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ANALYSIS AND PARTIAL REPLACEMENT OF CEMENT WITH SEA SHELL POWDER

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ABSTRACT

This review paper emphasis on seashells as partial cement replacement and its objective is to create sustainable environment and reduce problems of global warming. Cement production give huge impact to environment in every stage of its production. These include air pollution in form of dust and, gases, sound and vibration during quarry crushing and milling. One of the solutions to solve this problem is by using modified cement. As a civil engineer, we have planned to replace the cement which is widely used in construction by seashell powder. The modified cement is a cementations material that meets or exceeds the Portland cement performance by combining and optimizes the recycle and wasted materials. This will indirectly reduce the use of raw materials and then, become a sustain construction materials. Therefore, the replacement of cement in concrete by various sea shell ash may create tremendous saving of energy and also leads to important environmental benefits. This study includes previous investigation done on the properties of mechanical such as compressive strength and flexural strength of concrete produced using partial replacement of cement by seashells ash. The main objective of these paper is to check the strength of concrete after replacement of cement by seashell powder in various percentage such as 5%, 10%, 15% and 20% with the help of literature review found and studied. This is all research done to minimize the use of conventional material and form eco-friendly concrete.

KEYWORDS: Seashell Powder, Ordinary Portland cement (53 Grade), Mechanical composition

1. INTRODUCTION

Civil engineering practice and construction works 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 plastic state and can be moulded insitu or precast to virtually any form or shape. Its basic constituents are cement, aggregate, coarse aggregate and water. Hence, the overall cost of concrete production depends largely on the availability of the constituents. Cement is produced by heating limestone and clay to very high temperature in rotary kiln. Water react chemically with cement to form the cement paste, which is essentially acts as a "glue" holding the aggregate together. The water cement ratio is an important variable that need to be "optimized". High ratio's produce relatively porous concrete of low strength whereas low ratio will tend to make the mix unworkable. Aggregate tends to represent a relatively high volume percentage of concrete, to minimize the cost of the materials.

The sea shells are high potential materials to become partial replacement and filler in concrete. The calcium carbonate in the sea shells is more than 90% and is similar to the contain of calcium carbonate in the limestone dust that been used in the Portland cement production. The particle sizes of seashells is between 36 μ to 75μ and are similar to the particle size of Portland cement. Seashell is mainly composed of calcium and the make it suitable to be used as partial replacement which provides an economical alternative to the conventional. Concrete is widely used material in the world. This automatically creates a huge demand for the ingredients of

Volume 09 Issue 02 March 2021

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concrete. From the environmental point of view, the huge extractions of the aggregate create reduction and manufacture of cement cause pollution. This scenario affects the world ecological balance. As a civil engineer, we have planned to replace the cement which is widely used in the construction by seashell powder. Seashell is the dead remain of marine organism. We have replaced the seashell after grinding it to the powder to replace of cement. The IS 10262 – 2009 be followed for the mix design grade concrete after that optimization of cement is done. Seashell which is used in concrete confirming to the zone as per IS 383 – 1970. The cubes are casted for the 3 parts of partial replacement as 5%, 10%, 15% and 20%, for cement by seashell powder. The crushing of seashells into fine powder and mixed in concrete as chemical admixture, as it contain calcium these may help in increasing strength of concrete and also reduce the temperature emitted due to exothermic reaction in concrete. The purpose of the project was to use seashell in concrete and determine how the concrete would perform compared to a standard mix.

2. RELATED WORK

Raseela M K P .et.al. (2019) reported that the cockle shell is one of the effective replacement material as a coarseaggregate in M_{20} grade of concrete at optimum percentage of replacement. The percentage weight loss for various percentage of replacement including optimum percentage was less than 1% which is very small. Thus partial replacement of coarse aggregate with cockle shell gave a durable concrete. The density of concrete decreases with increase in percentage of cockle shell.

Bassam A Tayeh .et.al. (2019) observed that using seashells in concrete is beneficial in terms of waste reduction and environmental sustainability. The optimum substitution level of cement with seashell ash was found to be 5 – 10 %. Using seashell cement clearly enhances, the splitting tensile and flexural strength of concrete at lower level of substitution due to bonding improvement at the interfere of the cement paste and aggregate. Setting time and workability of the concrete could be grossly affected with seashell ash replacement.

SUPPLEMENTARY CEMENTIOUS MATERIAL USED

SEA SHELL POWDER

Sea Shell Powder is made from the deep – sea snow crab shells, unpolluted and safe character. It is the substance obtained by deacetylations of chitin. It is derived from natural sea shell. It is a rich source of calcium.

a) Seashell Powder

MATERIAL REQUIREMENTS

CEMENT

The cement water paste has its characteristics properties of adhesion and cohesion by which it can bond well with aggregate to form a strong rock like mass called concrete as a consequences of the chemical reaction

Volume 09 Issue 02 March 2021

JOURNAL OF CURRENT SCIENCE

ISSN NO: 9726-001X

between cement and water.

AGGREGATES

Aggregates are inert materials such as sand, gravel, crushed stone that alone with water and Portland cement, are an essential ingredient in concrete. For a good concrete mix, aggregates needs to be clean, hard, strong particles free of absorbed chemicals or coatings of clay and other fine materials that could cause the deterioration of concrete. Aggregates strongly influence concrete's freshly mixed and hardened properties, mixture proportions and economy. Consequently, selection of aggregates is an important process. Although some variation in aggregate properties is expected characteristics that are considered include grading, durability, particle shape and surface texture, abrasion, unit weight and voids, absorption and surface moisture.

Fine Aggregate

Fine aggregate are basically sand won from the land or the marine environment. Fine aggregates generally consist of natural sand or crushed stone with most particles passing through a 9.5mm sieve. As with coarse aggregates these can be from Primary, Secondary or Recycled source.

Coarse Aggregate

Construction aggregate, or simply "aggregate", is a broad category of coarse to medium grained particulate material used in construction, including sand, gravel, crushed stone, slag, recycled concrete and geosynthetic aggregates. Aggregates are the most mined materials in the world.

WATER

Water is an important ingredient of concrete because hydration takes place only in presence of water. The water, which is used for making concrete should be clean and free from harmful impurities such as oil, alkali, acid etc.

In general the water, which is fit for drinking but not for mixing concrete. Some specifications also accept water for making concrete if p^H value of water lies between 6 and 8.

MOULD

Cubical moulds of size 150 mm x 150 mm x 150 mm were used to prepare the specimens for determining the compressive strength of seashell powder concrete care was taken during casting and compaction. Cylindrical moulds of size 150 mm diameter,300 mm height and beam mould size 1000 mm × 100 mm × 120 mm were used to prepare the concrete specimens for the determination of split tensile strength of foundry sand concrete respectively. All the specimens were prepared in accordance with Indian Standard Specifications IS: 516 – 1959. All the moulds were cleaned and oiled properly. They were securely tightened to correct dimensions and prevent leakage of slurry.

BATCHING

CASTING AND CURING OF TEST SPECIMEN

The measurement of materials for making concrete is known as batching. There are two methods of batching:

1. Volume batching
2. Weigh batching

JOURNAL OF CURRENT SCIENCE

ISSN NO: 9726-001X

Volume batching

Volume batching is not a good method of proportioning the material because of the difficulty it offers to measure granular materials in terms of volume. Volume of moist sand in loose condition weighs much less than the same volume of dry compacted sands the amount solid granular material in a cubic meter is an indefinite quantity.

Weigh batching

Weigh batching is the correct method for measuring the materials. For important concrete invariably, weigh batching system is adopted. Different types of weigh batches are available, in smaller works, the weigh arrangement consist of two buckets, each connected through a system of levers to a spring-loaded dials which indicated the load.

MIXING

Thorough mixing of material is essential for the production of uniform concrete. The mixing should ensure that the mass becomes homogeneous, uniform in colour and consistency. There are two methods for mixing concrete:

1. Hand mixing
2. Machine mixing

Hand mixing

Hand mixing is practiced for a small unimportant concrete works. As the mix cannot be thorough and efficient: it is desirable to add 10% more cement to cater for the inferior concrete produced by this method.

Machine mixing

Mixing of concrete is most invariably carried out by machine, for reinforced concrete work. Machine mixingis not only efficient, but also commercial, when the quantity of concrete is to be produced is large.

COMPACTION OF CONCRETE

Compaction of concrete is the process adopted for expelling entrapped air from the concrete. The test specimens are made as soon as practicable after mixing and in such a way as to produce full compaction of concrete with neither segregation nor excessive laitance. Each layer is compacted by hand or by vibration. When compacting by hand the standard tamping bar is used and the strokes of bar are distributed in a uniform manner over the cross section of the mould. The number of strokes per layer required to produce the specified conditions vary according to the type of the concrete

CASTING OF SPECIMEN

Moulds were properly fixed with screws and oil is applied on the surface for easy demolding. Concrete is prepared in the mixture and put in a tray. In this tray required quantity of bottle cap fibers are added and mixed properly. Fresh properties of concrete are determined. The specimens are cast. In the next day, specimens were demolded and put in a curing tank.

CURING OF CONCRETE

Concrete derives its strength by the hydration of cement particles. The hydration of cement particle is

JOURNAL OF CURRENT SCIENCE

ISSN NO: 9726-001X

not a momentary action but a process continuing for a long time. Rate of hydration is fast to start with, but continuous over a

very long time at a decreasing rate. Curing can be described as keeping the concrete moist and warm enough so that the hydration of cement can continue. Curing methods may be divided into four categories:

1. Water curing
2. Membrane curing
3. Application of heat
4. Miscellaneous

COMPRESSION TEST

TESTING OF SPECIMENS

Compression test is the most common test conducted on hardened concrete, partly because it is an early test to perform and partly because most of the desirable characteristic properties of concrete are quantitatively related to its compressive strength. The compression test is carried out on specimen's cubical or cylindricalshape. The cubes specimen is of the size 15 x 15 x 15 cm if the largest nominal size of the aggregate does not exceed 20 mm, 10 mm size cubes may also be used as an alternative.

FLEXURAL STRENGTH TEST

The systems of loading used in finding out the flexural tension are central point loading and third point loading. In case of symmetrical two point loading where the bending moment is maximum. Since two point loading yield a lower value of modulus of rupture than the centre point loading, this test was performed on the beams specimens. The standard size of the specimens is 50 x 10 x 10 cm.

SPLIT TENSILE STRENGTH

Splitting test is an indirect method to determine the tensile strength of concrete. The apparatus used for finding splitting tensile stress were any compression testing machine of sufficient capacity and capable of applying load at specific rate. Concrete cylinder of 15 cm diameter and 30 cm length is used for the test, two packing strips of plywood conforming to IS 303-1960, 12 mm wide and 3 mm thick shall be used for each specimen.

EXPERIMENTAL RESULTS

COMPRESSIVE STRENGTH TEST

Table 1. 7th day compressive strength test results

MIX TYPE	COMPRESSIVE STRENGTH (N/mm^2)
0%	15.78
5%	12
10%	12.22
15%	13.5
20%	13.1

Volume 09 Issue 02 March 2021

JOURNAL OF CURRENT SCIENCE

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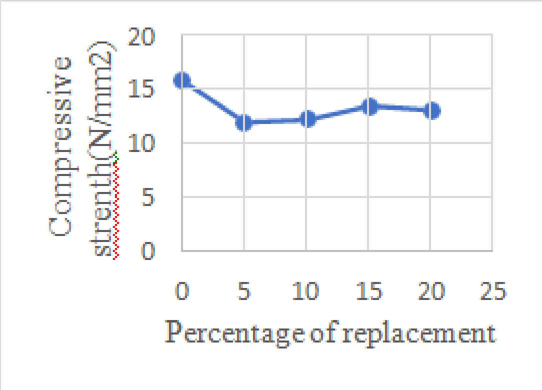
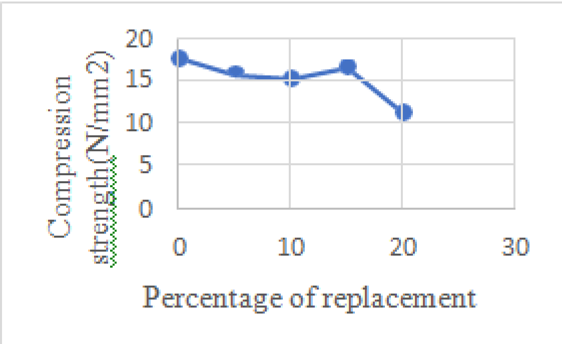


a) Graph showing 7th day compressive strength

Table 2. 14th day compressive strength test results

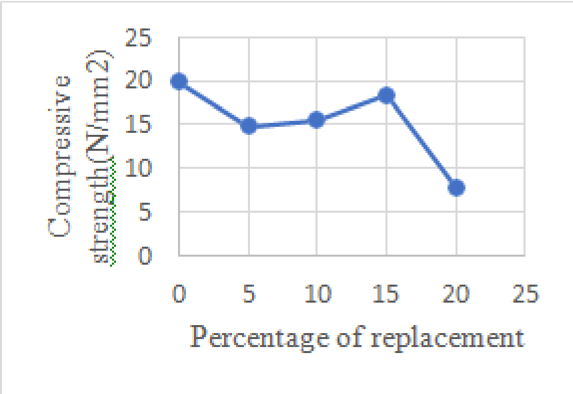
MIX TYPE	COMPRESSIVE STRENGTH (N/mm^2)
0%	17.55
5%	15.55
10%	15.11
15%	16.44
20%	11.11



a) Graph showing 14th day compressive strength

a) Table 3. 28th day compressive strength test results

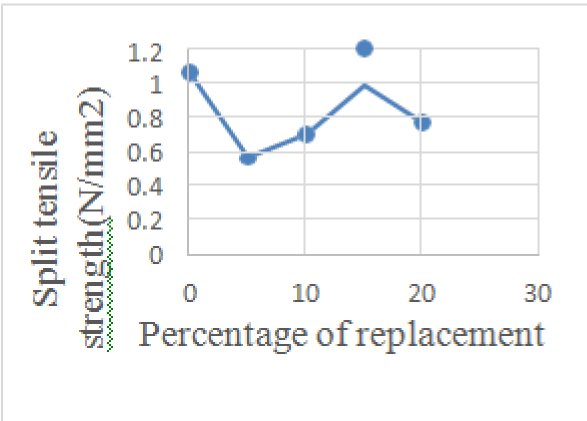
MIX TYPE	COMPRESSIVE STRENGTH (N/mm^2)
0%	19.8
5%	14.77
10%	15.5
15%	18.4
20%	7.77



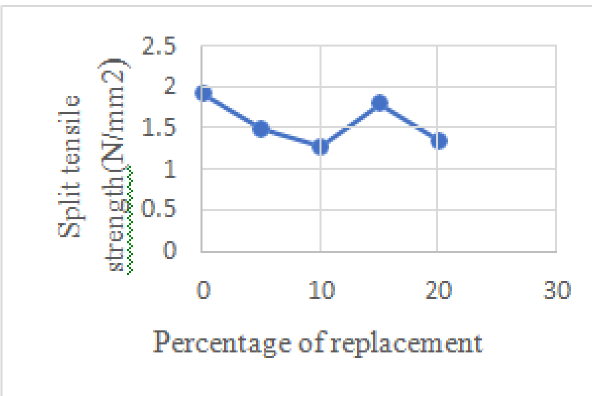
b) Graph showing 28th day compressive strength

SPLIT **TENSILE STRENGTH TEST**

MIX TYPE	SPLIT TENSILE STRENGTH (N/mm^2)
0%	1.06
5%	0.566
10%	0.7
15%	0.99
20%	0.77



a) Graph showing 7th day split tensile strength



a) Graph showing 14th day split tensile strength

Volume 09 Issue 02 March 2021

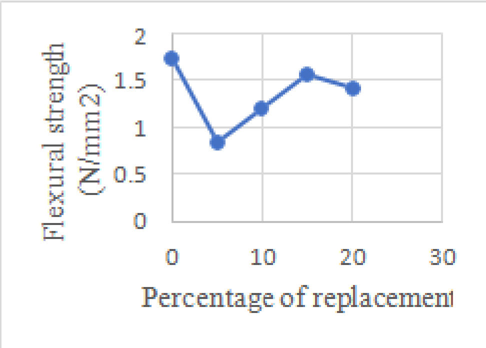
JOURNAL OF CURRENT SCIENCE

ISSN NO: 9726-001X

FLEXURAL TENSILE STRENGTH TEST

Table 7. 7th day flexural tensile strength test results

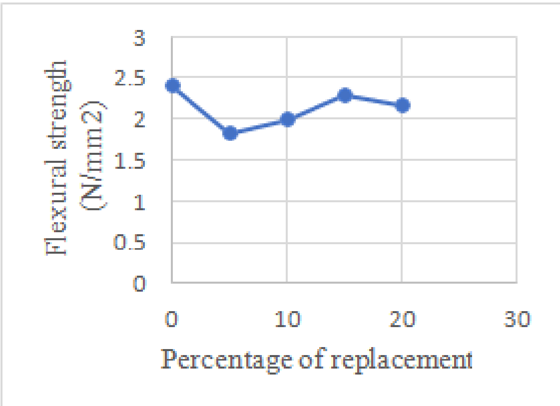
MIX TYPE	FLEXURAL TENSILE STRENGTH (N/mm^2)
0%	1.73
5%	0.84
10%	1.2
15%	1.56
20%	1.42



a) Graph showing 7th day flexural tensile strength

a) Table 8. 14th flexural tensile strength test results

MIX TYPE	FLEXURAL TENISLE STRENGTH (N/mm^2)
0%	2.39
5%	1.82
10%	1.98
15%	2.28
20%	2.16



b) Graph showing 14th day flexural tensile strength

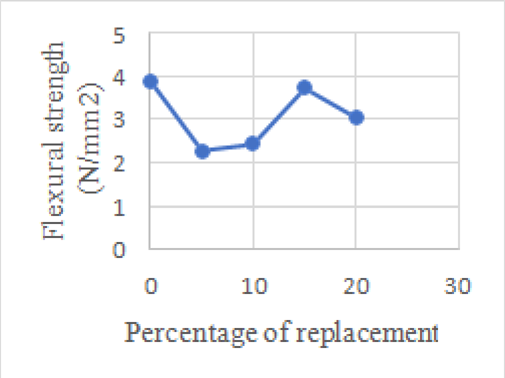
Volume 09 Issue 02 March 2021

JOURNAL OF CURRENT SCIENCE

ISSN NO: 9726-001X

Table 9. 28th day flexural tensile strength test results

MIX TYPE	FLEXURAL TENSILE STRENGTH (N/mm^2)
0%	3.89
5%	2.28
10%	2.43
15%	3.72
20%	3.04



b) Graph showing 28th day flexural tensile strength

CONCLUSION

Using seashells in concrete is a beneficial way for recycling this material instead of using landfills and this study promotes the incorporation of seashells into concrete mixes. The unit weight of concrete made using partial replacement of cement with seashell powder is almost unaffected. Using the same w/c ratio, increasing the replacement percentage of OPC with seashell powder increases the slump value and improves the workability. The basic test material results showed that the properties of seashell powder are similar to that of cement. The strength of concrete made with 5%, 10%, 15% seashell replacement met the target strength at 28 days and 20% replacement slightly failed to meet the target at 28 days of age. The workability of fresh concrete decrease with increase in the replacement of seashell powder content for the same dosage of concrete mix. The compression strength, tensile strength and flexural strength gradually increases from 0%, 5%, 10%, 15% replacement of seashell powder and decreases for 20% replacement of seashell powder. The 15% achieves the maximum tensile strength and flexural strength for partial replacement of cement with seashell powder is found to be greater than the conventional concrete. It reached maximum compressive strength when there is the partial replacement of cement with seashell powder (15%).So, the maximum percentage of replacement of seashell powder is 15%.This effort will create better benefit in future economic value to the local community and industries and also provide better solution in concrete technology.

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