Investigation On Mechanical Properties Of Bacillus Subtilis Bacterial Concrete Reinforced With Polypropylene Fibers

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Abstract— Concrete is generally weak in tension and strong in compression. The main aim of researches in concrete technology is to improve the tensile strength of concrete. To overcome this serious defect, fibers are added to the concrete. The strength and durability of the concrete can be improved by a technique involving bacterial induced calcite precipitation. Micro biologically induced calcite precipitation can heal cracks and improve the performance of the concrete. Bacillus Subtilis bacteria of concentration 10^5 cells/ml are added to improve the performance of concrete and life of the concrete. Incorporation of calcite precipitating bacteria to concrete in certain concentrations so that the bacteria will precipitate calcium carbonate when it comes in contact with water and this precipitate will heal the cracks. To impart tensile strength polypropylene fibers are added to the concrete. It is an environmental friendly and economical material that offers a combination of outstanding physical, mechanical, thermal and other properties. In this paper an experimental investigation is carried out to study the properties of polypropylene fiber reinforced bacillus subtilis bacterial concrete.

Index Terms— Concrete, Bacteria, Fibres, Polypropylene, Bacillus subtilis, Compression, Tension, Flexure

1 Introduction

The Concrete is most commonly used building material. It possesses low modulus, limited ductility and little resistance to cracking. Micro cracks developing the material during its manufacture due to inherent volumetric and micro structural changes. Hence it is necessary to impart tensile resistance properties to concrete structural members to use it as a load bearing material. Micro cracks are the main cause to structural failure. Micro biologically induced calcite precipitation can heal cracks and improve the performance of the concrete. Bacteria addition results in calcite precipitation in concrete to seal the freshly formed micro-cracks.These types of bacteria can be in dormant cell and be viable for over 200 years under dry conditions. Concrete is generally weak in tensile strength and strong in compressive strength. To impart tensile strength fibres are added to concrete. Addition of fibers would act as crack resistor and would substantially improve static and dynamic properties. For the improvement of pore structure in concrete the Bacillus Subtilis bacteria of concentrations 10^5 is used. To improve tensile strength Polypropylene (PP) fibers of length 12mm and diameter 0.036mm are used. Polypropylene is an economical material that offers a combination of outstanding physical, mechanical, thermal and electrical properties not found in any other synthetic fibres.

2 Objective

1. To experimentally investigate the characteristics of Polypropylene reinforced bacterial concrete
2. To determine the optimum percentage of addition of Polypropylene fiber in bacterial concrete
3. To compare the strength of conventional concrete with Polypropylene reinforced bacterial concrete

3 Materials

3.1 Cement

Ordinary Portland cement of 53 grade available in local market conforming to IS 269-1976 and IS 4031-1968 is used in investigation.

3.2 Fine Aggregate

Locally available clean, well graded M-sand was used as fine aggregate. The size of manufactured sand (M-Sand) is less than 4.75mm. It has cubical or rounded shape with smooth Surface Texture

3.3 Coarse Aggregate

Crushed granite angular aggregate of size 20mm nominal size from local source is used

3.4 Bacteria

Bacillus Subtilis bacteria obtained from TRM Biotech solutions, Erode, Tamil Nadu was used. The concentration of the bacteria was 10^5. To activate the bacteria, sugar solution or glucose was mixed with bacteria.

3.5 Polypropylene Fiber

Polypropylene are used as fibers. Fibers were of size 6mm. PP is an economical fibers which improve the properties of concrete. Polypropylene fibers are distributed throughout the concrete, they are effective close to where cracks start at the

aggregate-paste interface. This fiber is environmental friendly and non hazardous.

Fig 1 Polypropylene fiber

3.6 Water

Locally available potable water conforming to IS456 is used.

4 METHODOLOGY

In this study the properties of PP fiber reinforced bacterial concrete are compared with the plain concrete. As per IS 10262:2009 the mix proportions for M25 grade concrete was worked out. Bacillus subtilis were used as bacteria to cast bacterial concrete. PP fibers were added to the bacterial concrete at percentages of 0-1.5%. Slump test is conducted to determine workability of concrete. The strength tests conducted include compression test, tensile strength tests and flexural strength test. The graphical representation of methodology is shown in Figure 2

5 RESULTS

PP fibers were added to the bacterial concrete (Bacillus Subtilis were used as bacteria) At percentages of 0-1.5%. The workability test values and strength test values are compared with the control mix.

5.1 Compression test results

Compression test was conducted to determine the compressive strength. The test was conducted on the cubes of size 150mm X 150mm X 150mm using compression testing machine. The test results are shown in the Table 1 and are represented graphically in Figure 3

5.2 Split tensile test

Split tensile test was conducted to determine the tensile strength of the concrete. The test was conducted on cylinders of diameter 150mm and 300mm length in compression testing machine. The test results are shown in the Table 2 and are represented graphically in Figure 4.

4.2.3 Flexural test

Flexural test was conducted to determine the flexural strength. The test was conducted on prisms of size 100mmX100mmX500mm. Flexural strength is measured using universal testing machine. The test results are shown in the Table 3 and are represented graphically in Figure 5.

Fig 2 Methodology

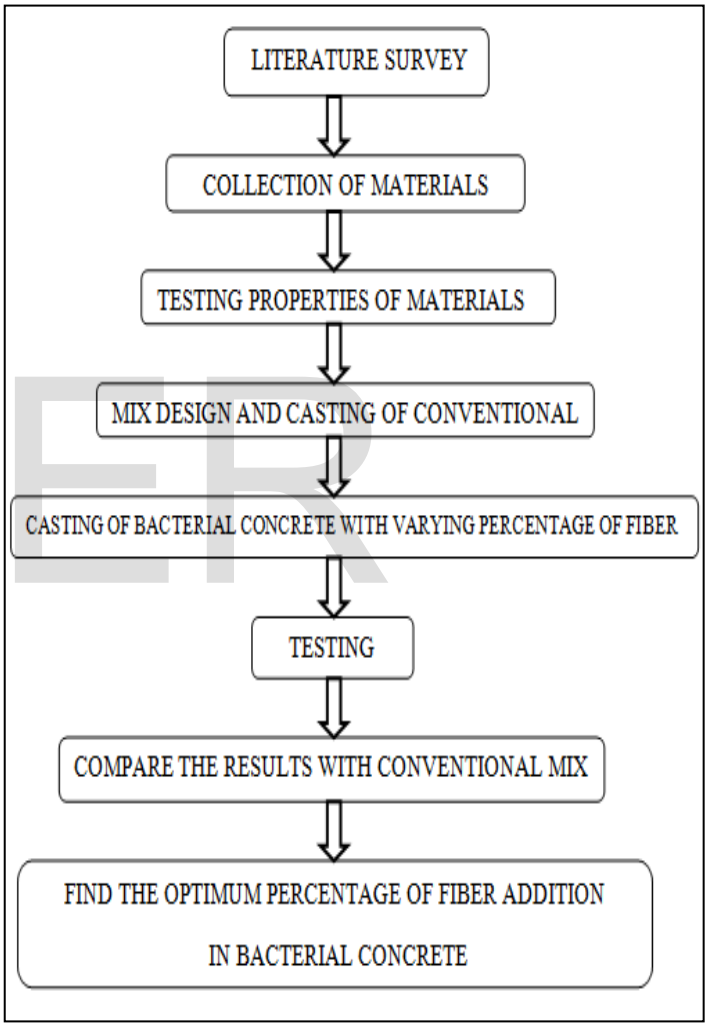

Fig 3 Compression test Results

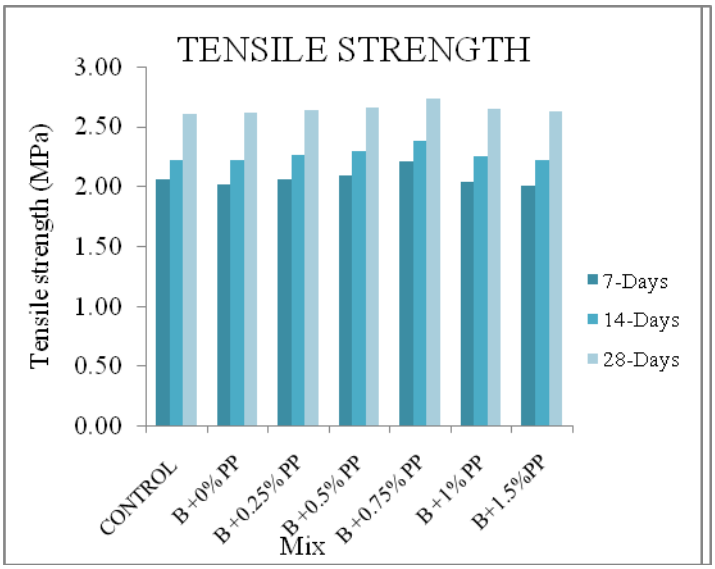

Table 2 Split Tensile Test Results

MIX	TENSILE TEST RESULTS (MPa)		
	7 day	14 day	28 day
CONTROL	2.06	2.22	2.61
B +0% PP	2.02	2.22	2.62
B +0.25% PP	2.06	2.27	2.64
B +0.5% PP	2.10	2.30	2.65
B +0.75% PP	2.21	2.38	2.73
B +1% PP	2.04	2.25	2.65
B+1.5%PP	2.01	2.22	2.63

Table 1 Compression Test Results

MIX	COMPRESSIVE TEST RESULTS (MPa)		
	7 day	14 day	28 day
CONTROL	19.36	24.13	26.53
B +0% PP	20.24	24.75	27.73
B +0.25% PP	20.57	25.23	28.17
B +0.5% PP	21.83	25.87	28.53
B +0.75% PP	23.54	26.12	28.71
B +1% PP	22.62	24.38	28.63
B+1.5%PP	20.75	23.45	28.42

Table 3 Flexural Test Results

MIX	FLEXURAL TEST RESULTS (MPa)		
	7 day	14 day	28 day
CONTROL	2.37	2.69	3.24
B +0% PP	2.42	2.75	3.31
B +0.25% PP	2.43	2.79	3.32
B +0.5% PP	2.47	2.83	3.34
B +0.75% PP	2.52	2.88	3.35
B +1% PP	2.43	2.76	3.33
B+1.5%PP	2.40	2.73	3.29

Fig 4 Split Tesile Test Results

5 CONCLUSION

1. Up to 0.75% of fiber addition, the compressive strength was found to increase on bacterial concrete made with Bacillus Subtilis bacteria. The compressive strength in bacterial concrete obtained with fiber content 0.75% was higher than plain cement concrete and bacterial concrete without fiber.
2. Up to 0.75% of fiber addition, the compressive strength was found to increase on bacterial concrete made with Bacillus Subtilis bacteria. The split tensile strength in bacterial concrete obtained with fiber content 0.75% was higher than plain cement concrete and bacterial concrete without fiber.
3. Up to 0.75% of fiber addition, the compressive strength was found to increase on bacterial concrete made with Bacillus Subtilis bacteria. The flexural strength in bacterial concrete obtained with fiber content 0.75% was higher than plain cement concrete and bacterial concrete without fiber.
4. The percentage of increase in Compression strength, Split tensile strength and flexural strength is 8.23, 4.59 and 3.29 respectively.

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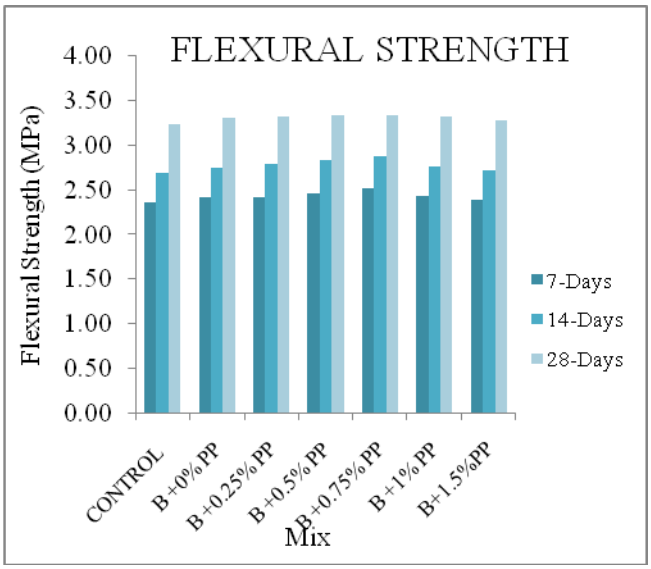

Fig 5 Flexural Test Results

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