Flexural Capacity of Rattan Cane Reinforced Concrete Beams

Sjamsuddin Kaaba^{1}, Mufti Amir Sultan², Sudarman Samad³*

¹Master Degree Program, Department of Civil Engineering, Universitas Khairun, Indonesia

²Department of Civil Engineering, Faculty of Engineering, Universitas Khairun, Ternate, Indonesia

³Department of Architecture, Faculty of Engineering, Universitas Khairun, Ternate, Indonesia

Abstract. To overcome the dependence on the use of reinforcing steel in concrete, alternative materials are used as reinforcement that is easy and cheap to obtain the resistant of corrosion namely rattan rods. With this material the natural resources can be utilized optimally. This research uses rattan as reinforcement for concrete beams. The test is carried out using a two-point loading method, used 4 types of beams, namely 2 rattan reinforcement beam (BR₂), 3 rattan reinforcement (BR₃), 4 rattan reinforcement (BR₄) and 2 steel reinforcement (BS₂) as control beams. The test results show that the addition of 2 times the amount of rattan reinforcement resulted in an increase in flexural capacity of 48.51%. The flexural capacity of rattan-reinforced beams is lower than the flexural capacity of steel-reinforced beams by 10%, so the use of rattan as reinforcement in non-structural construction.

Keyword: Rattan, Reinforced, Concrete Beams

1 Introduction

Steel-reinforced concrete is a construction material that is commonly used in building structures, where the compressive strength of concrete and tensile strength of steel is a complementary combination. However, the use of steel as reinforcement still poses several obstacles, including the higher price. The increasingly high price of steel reinforcement will be very burdensome for the community, especially the economically weak community, in an effort to meet their primary needs, namely in the form of decent housing.

Therefore, it is necessary to seek an alternative substitute for steel reinforcement in concrete [1-2]. The alternative as a substitute for the reinforcement is rattan cane. Rattan cane are a renewable natural resource that can be obtained easily, cheaply, and is resistant to corrosion.

Bamboo and rattan can be used as an alternative to steel in low-cost lightweight construction for areas where steel reinforcement is difficult to obtain [2]. The use of rattan as reinforcement can increase the load carrying capacity of beams that have the same dimensions. At peak load, Reinforced Concrete Beams of Single Rattan cane crumble under the load followed by the breaking of Rattan cane whereas Steel does not break but loses its elasticity [3]. The use of bamboo rods as reinforcement is suitable for structures with light loads, while for rattan, more reinforcement treatment is needed to increase interfacial bonding and load carrying capacity [4]. Rattan cane can be used as reinforcement in concrete blocks [5-6].

It is important to do this research by utilizing local rattan cane from the North Maluku region.

2 Materials and method

2.1 Rattan cane

The Rattan Cane used for this study was obtained from Goal Village, Halmahera Barat Regency, Indonesia. The rattan cane was 10 mm in diameter and it was cut into 500 mm long as required for the research work.

2.2 Coarse and fine aggregate

Coarse Aggregate used for this research work was 12 mm size. It was sourced from a quarry Kali Oba in Halmahera Island. Coarse aggregate test based on SNI [7-10].

The sand used for this research work was sourced from quarry Kalumata, Ternate Island, Indonesia. Fine aggregate test based on SNI [7-8] [11]. Quarry of coarse aggregate and fine aggregate as shown in Fig 1.

2.3 Steel reinforcement

The reinforcement of size 10 mm was obtained in Ternate, Indonesia. The reinforcement was cut into 500 mm long.

* Corresponding author : sjamsuddin654@gmail.com

2.4 Cement

The cement used was Portland Cement. It was sourced from Ternate, and it conformed to the requirements of SNI [12].

2.5 Concrete Mix Design

The cross section of beam specimen was 100 x 150 mm with the total length of 600 mm. All specimens were pre-cracked by a notch of 20 mm along the width of beams at the span center to localize the crack when loading. Un-continuous D10 steel reinforcement were applied in upper side of the beam with the space of 20 mm between them (Fig. 2) to avoid concrete failure or cracks on the shear span [13].

Fig. 1. Coarse and fine aggregate quarry

2.6 Specimen

Concrete beams were treated for 28 days. Cylindrical specimens measuring 150 x 300 mm were prepared to determine the material properties of concrete. Rattan reinforcement is placed at the bottom of the beam, the variations of reinforcement are 2 pieces with the symbol BR1, and 3 pieces with the symbol BR2, and 4 pieces with the symbol BR3. Beams with 2 pieces of steel reinforcement as control beams (BK), the details of the test object are shown in Fig. 2 and table 1.

Fig. 2. Details of specimens

Table 1. Summary of specimens

Beam cross section	Number of the test object	Symbol
	3	BR1
	3	BR2
	3	BR3
	3	BK

Fig. 3. Test set up

2.7 Test set up

The test object is placed on 2 supports. The effective span of the beam is 500 mm. The beam is tested for bending under two-point loading. The load is applied to the beams at a distance of 175 mm from each support. Loads are applied to the beam until the first crack is visible and the appropriate deflection is recorded until the final failure of the beam is achieved. The test setup is shown in the Fig. 3

3 Result and Siscussion

3.1 Maximum Moment

The calculation of the maximum moment of the results of this test uses the concept of simple beam statics with a uniform load and a concentrated load of $p/2$ in one third of the span. From the maximum load obtained during the test, the bending moment uses the eq. 1.

$$Mu = 0.0011 + 0.1P \quad (1)$$

The results of the calculation of the maximum moment of the test are presented in table 2

Table 2. The result of the calculation of the maximum moment of the test

Test Object	Maximum load (ton)	Maximum Moment (ton.m)	Average maximum moment (ton.m)
BR2-1	1.563	0.157	0.162
BR2-2	1.650	0.166	
BR2-3	1.625	0.164	
BR3-1	1.625	0.164	0.165
BR3-2	1.500	0.151	
BR3-3	1.800	0.181	
BR4-1	2.500	0.251	0.241
BR4-2	2.450	0.246	
BR4-3	2.250	0.226	
BS2-1	2.150	0.216	0.283
BS2-2	3.250	0.326	
BS2-3	3.050	0.306	

Based on table 2, it can be explained that the addition of the amount of rattan as reinforcement can increase the load capacity. However, it is lower than steel-reinforced beams by 14.7%.

3.2 Flexural Capacity

Calculation of flexural capacity using the equation

$$f = \frac{M.y}{I} \quad (2)$$

Where :

f = flexural capacity (ton/m²)
 M = Maximum moment (ton.m)
 I = Inersia moment (m⁴)

Fig. 4. Maximum flexural capacity of rattan and steel reinforced concrete beams

Based on Figure 4 it can be shown that the addition of the amount of rattan increases the flexural capacity of the concrete beam. The flexural capacity of BR2, BR3 and BR4 beams are 423.93 t/m², 440.71 t/m² and 642.93 t/m², respectively. However, the flexural capacity of rattan-reinforced beams of 4 reinforcement is still 10% lower than that of steel-reinforced beams.

4 Conclusion

From the research and calculations that has been done the author can give the following conclusions:

1. The flexural capacity of the rattan-reinforced beam increases with the addition of the rattan reinforcement.
2. The addition of 2 times the amount of rattan reinforcement resulted in an increase in flexural capacity of 48.51%.
3. The flexural capacity of rattan-reinforced beams is lower than the flexural capacity of steel-reinforced beams by 10%, so the use of rattan as reinforcement in non-structural construction.

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