

PHYSICAL, MECHANICAL PROPERTIES AND WORKABILITY IMPROVEMENT OF PINE FIBER REINFORCED CONCRETE

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ABSTRACT. There is an increasing interest among researchers to use natural fibres to enhance performance of concrete and other cement based products. Pine fibres are a waste material that often end up in landfills and also negatively impact undergrowth in pine estates. This study investigates using pine fibres to enhance the compressive and flexural performance of pine fibre reinforced concrete. In this research, 38 cubes and 38 beams were constructed using pine fibre reinforced concrete by varying fibre content from 0% to 6% by increasing the fibre content by 0.5% steps. Although no significant improvement on flexural and compressive strength were noticed through the study, adding fibres to concrete showed improved ductility of concrete. Despite lower compressive and flexural strengths reported when fibres added to the concrete, the workability of the concrete was noticed to be at acceptable level when 0.5% fibres added to concrete. The study further indicates possibility of using pine fibres in concrete to enhance its ductility and impact resistance performance with further modifications.

Keywords: Fiber reinforced concrete, Natural fibers, Pine Fibres, FRC

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INTRODUCTION

The concrete is used worldwide to do huge infrastructures. All the high rise buildings in Sri Lanka have the demand for the concrete. As a developing country, Sri Lanka has the demand for concrete in the development in the high rise buildings.

The demand of the concrete is increased although the concrete has its positive and negative impacts as well. The positive impacts are [1],

- Most of the materials are easily found.
- Can be manufactured to desired strength.
- It can be casted in to any desired shape.
- Almost no maintenance cost.
- Can resistant to wind and water.

The highlighted negative impact is that the concrete is much brittle in tensile strength than other construction materials. To improve this manner large amount of steel is used to strengthen the concrete. The steel gave a solution but on the other hand the reinforcement of steel fibers increased the cost and the weight of the steel reinforcement increased the dead load of the structure.

The introduction of fibers gave a solution in increasing the tensile strength of the concrete. The fiber reinforced concrete is plays a major role in the current world. There are four major types of fiber reinforced concrete according to the American Concrete Institute (ACI) they are,

- SRFC- Steel Fiber Reinforced Concrete
- GFRC- Glass Fiber Reinforced Concrete
- SNFRC- Synthetic Fiber Reinforced Concrete
- NFRC- Natural Fiber Reinforced Concrete

The fiber reinforcement concrete gave the solution for the improvement of the strength. At the early stage of fiber reinforcement the steel fibers was selected and gave some improvement in strengthening the concrete. On the other hand it didn't give a solution of replacing with a sustainable material and light weight material.

Natural fibers satisfied the essential need of sustainable and light weight material. It had some advantages mainly it doesn't cost much even we can get them freely. This research work will use the pine fiber as a natural fiber which is abundantly found in Sri Lanka.

The aims of the studies are,

- To study the physical mechanical properties of high strength concrete with varying percentage of pine fibers (0%, 0.5%, 1%, 1.5%, and 2%).
- To study the workability for the optimum strength achieved in the percentage of 0%, 0.5%, 1%, 1.5%, and 2% adding of pine fiber with the varying percentage of admixture (0%, 0.5% and 0.75%).

The main objective of this research is to enhance the tensile strength of the concrete by adding the suitable fiber percentage. The use of natural fibers in concrete will give us a

sustainable replacing material for the concrete and it will provide a cost effective replacement of material as well. To achieve the objectives we should identify the parameters given below,

- The ultimate tensile strength of the pine fiber reinforced concrete.
- The optimum fiber- cement ratio.
- The optimum fiber length.

The main scope of the research is limited to use the pine as the natural fiber which is easily available in Sri Lanka. Throughout the study the mix design of grade 60 concrete is used. The following properties of pine fiber reinforced concrete (PFRC) were recorded in the research.

- The varying compression strength of the PFRC.
- The varying flexural strength of the PFRC.
- The varying workability of the PFRC.

METHODOLOGY

By referring the past studies, they provided some ideas that how to perform the research work. The following methods were proposed to be done in the research work.

- Initially the pine fiber material was soaked in 7% concentration of the sodium hydroxide (NaOH) for 48 hours.
- After 48 hours the pine fibers was washed in order to remove the pith particles and lignin from the fibers.
- The dried fiber materials were manually chopped in to 10mm, 25mm, 40mm fiber sizes.
- Later the tensile strength of the pie fiber was determined for the treated and untreated samples.
- Next the cubes and beams were casted according to the proposed mix design with the varying fiber percentages and lengths.
- The slump value of each mixes was recorded in order to find the workability of the PFRC.
- The cubes and beams were kept in the curing tanks for curing for 28days.
- After 28days the cubes were taken out and tested the compression strength by using the compression testing machine in order to find the variation of compression of the PFRC.
- The beams also taken out after 28days of curing in order to test the flexural strength of the PFRC by using the universal testing machine.
- After the testing the collected testing data was analyzed and the optimum fiber cement ratio and fiber length was selected
- Finally the obtained fiber cement ratio and the length of the fibers were discussed in the manner of replacing material.

RESULTS AND DISCUSSION

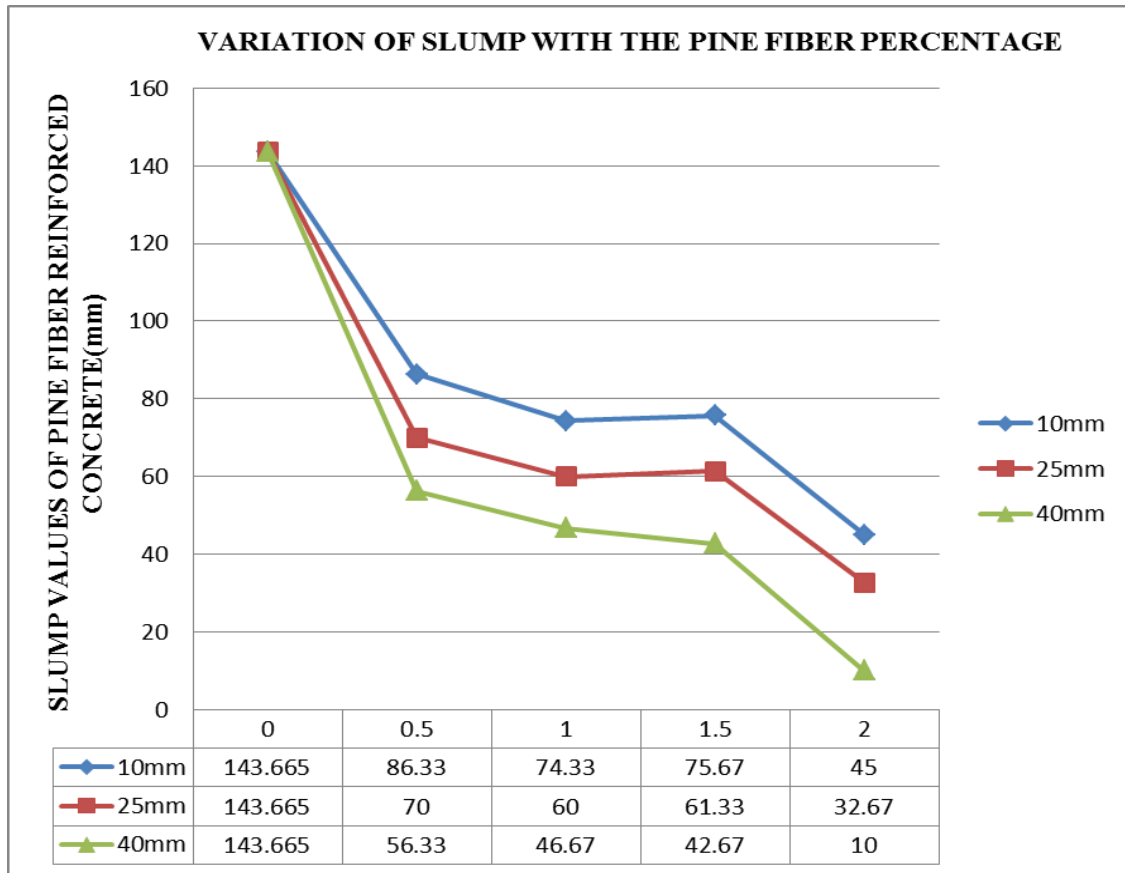


Figure 1 Variation of slump with the pine fiber percentage

The result above in the picture gives the data of the variation of the slump. This shows that the pine fiber reinforced concrete didn't achieve the workability comparing with the plain concrete. More over the 0.5% of 10mm size fiber has a little improvement comparing with other percentages and lengths.

This varying manner might depend in the water content of the aggregates. The workability of the concrete is depended on the water cement ratio. If the water content is not adjusted the workability of the mix will vary.

The figure 1 explains that the increment of pine fiber percentage and the pine fiber length will reduce the workability of the concrete. On the other hand it can be explained that the combination of the lesser fiber percentage and the short length will give a positive impact in the workability of the concrete

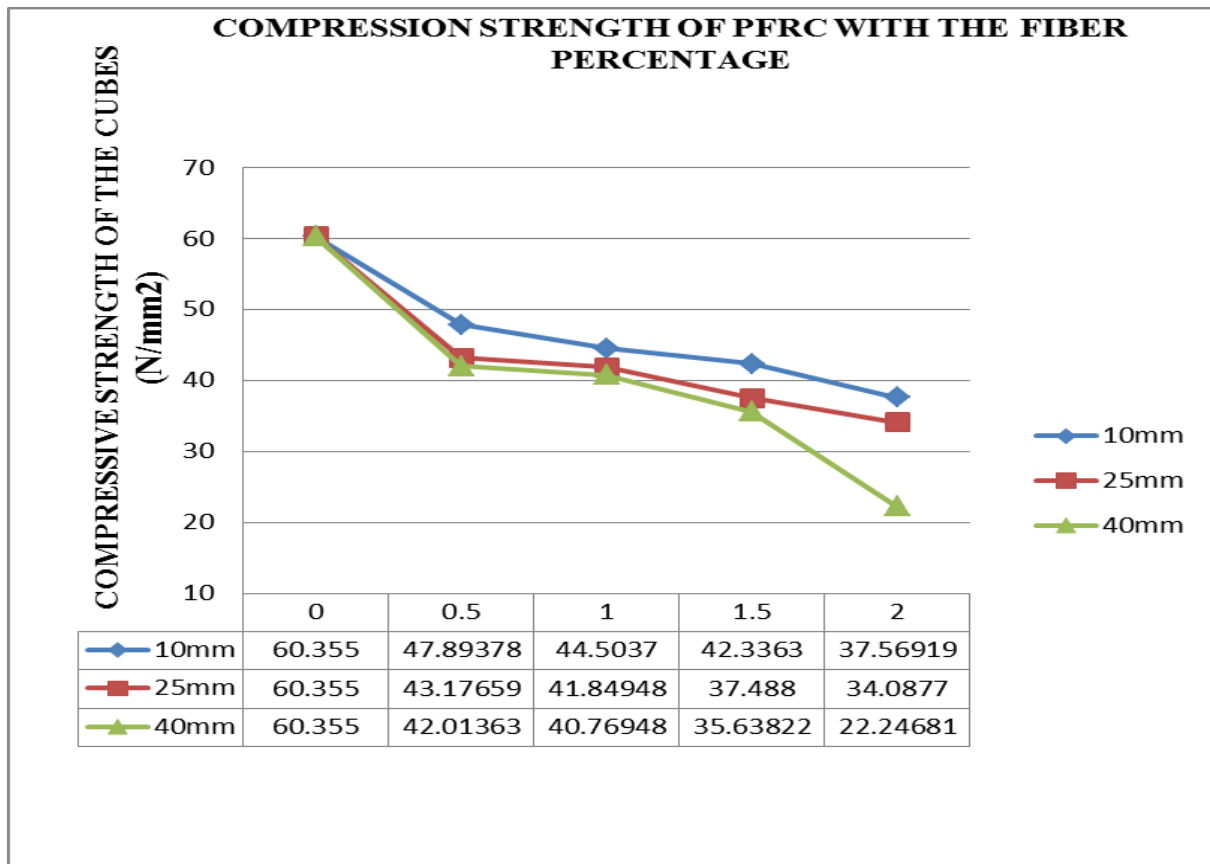


Figure 2 Variation of The Compressive Strength Of The Pine Fiber Reinforced Concrete

The above image shows the variation of the compressive strength of the plain concrete and the pine fiber reinforced concrete. Comparing the figure it's simply visual that the required compression strength is not achieved by any fiber cement percentage. In more detail the fiber cement ratio of 0.5% and 1% have achieved more than 67% of the compression strength comparing with other (1.5% and 2%).

Considering the length of the fibers the 10mm length shows a slight improvement comparing other (25mm and 40mm). The reduction in the compression strength is high this might be occurred by the balling effect. The increased fiber length and the fiber percentage will increase the voids in the concrete this will lead to end up with lower compression strengths. Therefore the increment of fiber cement and the fiber length percentages will significantly affect the compression strength of the pine fiber reinforced concrete.

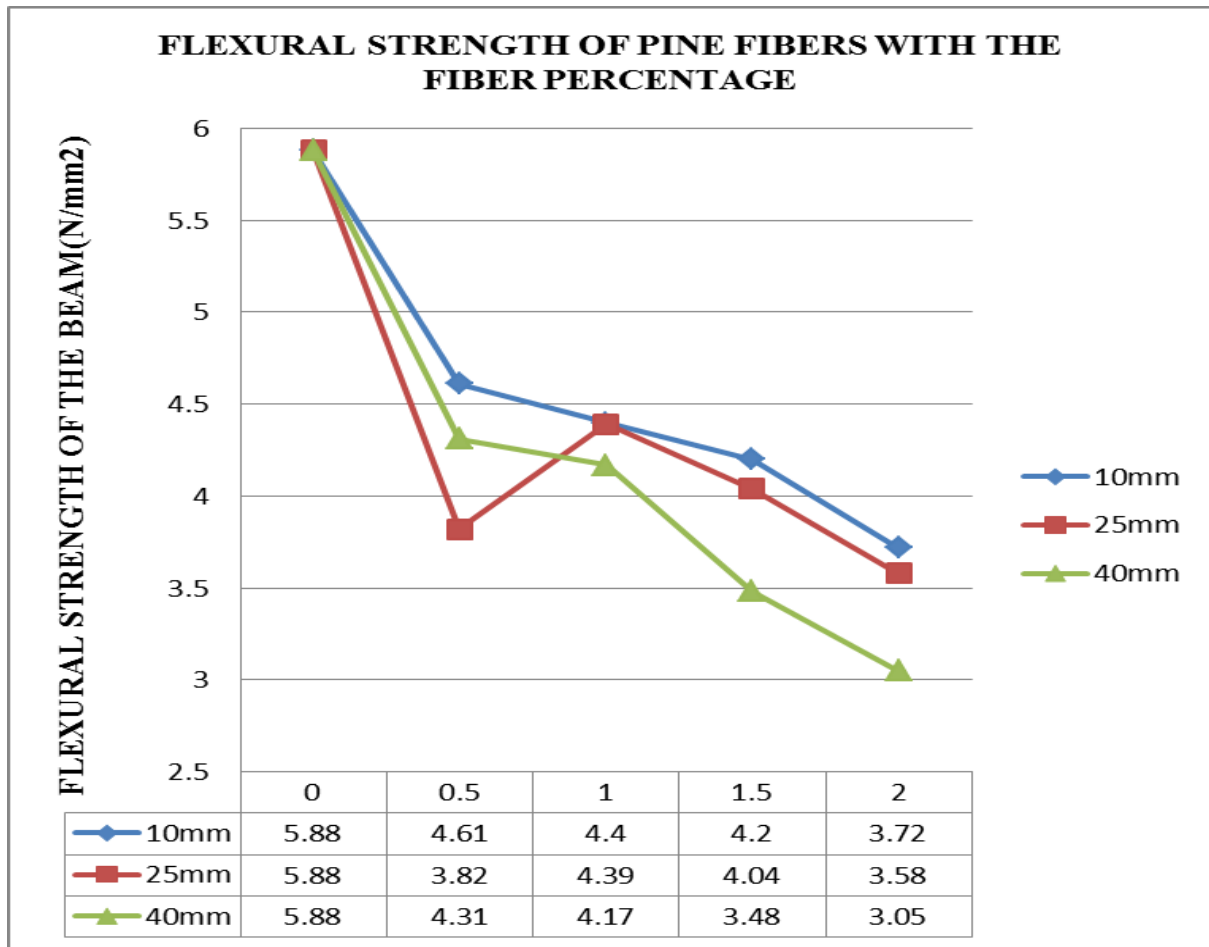


Figure 3 Flexural strength of pine fibers with the fiber percentage

The figure 3 explains the variation of the flexural strength of the plain concrete and the pine reinforced concrete. In general the tested beams didn't achieve the required flexural strength. The fiber cement ratio of 0.5%, 1% and 1.5% shows more than 70% of achieving the strength of the plain concrete beam. Comparing these three cases the 0.5% of 10mm fiber length has an improvement comparing others which achieved 78% strength of the plain concrete.

The graph shows that the increasing of the fiber cement ratio is lesser in achieving the flexural strength.

CONCLUSION

The main objective of this research is to increase the tensile strength of the high strength concrete by adding natural fiber (pine fiber). To achieve the goal the several number of testing cubs and beams were casted in order to find the mechanical properties and the workability of the pine fiber reinforced concrete.

Following are the salient conclusions based on the experimental investigations reported in this study

- The increment of pine fiber percentage and the pine fiber length will reduce the workability of the concrete
- The increment of fiber cement and the fiber length percentages will significantly affect the compression strength of the pine fiber reinforced concrete.

the increment of fiber cement and the fiber length percentages will affect the flexural strength of the pine fiber reinforced concrete

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