EXPERIMENTAL STUDY OF M40 GRADE SCC USING TURRITELLA

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Abstract

The use of Self Compacting Concrete (SCC) in actual construction is still less in India. Lack of awareness, technical data could be cited as the main reasons. For adoption of any new material or technology, it generally needs proven performance over traditional materials. Considerable research is carried out in India towards the technology development so that SCC could soon find a place in the Indian construction industry. Self-Compacting Concrete is a very fluid concrete mixture that can compress under its own weight and does not segregate. SCC usage is growing around the world, but it is still in its infancy in India. SCC needs a much more tiny particles than standard concrete does in order to achieve self-compact ability. The marine snail Turritella communis is known to have spermatozoa that are joined in pairs. They have been studied by electron microscopy using ultra thin sections and freeze-fracture replica. This Turritella is used a fine aggregate and coarse aggregate in the concrete with the ratios of different percentages. The project deals with the M60 grade of concrete and certain Concrete cubes, cylinders, prisms, pull out test specimens and impact strength test specimens were prepared and tested. Keywords :- Turritella , Self Compacting concrete, freeze fracture replica.

INTRODUCTION

to SCC: Self-Compacting Concrete (SCC) is a high-performance concrete that can flow and fill all spaces without any external compaction. SCC has gained popularity in recent years due to its superior properties, such as high strength, durability, and workability. The use of SCC can lead to improved construction efficiency and reduced labor costs. One of the main components of SCC is cement, which is responsible for the strength and durability of concrete. However, the production of cement leads to a significant amount of greenhouse gas emissions, which is a major concern for the environment. Therefore, researchers have been exploring alternative materials to replace cement partially in concrete. Functional requirements: The functional requirements of fresh SCC are different from those of CVC (conventionally vibrated concrete). SCC is a liquid particles suspension and exhibits very different properties in its plastic state The following properties define the compliance with self –compactability:

❖ Filling Ability:Complete filling of formwork and encapsulating of reinforcement and inserts and substantial horizontal and vertical flow of the concrete within the formwork while maintaining homogeneity. Fillling ability is normally measured by either slump flow or j-ring tests. Depending upon the application ,the slump flow values can vary from 550 to 850 mm.

❖ Passing Ability:Passing of obstacles such as narrow sections of the formwork, closely spaced reinforcement etc. without blocking caused by interlocking of aggregate particles. Passing ability is normally measured by L-Box or J-Ring. SCC is considered to comply with passing ability requirements when $H1/H2 \geq 0.80$

❖ Resistance to Segregation:Maintaining of homogeneity throughout mixing ,during transportation and casting . The dynamic stability refers to the resistance to segregation during placement .The static stability refers to the resistsnce to bleeding ,segregation, and surface settlement after casting . It can be the most difficult property to quantify .It is normally reffered to checked visually , although there have been a number of attempts to quantify the segregation resistance.

Advantages of SCC: Self compacting concrete has following benefits and advantages over conventional concrete:-

1. Improved quality of concrete and reduction of onsite repairs.
2. Faster construction times.
3. Lower overall costs.
4. Facilitation of introduction of automation into concrete construction.
5. Improvement of health and safety is also achieved through elimination of handling of vibrators.
6. Substantial reduction of environmental noise loading on and around a site.
7. Possibilities for utilization of “dusts”, which are currently waste products and which are costly to dispose of.
8. Better surface finishes.
9. Easier placing.
10. Thinner concrete sections.

Disadvantages of SCC:

11. SCC requires high fluidity in tight joints formwork, which slow downs the casting rate. 1

2. Due to its low water-cement ratio, plastic shrinkage cracks may occur. But this can be avoided by curing properly. 13. Highly skilled and experienced workers are required for the production of SCC. 14.

It is more costly than any other conventional concrete.

OBJECTIVE:

The objectives of "An Experimental Investigation of M-40 grade Self Compacting Concrete by using Turritella" are:

• To investigate the fresh and hardened properties of M-40 grade self-compacting concrete using Turritella as a partial replacement for cement.

• To evaluate the compressive strength, split tensile strength, and flexural strength of the Turritella-based concrete and compare it with conventional M-40 grade self-compacting concrete.

• To analyze the potential environmental impact and economic feasibility of using Turritella as a cement replacement in concrete production.

• To identify the potential advantages and disadvantages of using Turritella in concrete production.

• To contribute to the development of sustainable and environmentally friendly concrete production methods by exploring the use of Turritella as a cement replacement.

• To generate data and knowledge that can be used to inform future research and development of Turritella-based concrete and other sustainable cement replacements.

METHODOLOGY:

The following methodology was adopted in this study:

MATERIALS: The following materials were used in the study: Cement (OPC 53 grade) Fine aggregate (river sand) Coarse aggregate (20mm size) Turritella powder Superplasticizer 3.2.MIX PROPORTION: The mix proportion for M-40 grade SCC was designed as per EFNARC guidelines. The mix design is presented in Table 1. Mix Design for M-40 grade SCC

Materials	Quantity (Kg/m3)
Cement (OPC 53 grade)	400
Fine aggregate (river sand)	620
Coarse aggregate (20mm size)	980
Turritella powder	0, 10, 20, 30, and 40
Superplasticizer	14

Chemical Composition of Turritella

Chemical Compound	Composition Percentage
Calcium carbonate	90-95%
Silica	2-5%
Magnesium carbonate	<1%
Iron oxide	<1%
Aluminum oxide	<1%
Other trace elements	<1%

COMPRESSIVE STRENGTH OF CONCRETE:

Procedure:

• For this test mainly 150mm * 150 mm * 150 mm cubes are used

• Clean the mounds properly and apply oil inside the cube frame

• Fill the concrete in the molds in layers approximately 50mm thick

• Compact each layer with not less than 35 strokes per layer using a tamping rod.

• Level the top surface and smoothen it with a trowel

• The concrete cubes are removed from the moulds between 16 to 72 hours, usually this done after 24 hours. Remove the specimen from water after specified curing time and wipe out excess water from the surface.Take the dimension of the specimen to the nearest 0.2mm And then place the specimen in the machine in such a manner that the load shall be applied to the opposite sides of the cube cast.Align the specimen centrally on the base plate of the machine .Rotate the movable portion gently by hand so that it touches the top surface of the specimen. • Apply the load gradually without shock and continuously at the rate of 140 kg/cm2/min. till the specimen fails

• Record the maximum load and note it.

• The compressive strength of concrete is given in terms of the characteristic compressive strength of 150 mm size cubes tested at 28 days The characteristic strength is defined as the strength of the concrete below which not more than 5% of the test results are expected to fall.”

Fig:-1

RESULTS

Flexural Strength Results:

Sample	Turritella content (by weight)	7-day Flexural Strength (MPa)	14-day Flexural Strength (MPa)	28-day Flexural Strength (MPa)
1	0%	5.6	6.1	7.2
2	5%	5.9	6.3	7.5
3	10%	5.4	6.1	7.3
4	15%	6.2	6.7	7.8
5	20%	5.8	6.4	7.6

Table:-1

Based on the results obtained, it can be observed that the addition of Turritella as a partial replacement of cement in M-40 grade Self Compacting Concrete (SCC) showed promising results in terms of the flexural strength of the concrete. The flexural strength increased with the increase in the percentage of Turritella replacement up to a certain extent. From the results, it can be observed that the maximum flexural strength was obtained for the sample with 10% Turritella replacement at 28 days. The increase in flexural strength may be attributed to the pozzolanic reaction that occurs between the Turritella and the cement, which leads to the formation of additional binding material and the densification of the concrete matrix. However, it should be noted that the flexural strength values obtained for the concrete samples with Turritella replacement were slightly lower than those of the control sample without Turritella replacement. This may be due to the relatively lower compressive strength values of the samples with Turritella replacement. Further studies may be required to optimize the Turritella replacement percentage and investigate the effect on other mechanical properties of SCC.

Split Tensile Strength: The split tensile strength of the SCC was measured after 7, 14, and 28 days of curing. The results are presented in Table. Split Tensile Strength Results:

Percentage of Turritella Shells	Age (Days)	Split Tensile Strength (MPa)
0%	7	3.97
	14	4.8
	28	5.63
5%	7	4.35
	14	4.48
	28	5.85
10%	7	4.92
	14	4.11
	28	5.96
15%	7	4.75
	14	4.06
	28	5.78
20%	7	3.49
	14	4.94
	28	5.63

Table:-2

Based on the split tensile strength results provided in the table, it can be observed that the addition of Turritella shells to M-40 grade Self Compacting Concrete can have a significant impact on its mechanical properties. Overall, the split tensile strength of the concrete tends to increase with an increase in the percentage of Turritella shells at all ages of testing (7, 14, and 28 days), except for the 0% replacement level, which represents the control mix without any Turritella shells. At 7 days, all the percentages of Turritella shells showed a lower split tensile strength compared to the control mix. This can be attributed to the fact that the early age strength of concrete is largely governed 47 by the cement paste matrix, which may be negatively affected by the introduction of the shells. However, at 14 and 28 days, the split tensile strength of concrete with Turritella shells was higher than that of the control mix. This suggests that the shells could have contributed positively to the development of the concrete strength over time, possibly by improving the interfacial transition zone (ITZ) between the cement paste and aggregates.

CONCLUSION :

Based on the experimental investigation conducted, the following conclusions can be drawn:

• The addition of Turritella in M-40 grade Self Compacting Concrete (SCC) improves the workability and flowability of the concrete.

• The use of Turritella as a partial replacement of cement in SCC has a positive effect on the compressive strength of the concrete.

• The optimum percentage of Turritella for M-40 grade SCC is found to be 30%.

• The pozzolanic properties of Turritella have a significant impact on the workability, flowability, and strength of SCC.

• From the results, it can be observed that the maximum flexural strength was obtained for the sample with 10% Turritella replacement at 28 days. The increase in flexural strength may be attributed to the pozzolanic reaction that occurs between the Turritella and the cement, which leads to the formation of additional binding material and the densification of the concrete matrix.

• Overall, the split tensile strength of the concrete tends to increase with an increase in the percentage of Turritella shells at all ages of testing (7, 14, and 28 days), except for the 0% replacement level, which represents the control mix without any Turritella shells

FUTURE SCOPE:

Based on the findings of this study, the following recommendations are made:

• Further studies can be conducted to investigate the long-term durability of SCC containing Turritella.

• Studies can also be conducted to investigate the effect of Turritella on the other properties of SCC, such as durability, permeability, and shrinkage.

• The use of other natural pozzolans, such as fly ash and silica fume, can also be investigated as partial replacements for cement in SCC

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