

# Comparative Analysis the Addition of Natural and Artificial Fibres in Concrete

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**Abstract.** Concrete structurally has a fairly large compressive strength, but has a lack of tensile strength and is brittle. This weakness can be corrected by adding natural or artificial fibres to the concrete mix evenly with a random orientation. The purpose of this study was to investigate about the effect of adding natural fibres and artificial fibres on compressive strength and tensile strength of concrete. Test specimens used are cylindrical concrete measuring 150 mm x 300 mm with natural fibres from bamboo Betung and artificial fibres from local Bendrat wire. The variation of the percentage value of the fibre fraction volume is 0%, 0.2%, 0.4%, and 0.6% and the test is carried out when the concrete is 28 days old. The results showed that the addition of natural fibres and artificial fibres to the concrete mix can increase the compressive strength and tensile strength of normal concrete at a fraction volume of 0.4%. Increased compressive strength of normal concrete is 24.31% for bamboo Betung fibre and 20.81% for Bendrat wire fibre. Whereas the increased in tensile strength of normal concrete for Betung bamboo fibre increased by 77.12% and for Bendrat wire fibre increased by 3.24%.

## 1. Introduction

Concrete is one building material that is widely used in everyday life. Concrete has a strength that is greatly influenced by the composition and quality of the ingredients mixing. The strength of concrete lies in its compressive strength, while its weakness lies in its low tensile strength. The value of concrete tensile strength has range from 9% - 15% of the compressive strength. In line with the development of today's concrete technology, various attempts were made to improve the unfavorable character of concrete. The improvement method is by adding fibre into the concrete mixture. The main objective of adding fibre into concrete is to increase the tensile strength of the concrete. Very low tensile strength causes the concrete to crack easily, which in turn reduces the durability of the concrete. The intercalation of fibre in the concrete mixture is done evenly with random orientation. Types of fibres used can be natural fibres or artificial fibres. This research uses natural fibres from Betung bamboo peels (*Dendrocalamus Asper*) and artificial fibres from steel fibres in the form of Bendrat wire.

### 1.1. Steel Fibre

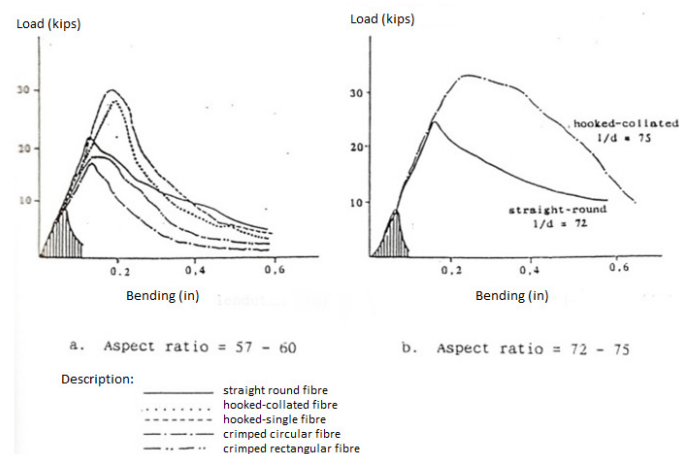
There are several types of steel fibres that are commonly used [1] which are straight, hooked, crimped, double duo form, ordinary duo form, paddled, enlarged ends, irregular, or indented. The cross section of the



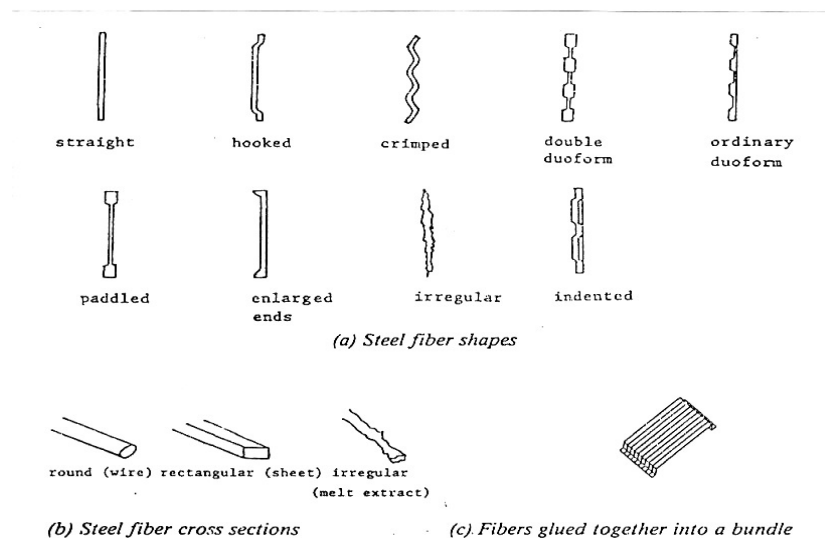
steel fibre can be round or wire, rectangular or sheet, or irregular or melt extract. The types of steel fibres glued together can be seen in Figure

### 1.1.1. Fibre glued together into a bundle

The bending and deflection load characteristics for each types of steel fibres and the illustration of the fibres can be seen in Figure 1 and Figure 2 respectively below.



**Figure 1.** Bending – deflection load characteristic of steel fibre concrete with different fibre types [1]

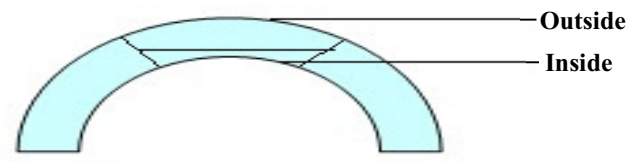


**Figure 2.** Various types of steel fibre shapes

## 1.2 Bamboo Fibre

Bamboo is a plant of the order of *bamboo idae* which grows quickly and can be harvested at the age of around 3 years. During the growth period, bamboo can grow vertically 5 cm per hour or 120 cm per day. [2] states, the presence of sklerenkin fibres in bamboo stems caused bamboo to have strength and can be

used for building materials. The strength of bamboo is generally influenced by the amount of sklerenkin fibre and cellulose in bamboo. The strength of bamboo on the outside is much higher than inside the bamboo.



**Figure 3.** Intake of Bamboo Specimens

Bamboo Betung (*Dendrocalamus Asper*) is a very strong and large bamboo with a diameter of 10 – 15 cm. Bambu Betung has a short internodes and thick walls and can grow very tall up to 10 – 20 meters. This bamboo tensile strength is 441 MPa [3]. This type of bamboo is usually used as the main structure of buildings, namely columns and beams.

Bamboo is an ingredient which is ductile so that it can be become immaterial for the house of earthquake proof. The level of high ductile, it is because bamboo is material who is a lightweight and the frame system work as a hinge. As natural material that can be renewed for 3-5 year, bamboo can be environmentally friendly. Excellence and this is what other unparalleled other materials.

## 2. Methods

The study was conducted in a laboratory to obtain actual data from the results of the study [4, 5]. Mixture comparison plan for concrete with fibres refers to regulations made by the ACI Committee 544, 1982. Trial concrete mix based on volume of weight was first made to obtain the desired concrete [6]. The specimens to be made consist of cylinders with a diameter of 150 mm with a height of 300 mm, a beam measuring 750 mm x 150 mm x 150 mm. Each specimen was made of 12 specimens consisting of four variations in the percentage of fibre content, namely 0%; 0.2%; 0.4%; 0.6%. The tests conducted in this research consisted of Slump testing, Compressive Strength testing, Tensile Strength testing.

## 3. Result and Discuss

### 3.1 The results of testing Workability

The severity of the fibre concrete mix was measured using the slump test and VB-test apparatus with vibration in the test. The slump value and the VB-time value of each mixture are presented in Table 1 below.

**Table 1.** Slump and VB-Time Values

Code	Fraction volume (%)	Cement Water Factor (fas)	VB-time		Slump Value (cm)		Comparison (cm)
			Bamboo fibres	Bamboo fibres	Bamboo fibres	Bamboo fibres	
BN-0%	-	0.5	-	13	18	8	10
BF-0,2 %	0,2	0.5	24	22	8	5	3
BF-0,4 %	0,4	0.5	26	23	1.5	5	-3.5

BF-0,6 %	0,6	0.5	25	25	3	4	-1
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Based on Table 1 above, it is known that the addition of fibre in a concrete mixture adds VB-Time value and decrease the value of Slump. The addition of inserted fibre into the concrete mix makes the concrete mixture become thicker and speediness smaller. This makes the concrete mixture more difficult to work with.

### 3.2 Compression Strength Calculation Results

The calculation results of the average compressive strength of three test pieces for each fibre concrete mixture are presented in Table 2 below.

**Table 2.** Concrete Compressive Strength

Code	Fraction volume (%)	Bamboo Fibre	Compressive Strength (MPa)		Influence (%)	Comparison (MPa)
			Influence (%)	Fibre Wire		
BN-0%	-	26.33	-	27.65	-	1.32
BF-0,2 %	0,2	23.78	-3,072	26.80	-9,68	3.02
BF-0,4 %	0,4	32.73	+20,81	33.40	+24,31	0.67
BF-0,6 %	0,6	17.37	-37,18	17.37	-34,03	0

Based on Table 2 above, it is known that the highest compressive strength value of concrete is in the volume of 0.4% fibre fraction both using artificial fibres (Bendrat wire fibres) which increase the compressive strength of normal concrete by + 24.31% and natural fibres (bamboo Betung fibres) increased compressive strength than normal concrete by + 20.81%. Comparison of compressive strength of concrete with artificial fibres (Bendrat wire) is higher than using natural fibres (bamboo Betung).

Research ananta ariatama ( 2005 ) of the fibres hooked wire obtained strong press increased 14,67 % and strong pliable increased 48,06 % and for research by edwar bamboo abraham said 2016 ) obtained strong press increased 7,00 % and 42,86 %.

### 3.3. Tensile Strength Calculation Results

The results of the calculation of the average tensile strength of three test pieces for each concrete fibre mixture are presented in Table 3 below.

**Table 3.** Concrete Tensile Strength

Code	Fraction volume (%)	Bamboo Fibre	Tensile Strength (MPa)		Influence (%)	Comparison (MPa)
			Influence (%)	Fibre Wire		
BN-0%	-	1.53	-	2,83	-	1.3
BF-0,2 %	0,2	2.17	+41,83	1,93	-31,67	-0.24
BF-0,4 %	0,4	2.71	+77,12	2,92	+3,24	0.21
BF-0,6 %	0,6	2.37	+54,9	2,32	-18,14	-0.05

Based on Table 3 above, it is known that the highest value of concrete tensile strength is in the volume of 0.4% fibre fraction both using artificial fibres (Bendrat wire fibres) which increase the tensile strength of normal concrete by + 3.24% and natural fibres (bamboo Betung fibres), increased the tensile strength of normal concrete by + 77.12%.

#### 4. Conclusion

Addition of natural fibres and artificial fibres to the concrete mix can increase the compressive strength and tensile strength of normal concrete at a fraction volume of 0.4%. the increasing of compressive strength of normal concrete is 24.31% for Betung bamboo fibre and is 20.81% for Bendrat wire fibre, while for normal concrete tensile strength concrete is 77.12% for Betung bamboo fibre and 32.45% for Bendrat fibre.

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