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THE INFLUENCE OF BAMBOO REINFORCEMENT AND ADDITION OF FIBERS ON HOLLOW BEAMS

FAISAL ANANDA, HENDRA SAPUTRA, and ARMADA SUKRI

Dept of Civil Engineering, Politeknik Negeri Bengkalis, Riau, Indonesia

The development of the artistic value of a building with reinforced concrete material continues to grow, one of which burrows the pipeline so as unexposed so that the condition of a building looks beautiful. This condition makes a weakening of the strength of concrete. As for the weakness of the concrete caused by a small crack due to deflection or the other anticipated by the addition of fiber one of the rebar tie wire (bendrat). Based on this condition, the beam testing was done with size by 150mm x 200mm x 1200mm with using one-point loading. Concrete mix design using SNI 03-2834-2000. The load obtained without fibers using the steel reinforcement by 12.9% greater than the use of bamboo reinforcement. This is because the tensile strength of bamboo is smaller than the tensile strength of iron. Likewise, on the beam that added fiber as much as by 2% on the bamboo reinforcement, there is a difference of loading is smaller than the steel reinforcement by 25%. The interesting result is found in the 0.5 inch diameter beam which has an increase in load with the initial crack conditions close to the same as the beam without a hole.

Keywords: Initial crack, Steel fiber, Flexural strength.

1 INTRODUCTION

Concrete is one of the main materials of infrastructure development. Concrete is formed by hardening of cement mixture, water, fine aggregate, coarse aggregate (crushed or gravel), air, and sometimes other additives (Nawy 2010). The concrete has a compressive strength value comparatively higher than its tensile strength. A 28-day strength concrete strength ranges from approximately 10-65 MPa. The value of tensile strength of concrete is only about 9% to 15% of its compressive strength (Mulyono 2005). The function of reinforcement in the concrete is to withstand the tensile forces carrying the loads acting on the concrete. Over time, the use of reinforcement continues to be developed to find a replacement, considering this material is a material that cannot be renewed by nature. One of the developments was to replace using natural materials such as bamboo. Bamboo is one of the oldest building materials used by mankind. The bamboo culm, or stem, has been made into an extended diversity of products ranging from domestic household products to industrial applications. In Asia, bamboo is quite common for bridges, scaffolding and housing, but it is usually a temporary exterior structural material (Latief *et al*. 1990). In Asia, bamboo is quite used for bridges scaffolding and housing, but it is usually temporary exterior structural material. In many overly populated regions of the tropics, certain bamboo supplies are the one suitable material, i.e., sufficiently cheap and plentiful. In response to global warming issues and sustainable society, manufacturing using natural material has become actively in developing countries. Bamboo is low cost, fast growing and broad distribution of growth is expected to contribute significantly in earthquake-resistant construction and seismic retrofit technology. On the other hand, plants and fibers are annually reproducible clean resources. Bamboo is a unique group of gigantic grasses the culm of which originates in underground rhizomes. It grows naturally in many parts around the world country but some species are artificially planted. Bamboo forests are found across tropic and sub-tropic zones between latitudes of about 40°south, i.e., areas with mean annual temperatures of from 20°C to 30°C. Compared with other fibers such as steel fiber and carbon fiber, bamboo fiber has significant advantages: high tensile strength (its tensile strength could reach 180Mpa (Huang *et al*). Concrete weak to tensile forces makes the initial crack of concrete in the tensile area. In addition to reinforcement, we can also add fiber. Whether in the form of stiff fiber (steel fibre) or not stiff. The addition of fiber can increase tensile strength (Ananda 2016a, Ananda 2016b, Ananda *et al.* 2017b), and minimize crack width (Ananda *et al.* 2017a).

2 MATERIALS AND METHODS

The study was conducted at the Laboratory of Building Materials and Concrete, Civil Engineering Department, State Polytechnic of Bengkalis. The test object was a beam with a dimension of 150mm x 200mm x 12mm with one-point loading (Figure 1). According to ACI Committee 224(2001), maximum crack width allowable for the protective condition is 0.41 mm (Table 1). This experiment was in full-scale test specimen, 1:1. It tested until it reached the first crack condition and used the simple support on both sides.

Table 1. Maximum crack width allowable.

Exposure Condition	Width Crack	
	mm	in
Dry air or protective membrane	0,016	0,41
Humidity, Moist air, Soil	0,012	0,30
Deicing Chemicals	0,007	0,18
Seawater and seawater spray, wetting and drying	0,006	0,15
Water-retaining structures	0,004	0,10

ACI Committee 224

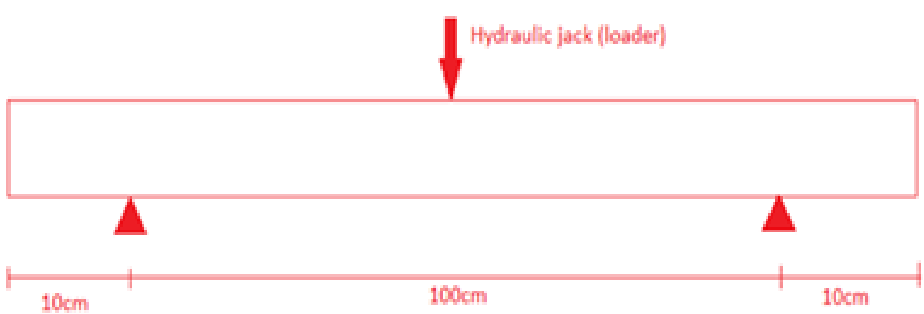

Figure 1. Loading scheme and testing.

The concrete mix design based on SNI 03-2834-2000, fc' = 15 MPa (T03-2834-2000, 2000). Steel fiber used in this research is the conventional steel fiber (bendrat) with length of ± 6cm.

Deflection testing and crack width use the fiber mixed with concrete by the initial slump 13 cm ± 2 cm. The experiment samples of compressive strength and tensile created using a cylinder.

After the specimen reaches the age of 28 days, the test was carried out to examine the static deflection, width crack and strain that occurs. Reinforcement uses fy = 240 MPa and bamboo reinforcement as a comparison. Specimens were subjected to a load line, started from zero to the first crack. Load (P) can be read on proving ring at intervals of 50 kg per one strip reading.

3 RESULT AND DISCUSSION

From the results of laboratory tests, it was found that the influence of the main reinforcement using bamboo reinforcement has a larger crack width size exceeding the maximum limit of crack allowed (Tables 2-5).

The interesting thing is found in this research is the increase of load on the 0.5-hole beam to the beam is not hollow with the initial crack conditions are more or less the same. The increase occurred on the beam of steel and bamboo reinforcement ± 3%, while on the beam of steel and bamboo reinforcement with additional 2% fiber by 25% - 35%.

In addition to the hollow block beam fibers to the hollow beam, there is no effect of fiber, where the initial crack that occurs close to the same magnitude despite the difference in the bending load that occurs on the beam (see Figures 2-5).

Table 2. Bending and initial first cracking loads of steel reinforcement beam (Tbi) without conventional fibers (bendrat).

Fiber (%)	Beam Holes (inch)	Initial First Cracks (mm)	Bending Loads (kg)
0	0	0,2	1550
	0,5	0,2	1600
	0,75	0,3	1300
	1	0,4	1250

Table 3. Bending and initial first cracking loads of steel reinforcement beam with additional conventional fibers (bendrat) 2%.

Fiber (%)	Beam Holes (inch)	Initial First Cracks (mm)	Bending Loads (kg)
2	0	0,1	1000
	0,5	0,2	1550
	0,75	0,2	1200
	1	0,1	1250

Table 4. Bending and initial first cracking loads of bamboo reinforcement beam (Tba) without conventional fibers (bendrat).

Fiber (%)	Beam Holes (inch)	Initial First Cracks (mm)	Bending Loads (kg)
0	0	1	1350
	0,5	0,8	1400
	0,75	1	1400
	1	0,6	1250

Table 5. Bending and initial first cracking loads of bamboo reinforcement beam with additional conventional fibers 2%.

Fiber (%)	Beam Holes (inch)	Initial First Cracks (mm)	Bending Loads (kg)
2	0	1	750
	0,5	0,9	1000
	0,75	1	800
	1	0,9	950

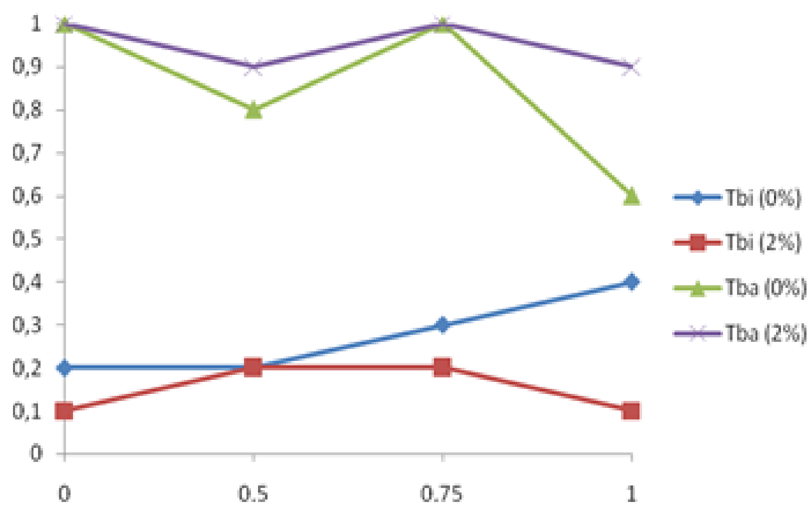

Figure 2. The width of cracking beam without holes and hollowed using bamboo and reinforcement.

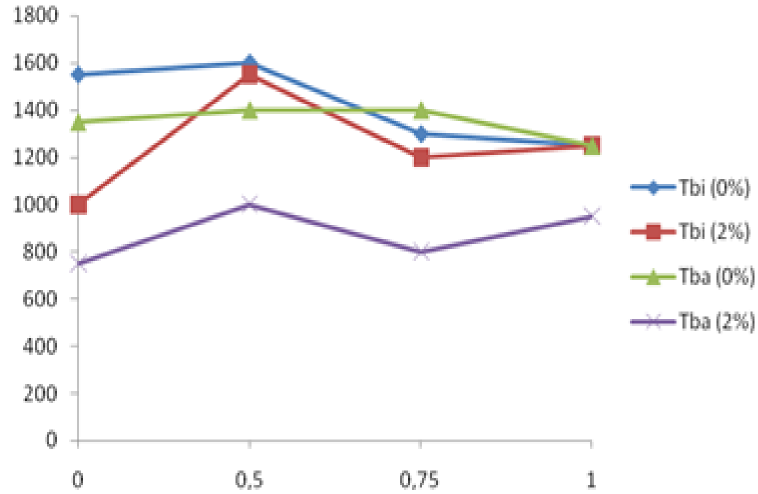

Figure 3. Bending loads of beam without holes and hollowed using bamboo and reinforcement.

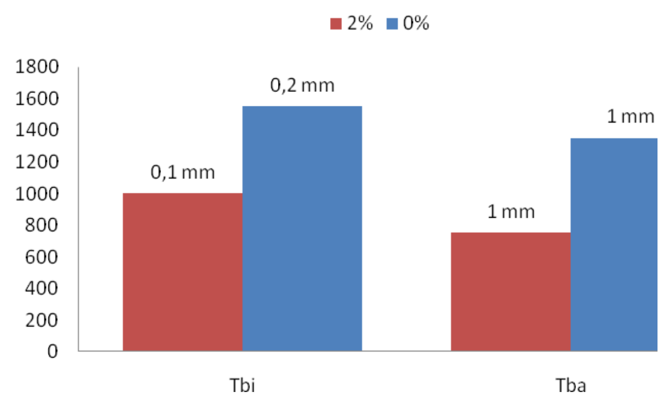

Figure 4. Comparison of load and initial cracks width in concrete reinforced beams of steel and Bamboo.

4 CONCLUSIONS

From the results of analysis and discussion, it can be concluded that the use of bendrat fibers on the bending test beam can affect the initial crack value although the bending load does not continue to increase with the beam enlargement. The 0.5-hole beam has better flexural strength than the 0.75 inches and 1-inch holes since the resilient load is greater than that of a hollow block, both of which are 2% or without fibers.

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