International Journal of Advances in Engineering and Management (IJAEM)
Volume 4, Issue 9 Sep. 2022, pp: 838-842 www.ijaem.net ISSN: 2395-5252

# Study on Strength of Concrete Prepared by Replacing Cement with Seaweed Powder

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Date of Submission: 10-09-2022 Date of Acceptance: 20-09-2022

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**ABSTRACT**:The demand for building materials is growing exponentially as development activities increase worldwide. Green building materials play an important role in sustainable construction. Seaweed is a purely natural substance that has many advantages such as thermal insulation, biodegradability, and strong carbon fixation. The study is carried out on the seaweed species Gracilaria Edulis. Seaweed mainly contains Agarose and Agaropectin. This causes strong gelling and thickening properties, which helps a better bonding mechanism. In this study, we investigated the partial replacement of cement with seaweed powder in M30 concrete at different percentages of 5, 10, 15, and 20%. The study concluded that replacing seaweed with cement at an optimal dose of 10 percent showed an increase in compressive and tensile strength compared to conventional concrete.

**KEYWORDS:**Agarose, Concrete, Carbon Fixation, Cement, Gracilaria, Sustainable.

## I. INTRODUCTION

Concrete is the most widespread artificial building material and its demand is increasing every day. Green building material plays an important role in sustainable construction. Portland cement-based concrete is theworld's most widely used building material, and its production is on the rise. About 15% of total concrete production contains chemical admixtures, which are chemicals added to concrete, mortar or grout at the time of mixing to modify their properties, either fresh or hardened. Now the main focus on sustainable construction is increasing, green building material plays an important role in sustainable development. Concrete has become the most popular building material in the world, sustainable concrete determines the sustainability of the structure. Several efforts have been made to achieve sustainable concrete. Seaweed is a purely natural material that offers numerous advantages such as thermal insulation and heat capacity as well as biodegradability, etc. Some valuable properties of seaweed such as high-water retention, improved strength, structural compactness, high fire resistance, good durability against alkali, non-toxic, odorless, no harm to skin and harmless to human body. The high-water holding capacity reduces the heat of hydration. Improve the tensile strength of the matrix in the form of fibres, and provide good strength and thermal insulation properties.

[1].Seaweed is a photo phyletic group of multicellular algae: red algae, green algae, and brown algae. Seaweed has many uses; as edible; as an ingredient in toothpaste, cosmetics, and paints. In addition to its edible and other direct uses, seaweed is a rich and varied source of raw material for the production of seaweed chewing gum, a group of natural compounds known for their thickening and gelling properties. These efforts make specific technological innovations "green", with less energy and less carbon emissions. Seaweed offers numerous advantages such as excellent thermal insulation and heat capacity properties, as well as full biodegradability and strong carbon dioxide fixation.

[2].Identify the optimal replacement of cement with seaweed powder. Study the fresh properties of concrete prepared by partially replacing cement with seaweed powder. Compare the compressive and tensile strength of seaweed concrete with control mix M30.

## II. MATERIALS AND METHODS

To study the strength parameters of seaweed concrete, samples of different dosages such as 5%, 10%, 15% and 20% by weight of cement are replaced and cast. Strength parameters are studied

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on M30 concrete from OPC 53 cement using the following results of experiments for 3, 7, and 28 days.

### 2.1 Materials

#### 2.1.1 Seaweed

Some seaweeds are microscopic, such as phytoplankton, which lives suspended in the water column and provides the basis for most marine food chains. Some are huge, like the giant kelp that grows in rich "forests" and rises like underwater redwoods from its roots on the sea floor. Most of them are medium in size and come in red, green, brown, andblack. Randomly wash up on beaches and coastlines. Today, the main focus on sustainable construction is increasing, and ecological building materials play an important role in sustainable development. Concrete has become the most popular building material in the world, sustainable concrete determines the sustainability of the structure. Several efforts have been made to achieve sustainable concrete. These efforts make specific technologies and innovations "green", with less energy and fewer carbon emissions. Seaweed is a purely natural material that offers numerous advantages such as excellent thermal insulation and heat capacity, as well as full biodegradability and strong carbon dioxide fixation.

#### 2.1.2 Cement

JosephAspdin invented Portland cement, which is a fine-grey powder. Among the various types of cement, it is most often used as a binder. It is a mixture of chalk or limestone along with the clay. It is a binder, a substance used in construction that sets, hardens, and adheres to other materials and binds them together. They are rarely used exclusively but are used to bind sand and gravel (aggregate) together and are used with fine aggregate to make mortar for masonry or with sand and gravel aggregate to make concrete. In India cement is produced with three grades of OPC namely 33, 43, and 53. As per standard test procedure, the compressive strength of cement will be obtained after 28 days. Here we use OPC 53 grade cement. The specific gravity of the obtained cement is 3.15.

#### 2.1.3 M-sand

A sand particle consists of small grains of silicon dioxide (SiO2). It is formed by the decompose

**Table 1.**Water content and Mix ratio of control mix of sandstone due to various weathering effects. Sand that was locally available and passed through a 4.75 mm IS sieve shall be used.

| Water Content | Cement | Fine Aggregate | Coarse Aggregate |
|---|---|---|---|
| 0.41 | 1 | 2.39 | 3.08 |

#### 2.1.4 Coarse Aggregate

It is aggregate, most of which is captured on the IS 4.75 mm sieve. In this study, we use 20 mm and 12 mm aggregate.

#### 2.1.5 Water

The water used for mixing and curing should be clean and free of harmful amounts of alkali, acid, oil, salt, sugar, organic material, plant growth, and other substances that may be harmful to brick, stone, concrete, or steel.

#### 2.1.6 Chemical Admixture

Chemical admixtures are usually added as liquids or powders in relatively small amounts and can be used to modify properties during the plastic or hardened state of concrete. Chemical additives can be divided into five types: accelerating, retarding, reducing or softening water, aerating, and water resistant. We use Auramix-200 in seaweed concrete. The specific gravity of AURAMIX-200 is 1.090.

### 2.2 Methods

#### 2.2.1 Mix Proportioning

Five concrete samples i.e. (M-1, M-2, M-3, M-4 and M-5) were prepared by replacing seaweed in different percentages i.e. (0%, 5%, 10%, 15%, and 20%) with cement. The control mix of concrete (without seaweed) had a compressive strength of 30 MPa for 28 days of curing according to IS: 10262–2019. The water-to-cement ratio was kept constant i.e., 0.41 for all concrete mixes. Details of the mixture are shown in Table 1 and Table 2.

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**Table 2.** Mix proportioning of concrete

| MIX | M1 | M2 | M3 | M4 | M5 |
|---|---|---|---|---|---|
| Cement (kg/m$^3$) | 370 | 351.5 | 333 | 314.5 | 296 |
| Seaweed (%) | 0 | 5 | 10 | 15 | 20 |
| Seaweed (kg/m$^3$) | 0 | 18.5 | 37 | 55.5 | 74 |
| Sand (kg/m$^3$) | 885 | 885 | 885 | 885 | 885 |
| Coarse Aggregate (kg/m$^3$) | 1141 | 1141 | 1141 | 1141 | 1141 |
| Water (kg/m$^3$) | 152 | 152 | 152 | 152 | 152 |

**2.2.2 Casting of Specimen**

Pouring, mixing, and batching operations should be done properly to achieve the desired concrete strength. The materials should be weighed first and then dry-mixed separately if the desired uniform colour is not achieved. Then, as needed, the superplasticizer is added separately in another container to the water in the required amount. The sample is then mixed in the machine on a waterproof platform until it reaches the desired uniform colour. All the concrete samples were prepared as per the procedure given in IS: 516–1959.

**2.2.3 Testing**

The compressive strength test procedure was carried out as per IS 516 – 1959. The splitting tensile test procedure was carried out as per IS 5816 – 1999. The specimens for these tests were tested at the age of 3, 7, and 28 days.

## III. RESULTS AND DISCUSSION

**3.1 Compressive Strength**

Compressive strength is the ability of a material or structure to resist or withstand pressure. The test follows IS 456-2000 recommendations. The compressive strength of hardened concrete is tested on a testing machine with a capacity of 2000 KN.
Table 3 shows the compressive strength values of the 3, 7, and 28-day samples. The compression test is performed on a cube sample of size 150x150x150mm.

**3.2 Split Tensile Strength**

A method of determining the tensile strength of concrete using a cylinder that is divided through the vertical diameter. The tensile strength of hardened concrete is an indirect measure that is made by placing a cylindrical specimen lengthwise.
A cylinder of 150 mm diameter and 300 mm length is cast and cured for 28 days and tested. Tensile strength values are shown in Table 4 for 28 days.

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**Table 3.** Compressive strength Test

| Percentage replacement of cement with seaweed powder | No. of days | Average Compressive strength (N/mm2) |
|---|---|---|
| 5% | 3 | 13.10 |
| | 7 | 21.51 |
| | 28 | 32.24 |
| 10% | 3 | 15.11 |
| | 7 | 24.55 |
| | 28 | 37.39 |
| 15% | 3 | 11.25 |
| | 7 | 18.28 |
| | 28 | 27.84 |
| 20% | 3 | 9.51 |
| | 7 | 15.47 |
| | 28 | 23.53 |

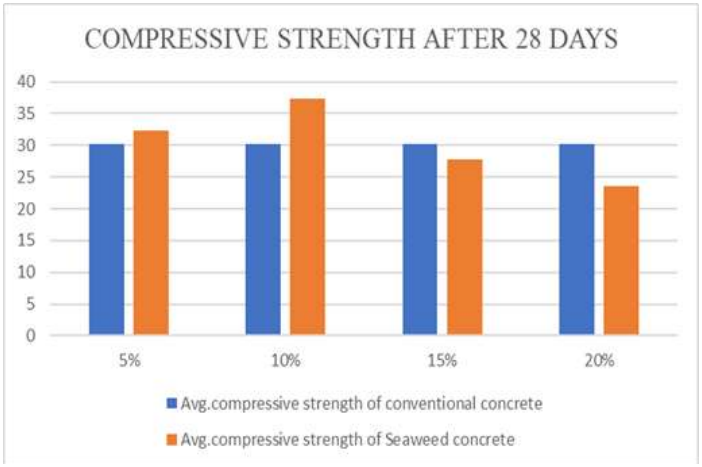


**Fig 1.** Compressive strength versus age

**Table 4.** Split tensile strength Test

| Percentagereplacement of cement with seaweed powder | No. of days | Average Split tensile strength (N/mm2) |
|---|---|---|

| | | |
|---|---|---|
| 5% | 28 | 3.01 |
| 10% | 28 | 3.33 |
| 15% | 28 | 3.11 |
| 20% | 28 | 3.05 |

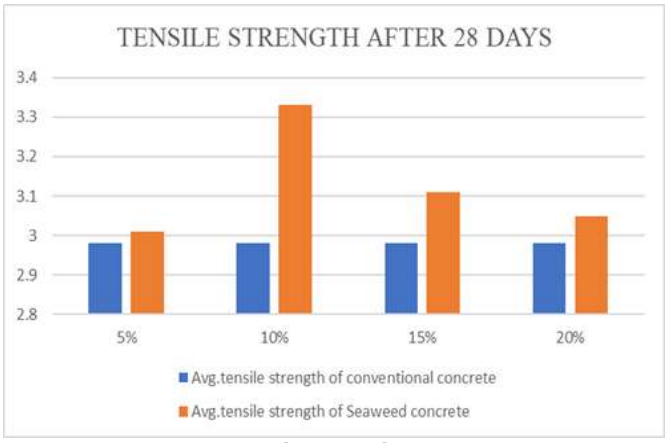


**Fig 2.** Tensile strength versus age

## IV. CONCLUSION

The optimal dose of seaweed is 10%. From this study, we found that there was an increase in the compressive and tensile strength of seaweed concrete compared to conventional concrete. There is an increase in compressive strength by 24% and tensile strength by 12%.

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