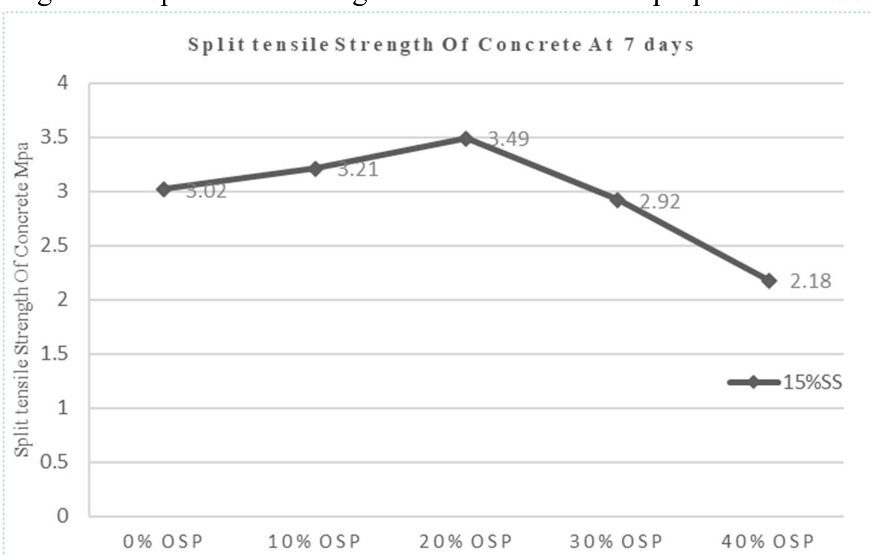



Figure 13: Split tensile strength with different mixed proportions of SS.



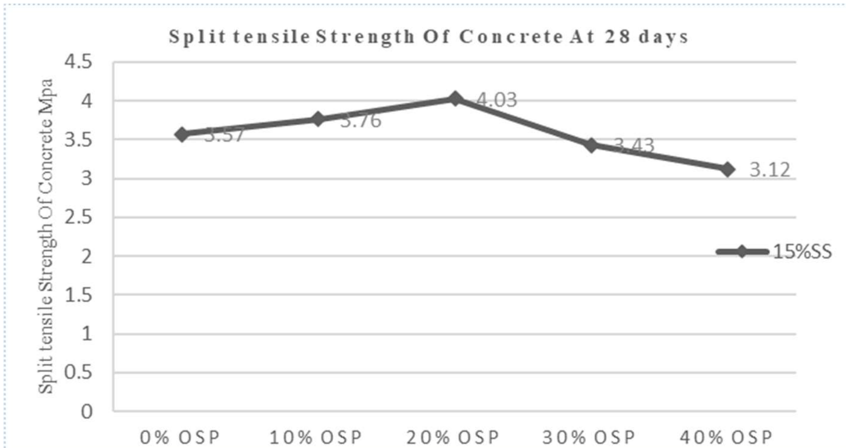



Figure 14: Split tensile strength with different mixed proportions of SS and OSP.

The above results show that the cylinder's splitting tensile strength was optimum at 15% and 20% of sea shell and oyster shell powder replacement. The percentage increase in strength exceeds the nominal mix by 25%. The percentage strength was increased up to 15%SS+20%OSP but then reduced due to a greater void space ratio in the specimens, resulting in a weaker bond between the concrete.

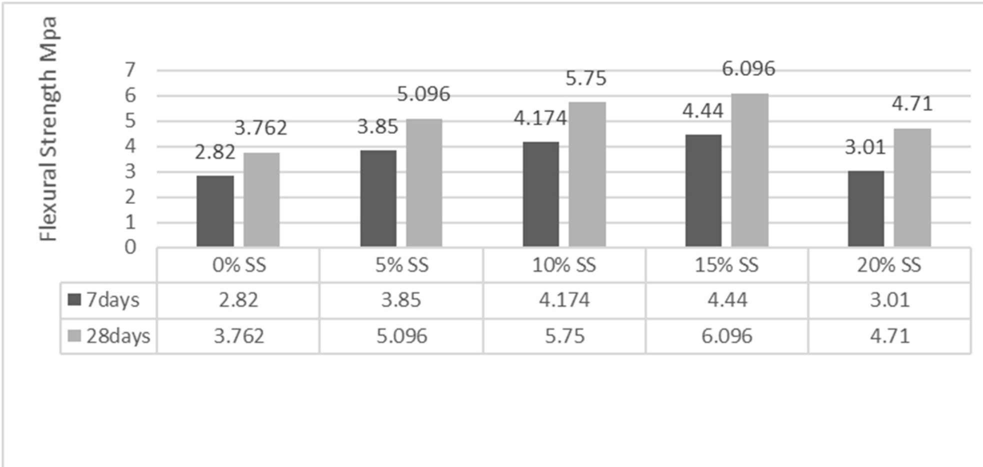
**C. Flexural Strength of Concrete:**

The concrete flexural test was performed on prisms 500 mm x 100 mm x 100 mm with an effective span of 400 mm and symmetrical two-point loads. Testing was performed after 7 and 28 days of water curing to ensure compliance with IS 516-1959. The specimen was held on two roller supports on the testing machine, with a 400 mm spacing between the centers. Until its breakdown, the load was applied hydraulically through two equal rollers placed at the third point of the supporting span.

Table 8: Flexural strength results.

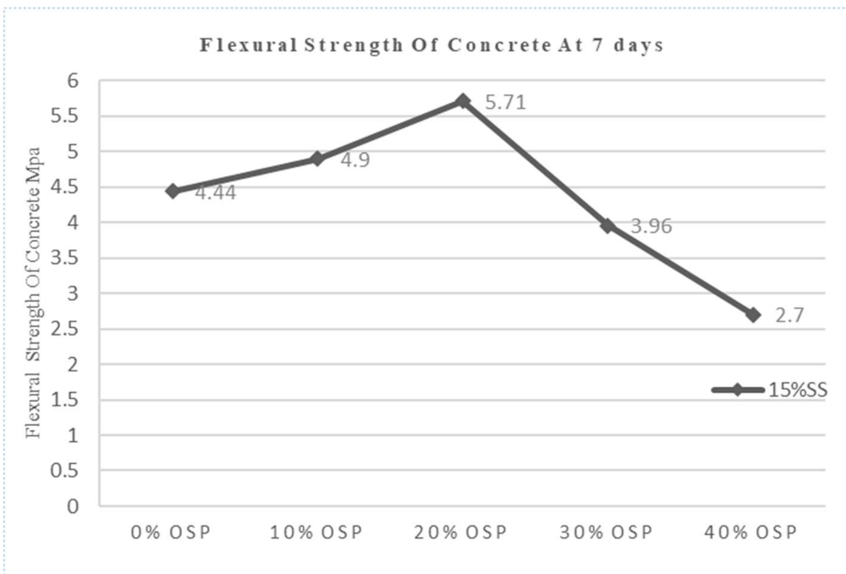
| **Mix Id** | **7 Days** | | **28 days** | |
|---|---|---|---|---|
| | **Ultimate Load(P) KN** | **Flexural strength (Mpa)** | **Ultimate Load (P) KN** | **Flexural strength (Mpa)** |
| M0(Conventional mix) | 7.0623 | 2.82 | 9.405 | 3.762 |
| M1(0% OSP +5% SS) | 9.63 | 3.85 | 12.74 | 5.096 |
| M2(0% OSP +10% SS) | 10.436 | 4.174 | 14.37 | 5.75 |
| M3(0% OSP +15% SS) | 11.10 | 4.44 | 15.24 | 6.096 |
| M4(0% OSP +20% SS) | 7.52 | 3.01 | 11.79 | 4.71 |
| M3(0% OSP+15%SS) | 11.10 | 4.44 | 15.24 | 6.096 |
| M5(10% OSP+15%SS) | 12.26 | 4.9 | 16.02 | 6.40 |
| M6(20% OSP+15%SS) | 14.28 | 5.71 | 17.2 | 6.88 |

| | | | | |
|---|---|---|---|---|
| M7(30% OSP+15%SS) | 9.91 | 3.96 | 12.9 | 5.15 |
| M8(40% OSP+15%SS) | 6.7491 | 2.7 | 8.70 | 3.48 |




| | 0% SS | 5% SS | 10% SS | 15% SS | 20% SS |
|---|---|---|---|---|---|
| 7days | 2.82 | 3.85 | 4.174 | 4.44 | 3.01 |
| 28days | 3.762 | 5.096 | 5.75 | 6.096 | 4.71 |

Figure 15: Flexural strength with different mixed proportions of SS.



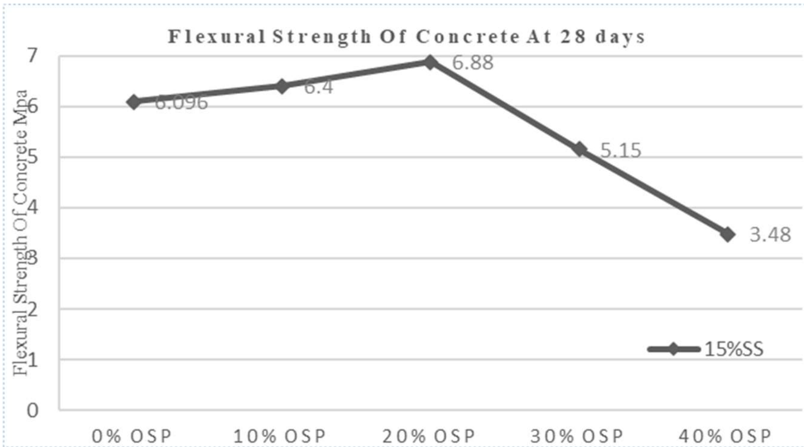



Figure 16: Flexural strength with different mixed proportions SS and OSP.

The previously stated results show that the flexural strength of the beam was maximum at 15% of sea shells and 20% of oyster shell powder replacement. Strength has increased by a percentage that is 35.5% greater than the nominal mix (M0). The strength of the proportion increased up to 15%SS+20%OSP, but after that, it decreased, possibly as a result of a higher void space ratio in the specimens, which led to a weaker bond between the concrete.

## V. CONCLUSION

In this work, the effect of the use of sea shells to partially replace coarse aggregate and cement with oyster shell powder was investigated. Based on the early research, mix 15%SS+20%OSP was determined to be the optimum mix in terms of compressive strength. All mixes were put through a workability test. Mechanical characteristics such as cube compressive strength, splitting tensile strength, and flexural strength was determined for all of the mixes. The results obtained were compared to the control mix (M0). The following results were reached according to the experimental investigation.

i. The workability of the concrete as measured by the slump and compaction factor reveals that as sea shell and oyster shell powder replacement increases, the slump decreases. The compaction factor also decreases as sea shell and oyster shell powder content increases, and the findings are within the typical range of concrete.

ii. The SS and OSP obtained have lower specific gravity than the OPC and coarse aggregate they replaced, which means mass replacement will produce a significantly higher volume of cementitious materials.

iii. It was reported that oyster shell powder has almost the same percentage of all the key chemical elements of cement as OPC, meaning that it will act as an acceptable alternative if the proper proportion is used.

iv. Compressive strength increased up to 15% and 20% with sea shell and oyster shell powder substitution, respectively, and then dropped at the remaining proportions. The compressive strength was increased by around 15.8% on the 28th day compared to the control mix (M0).

v. The cylinder's splitting tensile strength was maximum at 15% and 20% replacement with sea shells and oyster shell powder, respectively, and thereafter reduced at all ages. The percentage improvement in splitting tensile strength over M0 was approximately 25%.

vi. The flexural strength of the beam was greatest for mix 15%SS+20%OSP. The strength of this mix was around 35.5% stronger than the nominal mix M0.

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