Study on Engineering behavior of conventional cement concrete by partially replacing sea shell as Fine aggregate

D.Parthiban1, D.S.Vijayan2, Sachu andrews3, Sangsangrach sangma3, Arif mohammed3
1Assistant Professor, Department of Civil Engineering, Aarupadai Veedu Institute of technology, Chennai, India
2Associate Professor, Department of Civil Engineering, Aarupadai Veedu Institute of technology, Chennai, India. Email: vijayan.has.siva@gmail.com
3UG Final year Students, Department of Civil Engineering, Aarupadai Veedu Institute of Technology, Vinayaka Missions Research Foundation, Paiyanoor, Chennai – 603104.
Corresponding author: Parthi92bhde@gmail.com

ABSTRACT. In this study, it was investigate about the engineering behavior of conventional concrete of grade M25, by replacing the fine aggregate by partially with crushed sea shell. On because of progression in the field of infrastructure, the dearth of construction material becomes upsurge day by day. All the investigator was observe to find the substitute construction materials to meet the demand of construction in world wide. The reason behind is, while continuous utilizing of the natural raw material for construction decline the resource of those materials and further, it leads to affect the routine function of the earth and made drastic change in the life cycle of living beings. Therefore, it is obvious to find out the possible alternative material to suit for all type of construction. In this study, the sea shell was used as a fine aggregate in the method of crushed powder in an apparent proportion such as 10%, 20% and 30% replacing in the place of fine aggregate sand. The compression and split tensile behavior of sea shell aggregate mixed concrete comparatively with plain sand concrete was studied under different curing periods such as 7 days, 14 days and 28 days. It was shows that at 20% replacement of crushed sea shell aggregate provide the compressive strength of 35 N/mm2 at 28 days of curing nearly with the design strength of M25 grade conventional concrete. It was also noticed that, the percentage increase of crushed sea shell decline the strength of concrete as radically. Hence it was acclaimed that, the percentage of crushed sea shell as fixed equal or below 10 % to get a better strength of concrete.

Keywords: sea shell, Concrete, natural material, Distractive test

1. INTRODUCTION
Environmental pollution was the major problem faced almost by all the Developing countries. In order to control the pollution, all the countries have developed their own strategies to protect the environment by implementing strict regulations. In our India, to preserve the availability of natural resources, it was banned to extract the gravel and sand...
from the major rivers of the nation. But, it was estimated that annually more than 15 million tons of aggregate resources like processed rock, gravel and lime stone are required to meet the demand in construction industry [1]. Hence, it is necessary to find the alteration of new material in the replacement of aggregates. Generally the aggregates which are applied with the concrete are categorized in to coarse aggregate and fine aggregate. Usually the gravels and sand were used as aggregates from the ancient time. Out of which, the sand is consider as a major element in production of concrete [2]. Due to infrastructure growth, the necessity of sand becomes increases, but while concerning environment and scarcity of sand, it is recommended to use the alteration material [3] . Before selecting the suitable alteration material, it is important ot discuss the Already, so many industrial waste such as glass, slag and demolition wastes are utilized instead of sand by partially or fully. In that sequence, we are investigating the influence of replacing crushed sea shells as a fine aggregate in the conventional concrete.

Globally, it was estimated that the about 23% of mollusk a kind of sea shell organism was utilized for food, oil and medicine [4]. Our India was considered as the 9th largest exporter of marine food products in Asia and 16th largest exporter in the world. As per the latest information of fishery department of India, a billion tons of shellfish was harvested every year in the field of aquaculture industry, mostly they are clam shell or cockle shell based [5]. Usually, the shell are split in to two halves are joined with the hinge portion. This type of shell fishes are avail abundantly on west and east coastal regions of our India. After extracting the flesh, the shells are remaining as waste [6]. Due to poor disposal practices, the shells are become as a environment polluted materials and may cause several serious issues in future. Hence the usage of those sea shells in the form of crushed aggregate with concrete can reduce the problem of disposal and being a ecofriendly or sustainable material in the field of construction.

2. MATERIAL AND METHODS
The following are the materials which are utilized in this study

2.1 Cement
Cement is an essential element in the concrete; the major role of cement is to make the concrete as heterogeneous one by combined all the ingredients together and provides the strength to the concrete [7]. For this study, the OPC grade-45 cement was used and its specific gravity was measured as 1.818.

2.2 Aggregate
Aggregates are consider as the packing material of the concrete. For this study two kind of aggregates are used such as sand and Crushed sea shell [8,10]. The sand, which is collected from the estuaries of Pallar river, near Kalpakkam, Tamilnadu and the Sea shells were collected from the coastal region of Mahabalipuram, Tamil nadu as shown in Figure 1. The specific gravity of collected sand and aggregate were analyzed under the standard specification and found the values such as 2.74 for sand and 2.148 for crushed sea shell respectively.

![Pallar River Sand](image1.jpg) ![Crushed Sea Shell](image2.jpg)

Figure 1. Sample of River sand and Crushed sea shell
3. MIX DESIGN
As per IS 10262:2009 guidelines, by using the specific Gravity value of materials the mix design of M25 Grade concrete was arrived and find the proportion was arrived in the form of ratio as 1:3.23:3.85 with the standard water cement ratio of 0.4 [9]. The target mean compressive strength was calculated as 31.6 N/mm2 achieved at 28 days of curing. The crushed sea shell was introduced at 0%, 10%, 20% and 30% with the concrete by replacing the sand. The weight of crushed sea shell at each proportion was defined in the table 1 below.

| Table 1. Proportion of each materials under different Proportion |
|---------------------------------------------------------------|
| Sno | Materials [kg/m³] 1 : 3.23: 3.85 | 0% | 10% | 20% | 30% |
|-----|---------------------------------|-----|-----|-----|-----|
| 1   | Cement                          | 269 | 269 | 269 | 269 |
| 2   | Sand                            | 834 | 750.6 | 667.2 | 583.8 |
| 3   | Crushed shell                   | -   | 83.4 | 166.8 | 250.2 |
| 4   | Coarse aggregate                | 891 | 891 | 891 | 891 |

4. RESULT AND DISCUSSION
After the preliminary investigation of all raw materials and the proportion of design of mix, the concrete has to be tested at hardened form to find out its compression and tensile behavior. In this context, it is help to understand the behavior of crushed shell admixed concrete comparatively with conventional sand concrete based on the following test results.

4.1. Compressive strength of Cement Mortar Mixes
Before Preparing any type of concrete, it is advisable to check its compression behavior by using cement mortar cube of standard size 70.6mm x 70.6mm, compatible to IS : 10080-1982. For this study the cement mortar cubes were prepared under the ratio of 1:5 and Soaking the hardened demolded specimens in water for the period of 28 days. Later, it was tested under the series of compression load and the following results are shown in the Figure 2 below.

From the following results, it was understand that, the addition of crushed sea shell with cement mortar at different proportion can moderately reduce the strength of mortar mix when compared to conventional cement mortar mix. However, it was suggested that, to check the compressive behavior of each ratio of material when react with concrete as individually.

![Figure 2. Compression behavior of Crushed sea shell in Cement mortar mix](image-url)
4.2. Comparison study of compressive strength of cement concrete at different curing periods

The compression behavior was considered as the very essential parameter of any type of concrete. The stability of any structure was decided also by means of using compressive strength. Basically, the compression behavior of concrete was tested using the standard cubes of size 150mm x 150mm x 150mm as per the specification of IS456:2000. Here, the cube are tested under the controlled condition with the universal testing machine of capacity of 2000kN was shown in Figure 3 below.

![Figure 3. Compression of Cube Specimens](image)

4.3. Compressive strength of cement concrete at 7 days curing periods

The Figure 4 below, which depicts the comparative average compression strength of conventional concrete and the crushed sea shell replaced concrete at the curing period of 7 days. From the results, it was noticed that replacing 10% of sea shell in the conventional concrete could provide almost equivalent result comparatively with the conventional concrete. But, while increasing the percentage of replacement of sea shell, have decline the strength of concrete drastically when compared to pure conventional concrete. It was suggested that, to monitor the variation of strength in further curing periods.

![Figure 4. Average Compression strength of both concrete at 7 days curing period](image)
4.4. Compressive strength of cement concrete at 14 days curing periods

![Figure 5. Average Compression strength of both concrete at 14 days curing period](image)

The Figure 5 above, which represents the comparative average compression strength of conventional concrete and the crushed sea shell replaced concrete at the curing period of 14 days. From the results, it was noticed that replacing 10% and 20% of sea shell in the concrete could provide noticeable result comparatively with the Design strength of conventional concrete. But, while increasing the percentage of replacement of sea shell, have decline the strength of concrete drastically when compared to pure conventional concrete. It was suggested that, to monitor the variation of strength in further curing periods.

4.5. Compressive strength of cement concrete at 28 days curing periods

![Figure 6. Average Compression strength of both concrete at 28 days curing period](image)

The Figure 6 below, which represents the comparative average compression strength of conventional concrete and the crushed sea shell replaced concrete at the curing period of 28 days. Through the results, it was observed that almost all the replacing 10%, 20% of sea shell in the concrete was provide some promising result comparatively with the Design strength of conventional concrete. But not more than conventional concrete. Hence, it was suggested that, the addition of sea shell at the 20% was provide better results than other type of replaced concrete.
4.6. Split Tensile behavior of Concrete

Even though the concrete is good in compression, it also need to resist the Tensile force which acting over it. In the RC structures, the major portion of tensile force are carried out by the steel, However it is mandatory to carry the minimum percentage of tensile force by the concrete to avoid the failure of the structure. In this study, the Split tensile behaviour of concrete was examined using standard cylindrical specimen of length 300mm and diameter is 150mm by the ratio of 1:2. Figure 7 which shows the Split tensile testing of cylindrical specimen at 28 days of curing.

![Split Tensile Test of Cylindrical Specimen](image_url)

Figure 7. Split Tensile Test of Cylindrical Specimen

4.7. Split Tensile strength of cement concrete at 28 days curing periods

The Figure 8 below, which explains the comparative average split strength of conventional concrete and the crushed sea shell replaced concrete at the curing period of 28 days. While Concluded the results, it was observed that almost all the replacing 10%, 20% and 30% of sea shell in the concrete was not provide some promotable result comparatively with the Design strength of conventional concrete But during 10% addition of Crushed sea shell may provide some comparative result with conventional concrete. Hence, it was suggested that, the addition of sea shell at the 10% was provide better results than other type of replaced concrete.

![Average Split Tensile behaviour of conventional and Sea shell replaced concrete at 28 days curing](image_url)

**Figure 8. Split Tensile Test of Cylindrical Specimen at 28 days of curing**
5. CONCLUSION

The following points are recommended as conclusion based on the justification of results so far discussed in this study.

- The utilization of crushed sea shells provide promotable result when compared to conventional sand based concrete
- The replacement of 20% of crushed sea shells were provide appropriate design strength of concrete, but not same as conventional concrete strength
- The replacement of 10% of crushed sea shells were improve the tensile behaviour of concrete, but not meet the expectation of conventional concrete
- Based on result, it was suggested that the replacement of crushed sea shell at the minimum percentage can provide expected result and control the rate of exploitation of construction raw materials.
- By utilizing the crushed sea shell, may reduce the disposal problem of those wastes and control the overall cost of construction project as well as growth the economy of aquaculture industry.

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