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The Usage of Bamboo as the Concrete Carcass Due to the Pressure and Diffraction Strength

Philipus Betaubun and Lily Montarcih Limantara

Abstract: ***Concrete is as one of building materials that is relatively more used in development. Nowadays, there are more usages of additional materials for increasing the quality of concrete such as coming from gray and plant fiber. There are any kinds of bamboo in Merauke Regency which has not been well used by the society. Bamboo that is planted in Merauke Regency can be used as the alternative additional material of plant fiber and as the changing of steel carcass. This study intends to know the quality of concrete strength by adding plant fiber and bamboo carcass. The methodology consists of experimental method by using the variety of bamboo fiber and carcass. The variety of bamboo fiber is as 0.5% and 1%. The evaluation and analysis of cleft pull strength uses SK-SNI 03-2491-2002, concrete defraction strength uses SK SNI 03-4431-1997, and concrete pressure strength uses SK SNI 03-6429-2000. The samples consists of 30 units with cylindrical shape for cleft pulling strength and concrete pressure strength tests; and 15 units with block shape for concrete fraction strength test. Result shows that bamboo caracass in concrete is significantly affected and it can be seen from the increasing of diffraction strength which the normal concrete is 3.321 MPa and on bamboo carcass type 3 is as 19.925 MPa. However, bamboo carcass type 3 can be used as the changing of steel carcass mainly for non-structural building***

Keywords: concrete, concrete strength, bamboo fiber, bamboo carcass

I. INTRODUCTION

Nowadays, the development of technology is very fast. It is due to there are many ideas and new innovation [1][2] such as the development of concrete technology. Concrete has high enough of pressure strength but it is weak to the pulling. Therefore, the usage of concrete is always related to the material which has high pulling strength such as steel. Concrete with steel carcass is more used as building material because it has very high pulling strength value but in real, the high pulling strength value causes the new problem due to the the steel carcass is as the non-renewable mineral material so it will to the last anytime

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Bamboo is as one of building material but it is rarely used for construction design if it is compared with the other material [3][4]. It is due to some factors such as to be easily attacked by insect, easily to be burned, and the esthetic value is less appreciated. Based on the some factor as above, there are any advantages in using bamboo such as the pulling strength is relatively high, the growth is fast and easily to be planted. Serapu is a village in Merauke Regency; it is part of Semangga District where ±15 km from city center is. Serapu village has the potency of bamboo but it is not well used by the society surrounded it. This study intended to find the changing material as the natural yield such as bamboo. Bamboo is as natural yield that has very high pulling strength.

Rivani *et.al.* [5] said that the addition of 0.25% on bamboo skin cleft on normal concrete mix has caused the increasing of concrete block strength capacity significantly. It is followed by the increasing of ductility. The percentage value is as the optimum content of bamboo cleft addition which is randomly distributed in the test. The addition of 0.75% and 1% from mix weight of normal concrete has decreased the strength of sample block. The decreasing of strength is caused by the decreasing of mix work ability. Gale [6] with the title: Crack which is happened on the beginning of crash process is diffraction crack which is marked by straight upright crack pattern [7]. Generally, the crack is happened when the load reaches more than 90% of theoretical load or about 70% of crash load. The beginning crack is happened on loaded area at surrounded roll supporting, then the crack is happened in the middle of stretch and for the next in surrounded of joint and on the contrary. Putra *et.al.* [8] with the title: "Capacity of Bamboo Carcass Concrete Diffraction" expressed that ultimate pulling tension of Petung bamboo without nodia (f_0) on 640 MPa and ultimate pulling tension of Petung bamboo on 525 MPa produced ultimate mean of diffraction moment from experiment was more than 24.7% from mean result of theoretical analysis on Petung bamboo carcass without nodia and on Petung bamboo carcass with Nodia the experiment mean result is more than 39.4% from the analysis mean result, so bamboo can be used as the changing of steel carcass on concrete plat by holding the pulling force. Haryanto and Hariyanto and Wikana [9] presented the Effort to Add Diffraction Strength of Concrete Block with rope.

II. MATERIALS AND METHODS

A. Cleft Pulling Strength

Concrete pulling strength is often measured based on the pulling modulus such as diffraction pulling tension of cylindrical concrete of 8 inch [10]. Cleft pulling strength of concrete can be analyzed by using the formula as follow [11]:

$$fct = \frac{2p}{\pi LD} \quad (1)$$

Where: fct = cleft pulling strength (MPa), fp = maximum load of machine/ (cleft object/ breaking) (N), L = length of sample object (cm), D = diameter of sample object (cm)

B. Diffraction Strength

For testing the diffraction strength there is used rapture modulus of concrete, based on ACI: $f'c = 7,5\ \sqrt{f'c}\ psi = 0,62\ \sqrt{f'c}$ MPa for normal concrete, and based on SNI 03-2847-2002 [10] $f'c = 0,70\ \sqrt{f'c}$. The value of diffraction strength for loading of 2 points is analyzed by the formula as follow [12]:

$$f'lt = \frac{P.l}{b.h^2} \quad (2)$$

Where: f'lt = maximum diffraction strength of sample (Mpa), P= maximum load from the reading machine of sample, L = the distance between two points of laying-down (mm), b = mean width of block section (mm). h = mean height of block section (mm)

C. Pressure Strength of Concrete

Pressure strength of concrete is the ability of concrete to accept pressure force per-unit area number for controlling the reached concrete quality. Pressure strength of concrete can be determined with the formula as follow [13];

$$fc' = \frac{P}{A} \quad (3)$$

.

Where: F'cr = the average of pressure strength (kg/cm^2), Fc = pressure strength of sample (kg/cm^2), N = number of sample

D. Diffraction Strength

The component that experiences deflection which is more than maximum limit can be happened if the concrete strength does not meet the condition or the other factor [14]. Diffraction strength of beam can be calculated with the formula as follow [15]:

$$\sigma 1 = \frac{Pl}{bd^2}. \quad (4)$$

Where: $\sigma 1$ = diffraction strength (MPa). *P*= maximum load on the machine (split/ breakable object) (N), l = length of sample (mm), d = width of sample (mm), b = height of sample (mm)

E. Material and Location of Research

This research uses the variety of bamboo fiber and carcass. The variation of bamboo fiber is as 0.5% and 1%. It uses 30 samples in cylindrical form for testing the split pull strength and concrete pressure strength and 15 samples in beam form for testing concrete diffraction strength. Test of concrete diffraction strength uses 16 printed beams with the dimension of 15 cm x 15 cm x 60 cm due to the variety of different carcass such as beam without carcass, bamboo carcass type 1, type 2, and type 3. This research is conducted at Laboratory of Civil Engineering, University of Musamus.

F. Bamboo Fiber

Ampel bamboo is more found in Java, Sumatera, Sulawesi until Nusa Tenggara and Papua [15]. However, the scientific name of bamboo is Dendrocalamus Asper. This kind of bamboo is fertile growing in humid and wet land, but it can be growing in dry land too [16]. The adult ampel bamboo can reach until 20 meters of height and it has the diameter between 7 until 15 m as in Fig. 1.

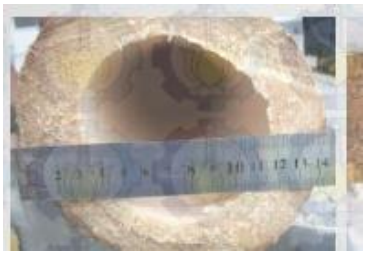

Fig. 1. Diametre of ampel bamboo

(The colour of rod skin is yellow-green and it can reach 10-14 metres of length, length of segment is in the range of 40-60 cm, and the thick is in the range of 10-15 mm)

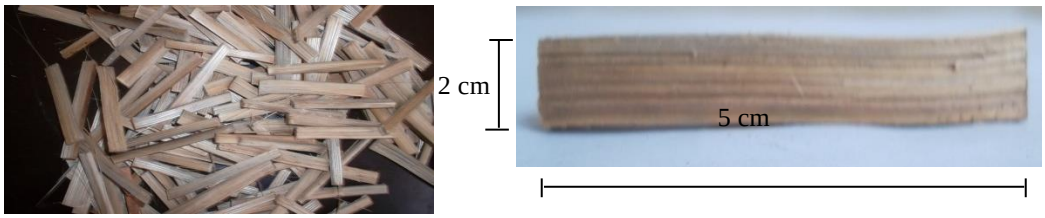

Fig. 2. Bamboo fiber

Fig. 2 presents the bamboo fiber. This fiber is as the piece which is produced from Ampel bamboo by using sharp knife.

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This fiber has width of ± 2 mm and the length of ± 5 cm.

G. Bamboo Carcass

This research uses carcass bamboo. Tools and materials consist of Apus bamboo, saw, chopping knife, knife, measuring tool, and wire bend-rat; the process of carcass making is as follow: 1) To prepare the demand of tools and materials; 2) To measure the length of bamboo regards to the willingness carcass length; 3) To cut the bamboo with the saw regards to the willingness size; 4) To split the bamboo with chopping knife into some parts; 5) To cut the bamboo with sharp knife until similar to the general carcass with the diameter of 12 mm; 6) After carrying out point 1 until 5, then the bamboo is marinated in the water for getting rid of starch in bamboo. From the marinating process, the bamboo has to be in pale condition, acid smiling, and there is no fur like on the bamboo that has not been marinated [4][17]. After point 6, then the bamboo is taken off the marinating place and it is dried by leaning it on the prepared place. In standing position, but the process of drying is cultivated not directly contaminated by sun; 8) After the bamboo is air dry, the carcass is measured with the length of 50 cm and then for the begel of 15 cm is cut; and 9) then, to make the carcass webbing as in the Fig. 3 below.

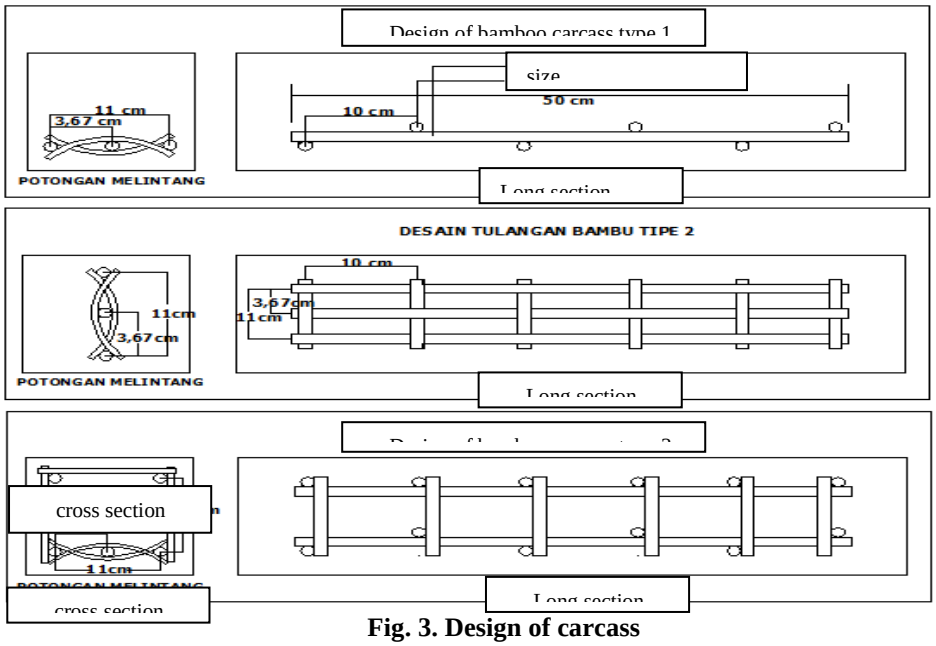

Fig. 3. Design of carcass

III. RESULTS AND DISCUSSION

A. Test of Split Pull Strengt

Result on split pull strength of concrete by using bamboo fiber can be seen in Table- I and Fig. 4.

Table- I. Calculation result of concrete split pulls strength

Code (K)	Diameter (D, cm)	Height (H, cm)	Weight (kg)	Load (P, kg)	f'tr = 2P/πHD (kg/cm^2)	Mean
N1	15	28	12.7	19,380	29,39	
N2	15	28	12,7	16,320	24.75	
N3	15	28	12.7	23,460	35.58	30.63
N4	15	28	12.5	17.340	26.30	
N5	15	28	12.6	24,480	37.12	
S1.1	15	28	12.7	20,400	30.94	
S1.2	15	28	12.6	22,400	34.03	
S1.3	15	28	12.5	22,440	34.03	33.40
S1.4	15	28	12.6	21,420	32.48	
S1.5	15	28	12.6	22,440	34.03	
S2.1	15	29	12.5	24,480	33.84	
S2.2	15	29	12.4	25,500	37.34	
S2.3	15	29	12.4	20,400	29,87	35.55
S2.4	15	29	12.5	24,460	34.35	
S2.5	15	29	12.4	27,540	40.33	

f'tr = Normal 30.63 kg/cm^2 Fiber 0.5% 33,10 kg/cm^2 Fiber 1% 35.55 kg/cm^2
= Normal 3.063 MPa Fiber 0.5% 3.310 MPa Fiber 1% 3.555 MPa

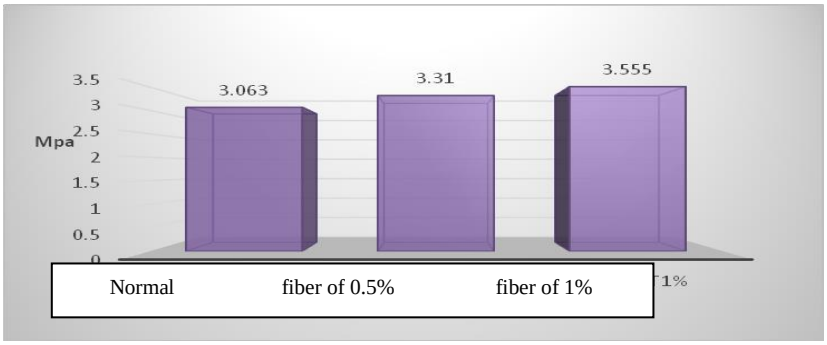

Fig. 4. Comparison of pull strength of normal concrete, fiber concrete of 0.5%, and fiber concrete of 1%

B. Analysis of Diffraction Strength

Table- II presents the data of concrete diffraction strength test and the result is presented as in Fig. 5.

Table- II. Data of concrete diffraction strength test

Code	Width (b,mm)	Height (h,cm)	Length (l,mm)	Load (P,N)	Cross Direct -ion 1 mm	Width of breaking section (b,cm)	Appea-rance height (h,mm)	*f'lt = P.1/b.h*^{2}	Mean
N1	150	150	600	27,000	450	157	150	3.4395	
N2	150	150	600	23,000	450	160	154	2.7276	
N3	150	150	600	24,000	450	150	150	3.200	3.231
N4	150	150	600	28,000	450	156	150	3.5897	
N5	150	150	600	24,000	450	150	150	3.2000	
S1.1	150	150	600	24,000	150	150	150	3.2000	
S1.2	150	150	600	30,000	450	150	150	4.0000	
S1.3	150	150	600	25,000	450	150	150	3.3333	3.255
S1.4	150	150	600	25,000	450	150	150	3.1217	
S1.5	150	150	600	26,000	450	180	157.5	2.6203	
S2.1	150	150	600	25,000	450	160	157.5	2.8345	
S2.2	150	150	600	24,000	450	150	152.5	3.0959	
S2.3	150	150	600	24,000	450	150	150	3.2000	2.992
S2.4	150	150	600	24,000	450	150	150	3.2000	
S2.5	150	150	600	25,000	450	178	155	2.6307	

flt = Normal 3.23 MPa Fiber 0.5% 3.255 MPa Fiber 1% 2.99 MPa

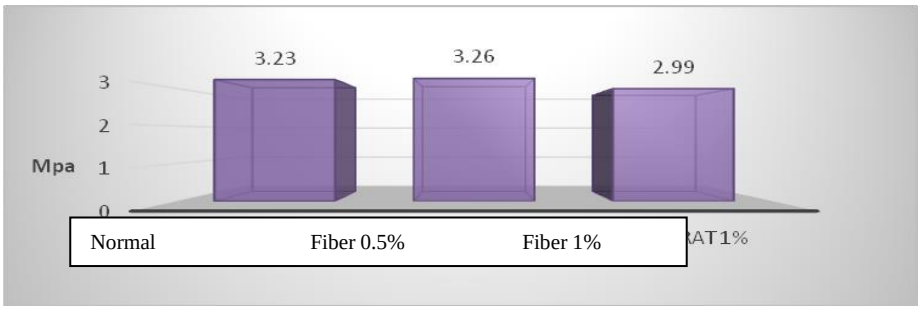

Fig. 5: Result of concrete diffraction strength test for normal, fiber 0.5% and 1%

C. Analysis of Pressure Strength

Table- III presents the data of concrete pressure strength and the result is presented as in Fig. 6

Table- III. Data of concrete pressure strength test

No	Code (K)	Diameter (D, cm)	Height (H,cm)	Weight (kg)	Number Area (L,cm^2)	Load (P,kg)	Fc=P/L (kg.cm^2)	Mean
1	N1	15	28	12.5	176.625	35.700	202.1231	205.588
2	N2	15	28	12.6	176.625	37.740	213.6731	
3	N3	15	28	12.6	176.625	36.720	207.898	
4	N4	15	28	12.5	176.625	37.740	213.6730	
5	N5	15	28	12.6	176.625	33.660	190.573	
6	S1.1	15	28	12.3	176.625	29.580	167.473	175.616
7	S1.2	15	38	12.5	176.625	26.520	150.149	
8	S1.3	15	28	12.4	176.625	33.660	190.573	
9	S1.4	15	28	12.5	176.625	33.711	190.862	
10	S1/5	15	28	12.6	176.625	31.620	179.023	
11	S2.1	15	28	12.6	176.625	31.620	179.023	168.629
12	S2.2	15	28	12.5	176.625	30.600	173.248	
13	S2.3	15	28	12.2	176.625	27.540	155.924	
14	S2.4	15	28	12.4	176.625	28.560	161.699	
15	S2.5	15	28	12.6	176.625	30.600	173.248	

F'c = Normal 205.5 kg/cm^2 Fiber 0.5% 175.6 kg/cm^2 Fiber 1% 168.6 kg/cm^2
= Normal 20.58 MPa Fiber 0.5% 17.56 MPa Fiber 1% 16.86 MPa

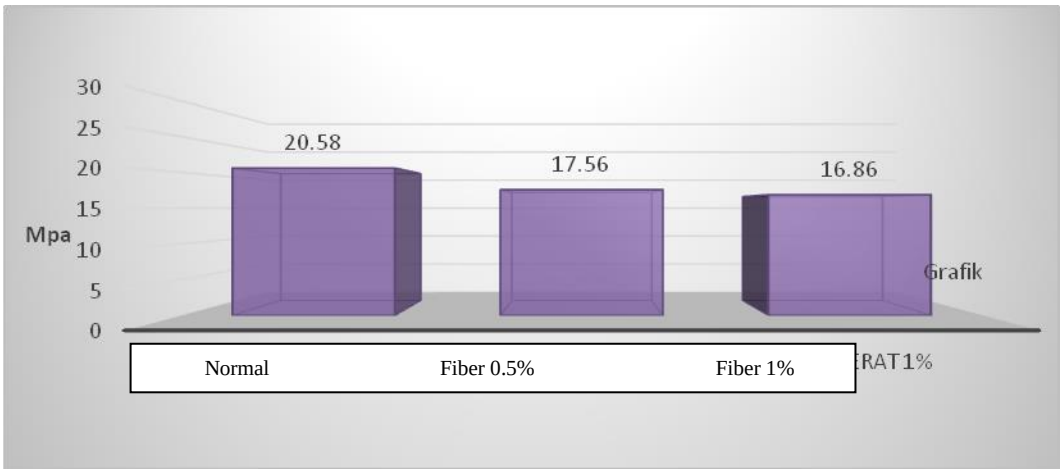

Fig. 6 Result of concrete pressure strength for normal, fiber 0.5 % and fiber 1 %

D. Percentage of Concrete Strength

Table- IV presents the percentage of concrete split pulls strength and Table 5 present the percentage of concrete diffraction strength.

Table- IV. Percentage of concrete split pulls strength

No	Sample	Split pull strength (MPa)	Split pull strength (%)
1	Normal	5.06	30.83
2	Fiber (0.5%)	3.31	33.35
3	Fiber (1%)	3.55	33.35

Based on the concrete split pull strength test, it is obtained that for the adding bamboo fiber of 5% causes the increasing of strength as 2.5% of normal concrete split pull strength. For the bamboo fiber usage of 1% causes the strength increasing as 5% of normal concrete split pull strength. Table- V presents the percentage of concrete diffraction strength.

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Table- V. Percentage of concrete diffraction strength

No	Sample	Split pull strength (MPa)	Split pull strength (%)
1	Normal	3.23	34.07
2	Fiber (0.5%)	3.26	34.39
3	Fiber (1%)	2.99	31.54

Result of concrete diffraction strength test indicates that bamboo fiber adding of 0.5% causes the strength increasing as 0.3% of normal concrete diffraction strength. For the bamboo fiber adding of 1% causes the strength decreasing as 2.5% of normal concrete diffraction strength. Table- VI presents the percentage of concrete pressure strength.

Table- VI Percentage of concrete pressure strength

No	Sample	Split pull strength (MPa)	Split pull strength (%)
1	Normal	20.58	37.40
2	Fiber (0.5%)	17.56	31.94
3	Fiber (1%)	16.86	30.66

Result of concrete pressure strength indicates that bamboo fiber adding of 0.5% causes the strength decreasing as 5.5% of normal concrete pressure strength. For the bamboo fiber adding of 1% causes the strength decreasing as 6.7% of normal concrete pressure strength.

E. Result of Bamboo Carcass Beam Diffraction Text

Table-VI presents the data of concrete diffraction strength test and the result is presented as in Fig 7

.

Table- VII Data of concrete diffraction strength test

Code	Width (b,cm)	Height (b,cm)	Length (l,cm)	Load (p, N)	Land-scape Dis-tance (l,mm)	Break-ing cross width (b,mm)	Break-ing cross height (b,mm)	$\sigma 1 = P.1/b.h^2$ MPa	Mean
N1	150	150	600	26,000	450	150	155	3.246	3.231
N2	150	150	600	26,000	450	155	150	3.354	
N3	150	150	600	25,000	450	155	150	3.225	
N4	150	150	600	24,000	450	155	150	3.096	
T1.1	150	150	600	31,000	450	160	105	8.673	7.801
T1.2	150	150	600	31,000	450	152	110	7.584	
T1.3	150	150	600	33,000	450	151	125	6.294	
T1.4	150	150	600	31,000	450	155	102	8.650	
T2.1	150	150	600	29,000	450	150	124	5.658	5.106
T2.2	150	150	600	27,000	450	152	130	4.729	
T2.3	150	150	600	30,000	450	153	128	5.385	
T2.4	150	150	600	29,000	450	154	135	4.649	
T3.1	150	150	600	43,000	450	156	92	14.65	19.925
T3.2	150	150	600	44,000	450	150	84	18.70	
T3.3	150	150	600	48,000	450	155	75	24.77	
T3.4	150	150	600	46,000	450	150	80	21.56	

ug$\sigma 1$= Normal 3.321 MPa, Bamboo carcass type-1 7.801 MPa, Bamboo carcass type-2 5.106 MPa, Bamboo carcass Type-3 19.925 MPa

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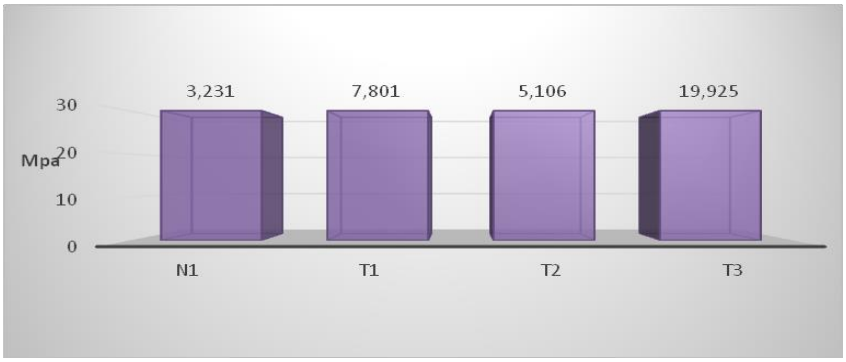

Fig. 7. Result of bamboo beam diffraction strength test

Based on the test by using bamboo as the addition on concrete, it indicates that the split pull strength of each test for normal concrete is 3 MPa, fiber-0.5% is 3.25 MPa, and fiber-1% is 3.48 MPa. However, the diffraction strength test shows that for normal concrete is 3.23 MPa, fiber-0.5% is 3.26%, and fiber-1% is 2.99%. Then, the concrete pressure strength test presents for the normal concrete is 20.16 MPa, for fiber-0.5% is 17.22 MPa, and for fiber-1% is 16.53%. The result as above indicates that bamboo fiber adding of 0.5% can be used as construction material because it is increasing the strength of normal concrete. Concrete pressure strength of normal concrete is 3.321 MPa, for bamboo carcass type-1 is 7.801 MPa, bamboo carcass type-2 is 5.106 MPa, and for bamboo carcass type-3 is 19.925 MPa. Based on the concrete diffraction strength,

4. CONCLUSION

Based on the research and discussion of bamboo usage as fiber material and concrete carcass, it can be concluded as follow: 1) Result of split pull strength test indicates that the strength for normal concrete is 3.06 MPa, for 0.5% fiber adding is 3.31 MPa and it is increasing as 2.6% from normal concrete, for 1% fiber adding is 3.55 MPa and it is increasing as 5% from normal concrete; 2) Result of diffraction strength test indicates that the strength for normal concrete is 3.23 MPa, for 0.5% fiber adding is 3.26 MPa and it is increasing as 0.3% from normal concrete, for 1% fiber adding is 2.99 MPa and it is increasing as 2.5% from normal concrete.; 3) Result of concrete pressure strength indicates that the strength for normal concrete is 20.58 MPa, for 0.5% fiber adding is 17.56 MPa and it is decreasing as 5.5% from normal concrete, for 1% fiber adding is 16.86 MPa and it is decreasing as 6.7% from normal concrete.

Result of concrete diffraction strength with some types of bamboo carcass can be concluded that for normal concrete is 3.321 MPa, for bamboo carcass type-1 is 7.801 MPa, bamboo carcass type-2 is 5.106 MPa, and for bamboo carcass type-3 is 19.925 MPa. Based on the concrete diffraction strength, it can be concluded that bamboo carcass in concrete is very influenced and it can be seen on the diffraction strength increasing which the normal concrete is 3.321 MPa and for the bamboo carcass type-3 is 19.925 MPa, so the bamboo carcass type-3 can be used as the changer of steel carcass mainly for non-structure building

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