ANALYTICAL AND EXPERIMENTAL STUDY
BAMBOO BEAM CONCRETE

Hery Riyanto, Sugito, Juli

Master of Civil Engineering, Graduate School, University of Bandar Lampung, Jl. Zaenal Abidin Pagar Alam 26 Bandar Lampung, 35142, Indonesia

Abstract-*This study is known as the Bamboo Concrete Beams (B3) with bamboo casing as an alternative reinforcement, conducted through experimental methods. The test results were then verified through analytical calculations. Behaviors examined included mechanical properties of bending, beam flexural strength and fracture patterns are burdened by the quasi-static load. Researchers used 16 pieces of the test specimen. Bamboo specimens used in this study is a type of Petung Bamboo (Dendrocalamus Asper), with a long piece of bamboo varies from 2860 mm to 3910 mm, outer diameter of the bottom of the 105 mm to 155 mm and the outer diameter of the upper section of 95 mm to 135 mm, which are grouped into 5 kinds of testing that is,*

1. *Bamboo intact, the inner segments remain, with BA code (2 pieces of the specimen)*
2. *Bamboo intact, the inner segments removed, the code BP (2 pieces of the specimen)*
3. *Bamboo shoots in a section removed (like bamboo pipes) and not given a bamboo rod stud, with code BTS (4 pieces of the test specimen).*
4. *Bamboo shoots in a section removed (like bamboo pipes) and given a bamboo rod stud on the inside along ½ bamboo inner diameter, with code BAS (4 pieces of the test specimen).*
5. *One side of the split bamboo rod sections with a thickness of 75 mm, inner bamboo segments remain (such as drums) and given a bamboo rod stud on the inside, with code KTGN (4 pieces of the test specimen). Value of the maximum load Pmax, the maximum moment Mmax and   max deflection for each specimen according to the results of observation and calculation is as follows:*

BA 1,	P_{max}	=	838	kg,	M_{max}	=	2.933,00	kNmm dan $\square_{max}$ = 50,11 mm.
BA 2,	P_{max}	= 1.044		kg,	M_{max}	=	3.654,00	kNmm dan $\square_{max}$ = 23,31 mm.
BP 1,	P_{max}	=	907	kg,	M_{max}	=	3.174,50	kNmm dan $\square_{max}$ = 42,90 mm.
BP 2,	P_{max}	=	838	kg,	M_{max}	=	2.933,00	kNmm dan $\square_{max}$ = 38,25 mm.
BTS 1,	P_{max}	= 1.250		kg,	M_{max}	=	4.062,50	kNmm dan $\square_{max}$ = 69,90 mm.
BTS 2,	P_{max}	= 3.032		kg,	M_{max}	= 10.612,00		kNmm dan $\square_{max}$ = 63,64 mm.
BTS 3,	P_{max}	=	838	kg,	M_{max}	=	3.037,75	kNmm dan $\square_{max}$ = 37,30 mm.
BTS 4,	P_{max}	= 1.798		kg,	M_{max}	=	8.091,00	kNmm dan $\square_{max}$ = 61,20 mm.
BAS 1,	P_{max}	= 1.387		kg,	M_{max}	=	4.507,75	kNmm dan $\square_{max}$ = 50,80 mm.
BAS 2,	P_{max}	=	838	kg,	M_{max}	=	2.723,50	kNmm dan $\square_{max}$ = 46,05 mm.
BAS 3,	P_{max}	= 1.044		kg,	M_{max}	=	3.393,00	kNmm dan $\square_{max}$ = 44,45 mm.
BAS 4,	P_{max}	= 1.044		kg,	M_{max}	=	3.393,00	kNmm dan $\square_{max}$ = 64,79 mm.
KTGN 1,	P_{max}	=	976	kg,	M_{max}	=	3.172,00	kNmm dan $\square_{max}$ = 21,00 mm.
KTGN 2,	P_{max}	=	976	kg,	M_{max}	=	3.172,00	kNmm dan $\square_{max}$ = 92,32 mm.
KTGN 3,	P_{max}	=	976	kg,	M_{max}	=	4.062,50	kNmm dan $\square_{max}$ = 44,67 mm.
KTGN 4,	P_{max}	= 1.387		kg,	M_{max}	=	4.507,75	kNmm dan $\square_{max}$ = 70,45 mm.

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INTRODUCTION

In the lives of rural communities in Indonesia, bamboo plays a very important. Bamboo material has long been known by the public has good properties to be used, among others, strong stem, resilient, straight, flat, hard, easy to cut, easy to set up and easy to work with and lightweight so it easily transportable. Besides bamboo is also relatively inexpensive compared to other building materials as are found in the surrounding rural settlements. A versatile bamboo plant for rural communities.

Bamboo in a round shape used for various constructions such as houses, warehouses, bridges, stairs, plumbing, water spots, as well as household appliances other. In the form of parts can be made of bamboo booths, walls or floors, battens, fencing, crafts, and so forth. Some bamboo lately started being used as industrial raw material such as chopsticks, craft items, kitchen utensils, hats, bags, lampshades, musical instruments, curtains and others. In general, the type of bamboo that is often used by people in Indonesia is Bambu Tali (Gigantochloa Apus), Petung Bamboo (Dendrocalamus Asper), Bamboo Andong (Gigantochloa verticillata) and Black Bamboo (Gigantochloa Nigrocillata).

Traditional bamboo preservation efforts already identified by rural communities. Curing is done by submerging it in water, stagnant water, mud or sea water and fumigation. Moreover, we often found a way preservation by investing lime and cow dung on the walls of bamboo and bamboo room. Bamboo preservation has the purpose to prevent fungal attack (dye and pelapuk) or insects (dry powder, dry wood termites and soil creep). Some bamboo furniture craftsmen undertook preservation using borax, camphor mixture of kerosene, or fumigation with sulfur. But effectiveness is not yet known how the chemicals used and the method of preservation is implemented.

Use of bamboo is also grown towards replacing steel reinforcement (as an alternative reinforcement) in reinforced concrete. It is based on the strength of bamboo is relatively good in resist gravity. Several studies on the bamboo as an alternative material reinforcing steel has been carried out, including:

a. Pathurahman, Jauhar Fajrin and Anggraini Dwi Kusuma (2003) states that the bamboo has the opportunity to be used as reinforcement, especially for simple concrete structures.

b. Purba (2007) states that Bamboo Wall Precast (DBP) with bamboo as reinforcement in the form of woven sasak effectively used as an alternative reinforcement.
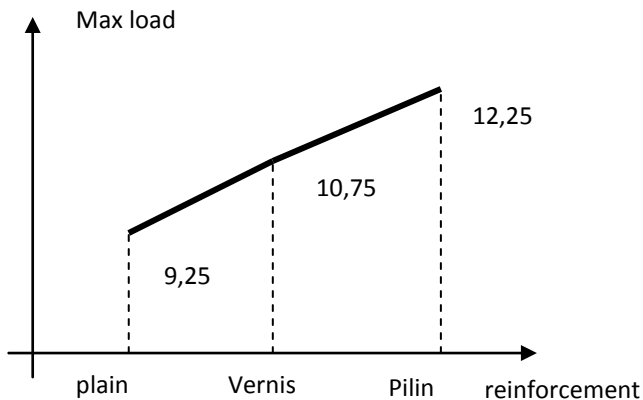
LITERATURE REVIEW

1. Maximum Load

Comparison of average maximum load that caused the collapse of the beam test specimen for plain bamboo reinforcement, the maximum load that can be supported beam test increased to 16.21% after the varnish coated bamboo reinforcement , and increased 32.43% after twisted bamboo reinforcement.

These results suggest that there is a strong improvement-Adhesion reinforcement (bond strength bar), which is quite significant when bamboo was treated divernis especially nominal.

Those results also prove that the result divernis, bamboo water rate be maintained at a constant value of specific and preventable decline until frictional forces between the reinforcement to the concrete surface is maintained at its initial value.

With nominal, depressions formed between strand-groove bamboo reinforcement spesi filled by concrete when casting is done. Despite the decline occurred, but darispesi depressions that have hardened concrete is able to prevent slips (slips) of bamboo with concrete reinforcement around

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Figur. 1.
Comparison of the maximum load beam test
plain bamboo reinforcement, and varnish finishes in spiral

RESEARCH METHODOLOGY

1. Dimensional Objects Test

Researchers used 16 pieces of the test specimen. Bamboo specimens used in this study is a type of Petung Bamboo (Dendrocalamus asper), with a long piece of bamboo varies from 2860 mm to 3910 mm, outer diameter of the bottom of the 105 mm to 155 mm and the outer diameter of the upper section of 95 mm to 135 mm.

As a base line of this research will be tested against the bamboo, namely:

a. Bamboo intact, the inner segments remain,
   with BA code (2 pieces of the specimen)

b. Bamboo intact, the inner segment eliminated, with the BP code (2 pieces specimen)

Furthermore there are 3 categories of things Bamboo composite test-Concrete (concrete as fill material) which will be done in this study, namely:

a. Bamboo inner segments removed (like bamboo pipes) and bamboo not given stud, with BTS code (4 pieces of the specimen).

b. Bamboo inner segments removed (like bamboo pipes) and bamboo given all the studs on the inside of the
½

bamboo inner diameter, with code BAS (4 pieces of the specimen).

c. One side of on the shaft of bamboo cleaved with a thickness of 75 mm, segments bamboo inner stay there (such as kentongan) and bamboo sticks were stud on the inside, with code KTGN (4 pieces of the specimen).

2. Preparation of Sample

Besides bamboo specimen specimen also needs concrete constituent materials are cement, sand, gravel and water. To get the right amount of concrete needs to be used, t must be prepared careful calculation that can efficiently use such material. Total demand for fresh concrete specimen category I, is 0.0988 m3. Total demand for fresh concrete specimen category II, is 0.0795 m3. Total demand for fresh concrete specimen category III, is 0.0705 m3.

While concrete mixer molen capacity available in the Civil Engineering Laboratory of the University of Bandar Lampung is 0:04 m3. Thus, making 12 pieces of the test object is planned to be done in 12 times the foundry (1 piece specimen 3.14 x r2 x length + bamboo specimen concrete cube 15 cm x 15 cm x 15 cm).

Twelfth casting specimens will be performed in one or two days of work, researchers therefore set up 12 bamboo petung directly to the test.

RESEARCH AND DATA ANALYSIS RESULTS

1. Testing Analysis Bamboo Concrete Beam

To obtain a thorough understanding of the behavior of B3, data verification testing of analytical calculations (theoretical) need to be done. Pattern approach is to compare the magnitude of the moment / experimental and theoretical load for each specimen group. Data deflection and crack patterns complement the data verification test.

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2. Group Sample Test Beams Bamboo Base Line BA

Based on the results of the testing and analysis of test objects that group Line Timber Bamboo Base BA are as follows:

- BA 1 mm distance between the foundation in 2800, the largest maximum load that can be carried on the test specimen reaches Pmax = 838 kg, maximum moment Mmax = 2,933 kNmm and deflection occurs = 50.11 mm.
- BA 2 mm distance between the foundation in 2800, the largest maximum load that can be carried on the test specimen reaches Pmax = 1,044 kg, maximum moment Mmax = 3,654 kNmm and deflection occurring = 23.31 mm.

3. Group Objects Test Beams Bamboo Base Line BP

Based on the results of the testing and analysis of sample test that group Line Timber Bamboo Base BP is as follows:

- BP 1 mm distance between the pedestal in 2800, the largest maximum load that can be carried on the test specimen reaches Pmax = 907 kg, maximum moment Mmax = 3174.5 kNmm and deflection occurring = 42.90 mm
- BP 2 mm distance between the pedestal in 2800, the largest maximum load that can be carried on the test specimen reaches Pmax = 838 kg, maximum moment Mmax = 2,933 kNmm and deflection occurring = 38.25 mm.

4. Group Sample Bamboo Concrete Beams Test BTS

Based on the results of testing and analysis that groups of specimens Bamboo Concrete Beams BTS is as follows:

- BTS 1 mm distance between the pedestal in 2600, the largest maximum load that can be carried on the test specimen reaches Pmax = 1,250 kg, maximum moment Mmax = 4062.5 kNmm and deflection occurring = 69.90 mm.
- BTS 2 mm distance between the pedestal in 2800, the largest maximum load that can be carried on the test specimen reaches Pmax = 3,032 kg, maximum moment Mmax = 10,612 kNmm and deflection occurring = 63.64 mm.
- BTS 3 mm distance between the pedestal in 2900, the largest maximum load that can be carried on the test specimen reaches Pmax = 838 kg, maximum moment Mmax = 3037.75 kNmm and deflection occurring = 37.30 mm.
- BTS 4 mm distance between the pedestal 3600, the maximum load that can be carried biggest specimen reaches Pmax = 1,798 kg, maximum moment Mmax = 8,091 kNmm and deflection occurring = 61.20 mm.

5. Group Sample Bamboo Concrete Beams BAS

Based on the results of testing and analysis that groups of specimens Bamboo Concrete Beams BAS is as follows:

- BAS 1 mm distance between the pedestal in 2600, the largest maximum load that can be carried on the test specimen reaches Pmax = 1,387 kg, maximum moment Mmax = 4507.75 kNmm and deflection occurring = 50.80 mm.
- BAS 2 mm distance between the pedestal in 2600, the largest maximum load that can be carried on the test specimen reaches Pmax = 838 kg, maximum moment Mmax = 2723.5 kNmm and deflection occurring = 46.05 mm.
- BAS 3 mm distance between the pedestal in 2600, the largest maximum load that can be carried on the test specimen reaches Pmax = 1,044 kg, maximum moment Mmax = 3.393 kNmm and deflection occurring = 44.45 mm.
- BAS 4 mm distance between the pedestal in 2600, the largest maximum load that can be carried on

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the test specimen reaches Pmax = 1,044 kg, maximum moment Mmax = 3393 kNmm and deflection occurring = 64.79 mm.

6. Group Sample Bamboo Concrete Beams KTGN

Based on the results of testing and analysis that groups Bamboo Concrete Beams specimens are as follows KTGN:

- KTGN 1 mm distance between the pedestal 2600, the maximum load that can be carried biggest specimen reaches Pmax = 976 kg, maximum moment Mmax = 3.172 kNmm and deflection occurring = 21.00 mm.

- KTGN 2 2600 mm distance between the pedestal, the largest maximum load that can be carried on the test specimen reaches Pmax = 976 kg, maximum moment Mmax = 3.72 kNmm and 91.80 mm deflection occurs

- KTGN 3 mm distance between the pedestal in 2600, the largest maximum load that can be carried on the test specimen reaches Pmax = 1,250 kg, maximum moment Mmax = 4062.5 kNmm and deflection occurring = 44.675 mm.

- KTGN 4 mm distance between the pedestal in 2600, the largest maximum load that can be carried on the test specimen reaches Pmax = 1,387 kg, maximum moment Mmax = 4507.75 kNmm and deflection occurring = 70.45 mm.

CONCLUSION

The value of the maximum load, maximum moment and lendutannya appropriate observations and calculations of the test object is as follows:

1. The maximum load that can be carried biggest specimen BA 1 reaches Pmax = 838 kg, maximum moment Mmax = 2933.00 kNmm and 50.11 mm deflection occurs.

2. The maximum load that can be carried biggest specimen 2 BA reaches Pmax = 1,044 kg, maximum moment Mmax = 3654.00 kNmm and 23.31 mm deflection occurs.

3. The maximum load that can be carried biggest specimen BP 1 reaches Pmax = 907 kg, maximum moment Mmax = 3174.50 kNmm and 42.90 mm deflection occurs.

4. The maximum load that can be carried biggest specimen BP 2 reaches Pmax = 838 kg, maximum moment Mmax = 2933.00 kNmm and 38.25 mm deflection occurs.

5. The maximum load that can be carried biggest specimen BTS 1 reaches Pmax = 1,250 kg, maximum moment Mmax = 4062.50 kNmm and 69.90 mm deflection occurs.

6. The maximum load that can be carried biggest specimen BTS 2 reaches Pmax = 3,032 kg, maximum moment Mmax = 10612.00 kNmm and 63.64 mm deflection occurs.

7. The maximum load that can be carried biggest specimen BTS 3 reaches Pmax = 838 kg, maximum moment Mmax = 3037.75 kNmm and 37.30 mm deflection occurs.

8. The maximum load that can be carried biggest specimen BTS 4 reaches Pmax = 1,798 kg, maximum moment Mmax = 8091.00 kNmm and 61.20 mm deflection occurs.

9. The maximum load that can be carried biggest specimen BAS 1 reaches Pmax = 1,387 kg, maximum moment Mmax = 4507.75 kNmm and 50.80 mm deflection occurs.

10. The maximum load that can be carried biggest specimen BAS 2 reaches Pmax = 838 kg, maximum moment Mmax = 2723.50 kNmm and 46.05 mm deflection occurs.

11. The maximum load that can be carried biggest specimen BAS 3 reaches Pmax = 1,044 kg, maximum moment Mmax = 3393.00 kNmm and 44.45 mm deflection occurs.

12. The maximum load that can be carried biggest specimen BAS 4 reaches Pmax = 1,044 kg, maximum moment Mmax = 3393.00 kNmm and 64.79 mm deflection occurs.

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13. The maximum load that can be carried biggest specimen KTGN 1 reaches Pmax = 976 kg, maximum moment Mmax = 3172.00 kNmm and 21.00 mm deflection occurs.

14. The maximum load that can be carried biggest specimen KTGN 2 reaches Pmax = 976 kg, maximum moment Mmax = 3172.00 kNmm and 92.32 mm deflection occurs.

15. The maximum load that can be carried biggest specimen KTGN 3 reaches Pmax = 976 kg, maximum moment Mmax = 4062.50 kNmm and 44.67 mm deflection occurs.

16. The maximum load that can be carried biggest specimen KTGN 4 reaches Pmax = 1,387 kg, maximum moment Mmax = 4507.75 kNmm and 70.45 mm deflection occurs.

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Table 1. Load, Moment and Deflection

No	Code of Speciment	Long of Pedestal (mm)	P_{max} (Kg)	M_{max} (kNmm)	Deflection (mm)
1	BA 1	2800	838	2.933,00	50,11
2	BA 2	2800	1.044	3.654,00	23,31
3	BP 1	2800	907	3.174,50	42,90
4	BP 2	2800	838	2.933,00	38,25
5	BTS 1	2600	1.250	4.062,50	69,90
6	BTS 2	2800	3.032	10.612,00	63,64
7	BTS 3	2900	838	3.037,75	37,30
8	BTS 4	3600	1.798	8.091,00	61,20
9	BAS 1	2600	1.387	4.507,75	50,80
10	BAS 2	2600	838	2.723,50	46,05
11	BAS 3	2600	1.044	3.393,00	44,45
12	BAS 4	2600	1.004	3.393,00	64,79
13	KTGN 1	2600	976	3.172,00	21,00
14	KTGN 2	2600	976	3.172,00	92,32
15	KTGN 3	2600	976	4.062,50	44,67
16	KTGN 4	2600	1.387	4.507,75	70,45

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