Study on basalt rock fiber reinforced concrete with Manufactured sand

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Abstract - This experimental work aims to determine the mechanical strength properties of basalt fiber-reinforced concrete when natural river sand is replaced partially with manufactured sand. In this experiment natural river sand is replaced with manufactured sand by 0%, 25%, 50%, 75%, and 100%. A total of 30 cubes of size 0.15 x 0.15 x 0.15 meters and 30 cylinders of size 0.15 x 0.15 x 0.3 meters were casted respectively to check the compressive strength and tensile strength of the basalt fiber reinforced concrete when they age 7 days and 28 days. Also slump tests were conducted on each mix to determine the workability of the basalt fiber reinforced concrete. For ages, fiber-reinforcement has known to lead to improved tensile strength. In this research, basalt fibers of length 12mm, diameter 0.2mm and an aspect ratio of 60 are used by 0.25% of the total volume of concrete.

Index Terms - Artificial sand, Basalt rock fiber, Manufactured Sand, M-sand.

I. INTRODUCTION

Reinforcing the concrete with bars or fibers having better tensile properties result in improved tensile property of the otherwise brittle concrete. Concrete is known to have excellent compressive strength but possesses very low tensile strength. The technique of reinforcing materials to improve their properties is not new and dates back to Egyptian civilization. Reinforcing the concrete with fibers also has shown to improve its ductility and resistance to cracking.

This research also addresses the immediate requirement of finding a replacement for natural sand, which is depleting at a fast pace. Mining, sourcing and using natural sand has also been banned in many states of India.
In this study, natural sand is partially replaced with M-sand by 0%, 25%, 50%, 75%, and 100%. In this research, basalt fibers of length 12mm, diameter 0.2mm and an aspect ratio of 60 are used to 0.25% of the total volume of concrete. Compression test and tension test were conducted on 7th day and 28th day to check the mechanical properties of the basalt rock fiber reinforced concrete. Slump tests were also conducted on each mix to study the workability of the reinforced concrete in fresh condition.

Basalt rock fiber

Basalt fiber is obtained by melting basalt rock at very high temperatures. Because of its fire resisting properties, basalt rock fibers is widely used in fire proof textiles and aerospace industry. It is non - metallic and is found to have excellent elastic modulus.

Fig. 1 Basalt rock fiber

II. RESEARCH OBJECTIVES

The main objective of this experimental process is to study the workability and mechanical behavior of concrete using manufactured sand reinforced with basalt rock fibers.

1. To design M-40 grade of concrete using basalt rock fiber.
2. To study and investigate the mechanical behavior of concrete viz. compressive and tensile strength of concrete reinforced with basalt fiber.

3. To have a better understanding on the workability of concrete when reinforced with basalt rock fiber.

III. MATERIALS USED AND METHODOLOGY

A. Materials used

Basalt rock fiber - Chopped basalt rock fiber of aspect ratio 60 has been used for about 0.25% of total volume of concrete.

Cement – Cement acts as a binding material, it is cohesive in nature and has a beautiful property of setting in on addition of water. For the current experiment, Ordinary Portland cement (OPC – 53 – grade) has been procured and used for casting all the specimens.

Aggregates - Natural sand and manufactured sand passing through 4.75mm and retained on 0.075mm IS sieve was used as fine aggregate. Aggregates of particle size passing 20mm IS sieve and retained on 4.75mm IS sieve are used for coarse aggregate.

Water - Potable water of drinking quality has been used for mixing and curing.

Admixture - Super Plasticizer Supaflo PC 360.

B. Material properties and results.

Table 1. Ordinary Portland cement

PROPERTY	RESULTS
Specific gravity of cement	2.7
Normal consistency of cement	26%
Initial setting-time of cement	70 minutes

Table 2. Natural River sand

PROPERTY	RESULTS
Specific gravity of river sand	2.794
Water absorption of river sand	1.13%
Fineness modulus of river sand	3.44

Table 3. Manufactured sand

PROPERTY	RESULTS
Specific gravity of M sand	2.4
Water absorption of M sand	2%
Fineness modulus of M sand	3.014

Table 4. Properties of coarse aggregate

PROPERTY	RESULTS
Specific gravity of CA	2.57
Water absorption of CA	1.01%

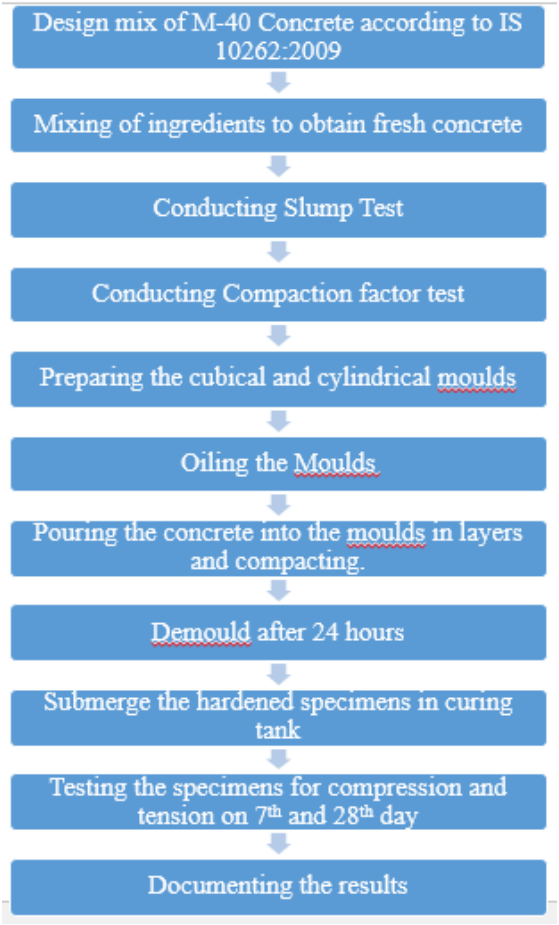

Fig. 2 Experimental set up

IV. RESULTS AND DISCUSSIONS

A. Workability

Workability of the concrete was tested by conducting slump test and compaction factor test for each replacement mix. Studies have shown improved workability when river sand is replaced by manufactured sand. However, the workability reduces when we add fibers to concrete. The workability is measured by conducting slump test and compaction factor test.

a. Slump test:

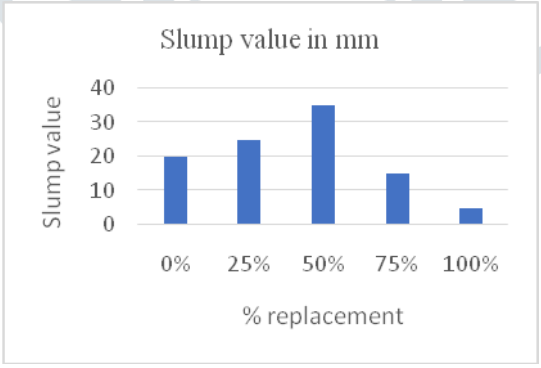

Fig 3. Slump test values

From the above chart, it is observed that the workability went on increasing till 50% replacement of natural sand with M-sand and then it decreased for further replacement. Hence the optimum replacement for improved workability is 50 % replacement of natural sand with M-sand.

b. Compaction factor test:

On conducting compaction factor test, it was observed that the compaction factor goes on increasing till 100% replacement of natural sand with M-sand.

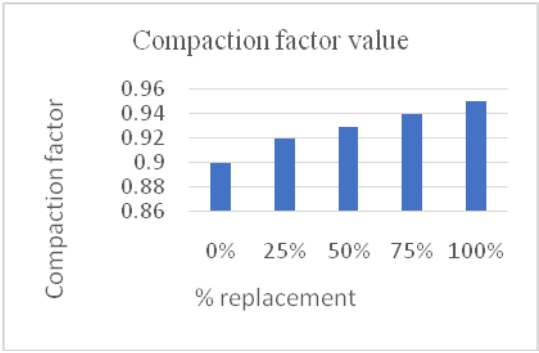

Fig 4. Compaction test values

B. Compressive strength:

Addition of fibers affects the compressive strength of the concrete. The type of fiber, aspect ratio, volume of fiber added to concrete also affect the various mechanical properties of fiber reinforced concrete.

Compressive tests were conducted on cubical specimens of dimensions 150 x 150 x 150mm, on 7th day and 28th day. The test results showed that the compressive strength steadily increased for every replacement of natural sand with manufactured sand at 7th and 28th day.

Fig 5. Testing of concrete cube in compression machine

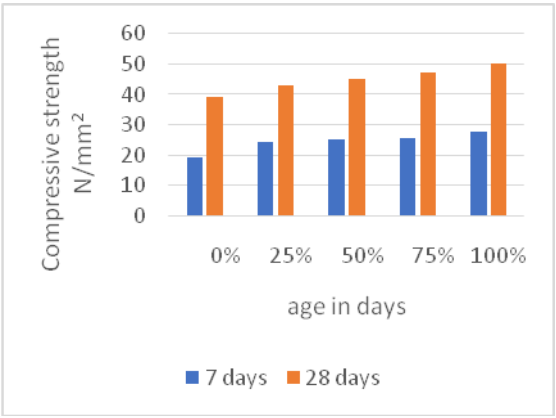

Fig 6. Compressive strength test at 7 days and 28 days

C. Tensile strength:

Tensile strength test was conducted on cylindrical specimens of size 150 x 150 x 300 mm. Concrete should have good tensile strength in order to take the tensile stresses that the structural members are subjected to. As concrete in itself is a brittle material and has low tensile stress, it is often reinforced with bars or fibers having better tensile strength. This process results in improved tensile strength of the reinforced concrete.

Fig 7. Testing of concrete cube in compression testing machine

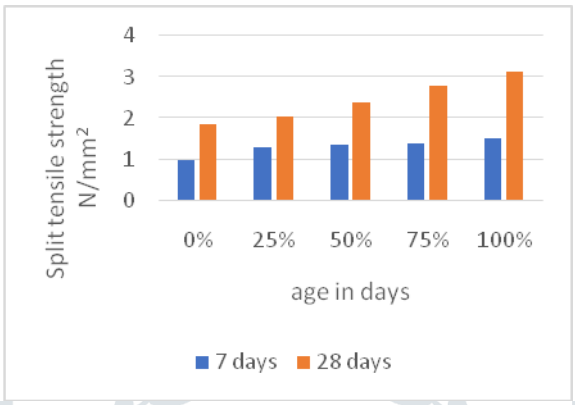

Fig 8. Split tensile strength test at 7 days and 28 days

From the above graph, we can observe that as the percentage of manufactured sand increases in replacement to natural sand, the tensile strength of concrete also increases and is highest for 100% replacement of river sand with 0.25% of basalt rock fiber.

V. CONCLUSIONS

Addition of fibers in concrete has proved to improve the properties of concrete, making it more tensile, durable and crack resistant.

In this project, the fresh state properties and mechanical properties were studied and the conclusion is as follows:

1. From the slump test, the workability is found to increase with the addition of manufactured sand till 50% and it went on decreasing for 75% and 100%.
2. The compaction factor went on increasing as increase of percentage of replacement of natural sand with manufactured sand.
3. The percentage increase in the replacement of natural sand with manufactured sand increases the compressive strength.
4. The percentage increase in the replacement of natural sand with manufactured sand increases in the split tensile strength.

VI. REFERENCES

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