

# Mechanical Behaviour of Normal Concrete using Fibre of Pine Tree Needle Leaves



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**Abstract:** This research was carried out to study the behaviour of concrete, specifically flexural strength, by incorporating two types of pine needle leaves (green, and brown) recycled as fibre reinforcement in the concrete. The other goal of the study is to compare the two types of fibre and determine the maximum proportion of fibre to be added in the normal concrete. OPC concrete with 0%, 1% and 2% pine needle leaves fibre (green, and brown) was prepared based on the total weight of the mixture. At an ambient temperature of  $28 \pm 2^\circ\text{C}$ , the specimens were checked for flexural strength (FS). Laboratory test results based on short term investigation reveals that the flexural strength of concrete containing brown pine fibre (BPF) is higher than that of Green pine fibre (GPF), and also higher than normal (OPC) concrete. The optimum proportion of pine needle leaf fibre is the brown fibre (fallen leaves) to be added in the concrete as fibre is 1% by the total weight of the mixture, which gave a positive reaction from the test that was performed.

**Keywords:** Brown pine fibre, Green pine fibre, Flexural strength, Density, Normal concrete.

## I. INTRODUCTION

Pines are the most prevalent species in the Pinaceae family, and 109 species are recognized and contribute to forest systems and are widely distributed in the Northern Hemisphere [1]. they are widely spread, from tropical areas to northern areas in America and Eurasia. Only in Southeast Asia does their natural range cross the equator. In Africa, there are areas close to the Mediterranean in Central America and China, and there are 43 species in Mexico [2,3]. On that, these trees are produced in some waste such as leaves, various agro-industrial sectors [4-5] that, through its accumulation in landfills and unregulated burning, generates serious environmental and social problems. The various fibre were

and thus the use of this agricultural waste in concrete can contribute to reducing environmental problems. In recent years, Recent research has focused on waste produced in developed and used in the construction industries. E-waste plastic is used like fibre in a small size, which gets good results from a larger size [6]. It decreases environmental emissions when e-waste is used in concrete and overcomes the issue of solid waste [7] Compared to normal concrete, fibre-reinforced concrete helps to decrease crack propagation and improve mechanical properties [8]. Microfibres have delayed the production of macro cracks in hybrid concrete and exhibit higher strength and crack resistance [9]. It also increases the improvement of concrete's mechanical properties [10]. The period in recent years, thinking the waste management system and the global energy crisis, a variety of research studies have been carried out on waste materials to assess the characteristics and benefits [11]. This work presents the first study on the effect of mechanical properties of concrete by using two types of pine needle leaves fibre with different proportions of the total weight of the mixture (OPC).

## II. MATERIALS AND METHODS

### 2.1 Materials used for concrete

Ordinary Portland cement (OPC) complying with the specifications of ASTM [12] was used as the main binder, while, the fibre of pine tree needle leaves was used at 1% and 2% of the total weight of the mixture. As a fine aggregate, natural river sand was used with a fineness modulus of 3.1, a specific gravity of 2.7 and water absorption of 0.62 %. In order to achieve high power, a polymer-based superplasticizer form F was used to obtain high workability at a low water content. A mixture of proportions can be seen in Table 1.

### 2.2 Fibre of pine tree needle leaves

Pine leaves were used as fibre in normal concrete. These leaves were collected from trees located near the laboratory, School of Civil Engineering, in USM Engineering Campus, as shown in figure 1. Pine leaves were cut at the joints of the leaf into small needles as in figure 2, the average length of the needles (fibre) is 10 mm and the diameter is 0.7 mm. Since the joints in the pine leaf are very weak, it was therefore cut at the joints into durable fibre to be used in concrete.

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Fig. 1. Pine trees, School of Civil Engineering, in USM Engineering Campus.

Table 1 Mixture proportions (kg/m<sup>3</sup>)

Fibre Content	w/b	OPC	FPN	Sand	Add water	Super plasticizer
0%	0.2	1320.1	-	1980.2	369.6	19.8
BPF1%	0.2	1320.1	36.9	1980.2	369.6	19.8
GPF1%	0.2	1320.1	36.9	1980.2	369.6	19.8
BPF2%	0.2	1320.1	73.8	1980.2	369.6	19.8
GPF2%	0.2	1320.1	73.8	1980.2	369.6	19.8

Note: FPN is fibre of pine tree needle leaves, BPF is brown pine fibre, GPF is Green pine fibre, w/b is water cement ratio.



Brown pine fibre (BPF)



Green pine fibre (GPF)

FIG. 2. prepare the fibre from needles pine leaves



### 2.3 Testing of Specimens and Curing method

Concrete flexural strength was obtained by 40 mm X40 mm X160 mm prism testing and assessed according to ASTM C109 [13]. At an ambient temperature of  $28 \pm 2$  °C (70 %) relative humidity (RH) for 7, 14 and 28 days. there are displayed in fig 3.



Fig. 3. Prepare samples for testing of flexural strength

## III. RESULT AND DISCUSSION

### 3.1 Density of specimens

As shown in Fig. 4. below, the density of all samples containing the fibre decreased at curing age of 28 days. This indicates that fibre of pine needles are very lightweight. The

result shows that for each type of sample, concrete with 1% fibre has an average density compared to the others. On the other hand, concrete with 2% fibre has the lowest density.

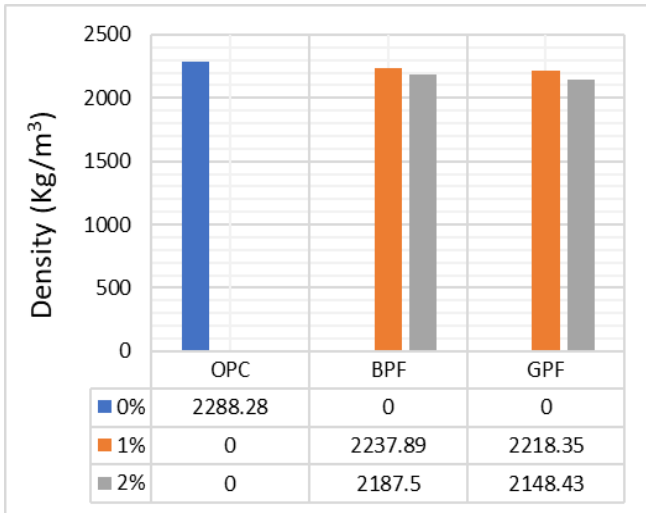


Fig. 4. Density of specimens at curing age of 28 days.

**Flexural strength test**

The flexural strength of normal concrete added with a fibre of pine tree needle leaves was tested at curing age of 7, 14 and 28 days. Table 2, and fig 7 show the result of flexural strength test. The results show an increasing value of flexural strength with an increase in the quantity of brown pine fibre (BPF) in the samples while the strength decreases with an increase in the amount of green pine fibre (GPF) in the concrete. The normal concrete has the value of 10.13 N/mm<sup>2</sup> at 28 days. However, when the strength reaches the highest value in the sample with 1% brown pine fibre of 12.56 N/mm<sup>2</sup>, the value decreases significantly at 2% of the fibre sample of 9.12 N/mm<sup>2</sup> at 28 days. While green pine fibre added to concrete, as the flexural strength is less than brown pine fibre and ordinary concrete. These findings showed that the increase in flexural strength optimum was only 1% of the content of brown pine fibre, but it decreased as the fibre quantity increased.

Table 2 show the result of flexural strength test

Fibre Content	Flexural Strength (MPa)		
	7 days	14 days	28 days
0%	7.90	8.86	10.13
BPF1%	8.20	9.80	12.56
GPF1%	6.80	7.10	7.77
BPF2%	6.0	7.65	9.12
GPF2%	4.0	4.72	5.20



Fig. 5. flexural strength test during laboratory work



Fig. 6 Brown pine fibre is more durable than green pine fibre

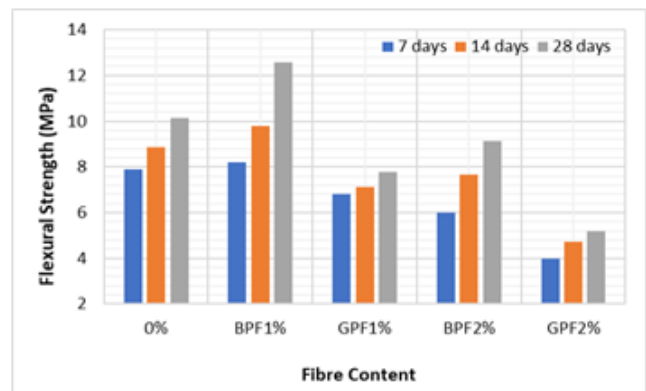


Fig.7. show the result of flexural strength test



Fig.8. Digital Microscope DM /Clarification of pine fibre in concrete



Fig.9. Flow table

#### IV. CONCLUSION

The following conclusions could be drawn from the present investigation.

- 1) These results showed that the increase in the optimum flexural strength was only 1% of the brown pine fibre content but it decreased when the amount of fibre increased.
- 2) Green pine fibre added to concrete reduces flexural strength when compared to brown pine fibre.
- 3) The negative response that concrete with 2% pine fibre has the least flexural strength is because of the loss of bonding due to excess amount of fibre. It also can be deducted that normal concrete with higher quantity of fibre of cannot carry extra load due to congestion of fibre.
- 4) The decrease in density of concrete containing a fibre of pine needle leaves, while the flexural strength of concrete containing brown pine fiber (BPF) increases by 1% of the total weight of the mixture.
- 5) Pine needle fibre concrete has a lighter weight than normal concrete.

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