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BAMBOO KNIT REINFORCEMENT CONCRETE PLATES AS WALLS TO RESIST LATERAL LOAD

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Abstract: **Bamboo is an alternatif material to replace the steel reinforcement in concrete, it have almost equal in tensile strength. Concrete plates with knitted bamboo reinforcement can be used to withstand the lateral load. By using bamboo knitting reinforcement, concrete plates have different bending stresses than concrete using steel reinforcement. Knitted bamboo is also used to overcome the bond slip that occurs to the action of concrete composite with bamboo[1]. In this study, The lateral loads received concrete plates with bamboo knitting reinforcement. It supported by two facing edge is pinned, one edge is fixed, and one edge is free. In this case, the the position of plates is put horizontally and recieved 4 joint load as the uniform load. to compare experiments with theoretical it is necessary to use finite element analysis by using abaqus program to find the deflection value, strain, and crack pattern that happened in bamboo reinforcement. By eksperiment, Maximum load that can be retained by concrete plate with bamboo reinforcement with 3 knits that is equal to 625,17 Kg, deflect at 15,24 mm and strained at 4,11 x 10-5. By Finite element analisys in maximum loading is deflect at 12,8 mm and strained at 4,68 x 10-5.**

Keywords: **Concrete Plates, Lateral Load, Knitted Bamboo, Reinforcement, walls, Elasticity**

1. INTRODUCTION

Bamboo is a material that can be special because of its high tensile strength, between 100 - 400 MPa so as to match even exceed the tensile strength of steel whereas how to obtain bamboo is easier because there are many in nature and the price is quite eonomical than the steel as proposed [1], that the selection of bamboo as a building material can be based on such a relatively low price, fast growth, easy to plant, easy to work, and specific advantages of bamboo fiber having good mechanical properties and high ratio between strength and weight.The important thing in the structure of the building is the stability and its ability to withstand lateral forces either caused by wind, hydrostatic pressure, landslide or earthquake. Wind loads are more related to the height dimension of the building, while the earthquake load is more related to building mass. If tall buildings are not properly designed against lateral forces there can be very high voltages and vibrations and swaying as they occur. As a result not only cause severe damage to buildings but also cause discomfort to residents. Plates with knitted bamboo walls are lateral load-bearing structures that can be carried out in areas where steel prices are more expensive than bamboo. With the existence of knitted bamboo then there will be interlocking between bamboo reinforcement with concrete. This mechanism is formed due to the interaction between thread (rib) reinforcement with the surrounding concrete matrix[5]. This mechanism is very dependent on the strength of concrete materials, reinforcement geometry and reinforcement diameter.

LATERAL LOAD

Lateral ground stress is the force generated by the impulse of the soil behind the retaining structure. Parts of buildings that hold the ground should be planned to be able to withstand the pressure of the soil in accordance with existing provisions[2].

Table 1: The moment in the middle of the plate span due to lateral load

b/a	X = a/2 , y = b		X = a/2 , y = b/2		
	w	Mx	w	Mx	My
1/2	$0.00230qa^4/D$	$0.0197\ qa^2$	$0.00135qa^4/D$	$0.145\ qa^2$	$0.0120\ qa^2$
2/3	$0.00304qa^4/D$	$0.0265\ qa^2$	$0.00207\ a^4/D$	$0.0220\ qa^2$	$0.0156\ qa^2$
1	$0.00368qa^4/D$	$0.0325\ qa^2$	$0.00313\ a^4/D$	$0.0331\ qa^2$	$0.0214\ qa^2$
1,5	$0.00347qa^4/D$	$0.0308\ qa^2$	$0.00445\ a^4/D$	$0.0453\ qa^2$	$0.0231\ qa^2$
2	$0.00291qa^4/D$	$0.0258\ qa^2$	$0.00533\ a^4/D$	$0.0529\ qa^2$	$0.0222\ qa^2$

(Source : Timoshenko, Theory of Plates and Shells)

MOMENT RESISTANCE

The simple strip method may be used to determine the moments through the slab for a given ultimate load[3]. The next equation to know the nominal stress of the plate is to first calculate the moment resistance of plate by using the following equation:

$$Mr = \emptyset A_s F_y (d - 0{,}59 A_s \frac{f_y}{f'_c})$$

where :

Mr : Momen resistance

Ø : Reduction factors

F'_C : compression

A_S : cross-sectional area

F_Y : Tensile strength of steel

FINITE ELEMENT METHOD

In boundary value problems of solid mechanics, one deals with solving for internal displacements, strains, and stresses, given sufficient boundary traction or displacement conditions. The existence and uniqueness of such direct problem solutions has been established[4]. For this reason, an experimentalist may wish to perform the mor accurate and easier measurement of displacements, or a manifestation of them, such as strain, at internal points to deformed body[6]. Abaqus is a software that used to analyze the structure of building elements based on finite element method, which can solve problems ranging from relatively simple linear analysis to nonlinear simulations.

2. MATERIAL AND METHODS

The research was conducted on a scale of 1:3 field conditions. The independent variable of this research is the number of knitted bamboo used as reinforcement. Bamboo knitted to reduce slip on interconnection between bamboo and concrete reinforcement. Concrete plates measuring 100 x 100 cm. To model the wall of the house are using pinned on the opposite edge, fixed on one of the sides, and without edge on the other side.Loading is modeled by the following treatments:1. There are 4 edge as equal load.2. Load cells are placed at the point located on the 1/3 span above the spreader beam that is channeled to the 4 points of weight distribution earlier.

Table 2: Specimen of plates

Plates size = 1 x 1 x 0,03 m			
	BB1	BB2	BB3
spacing	10 cm	10 cm	10 cm
Cross sectional area.	1 cm x 3 mm	1 cm x 3 mm	1 cm x 3 mm
Quantity of knit	1	2	3
Quantity of speciment	3	3	3

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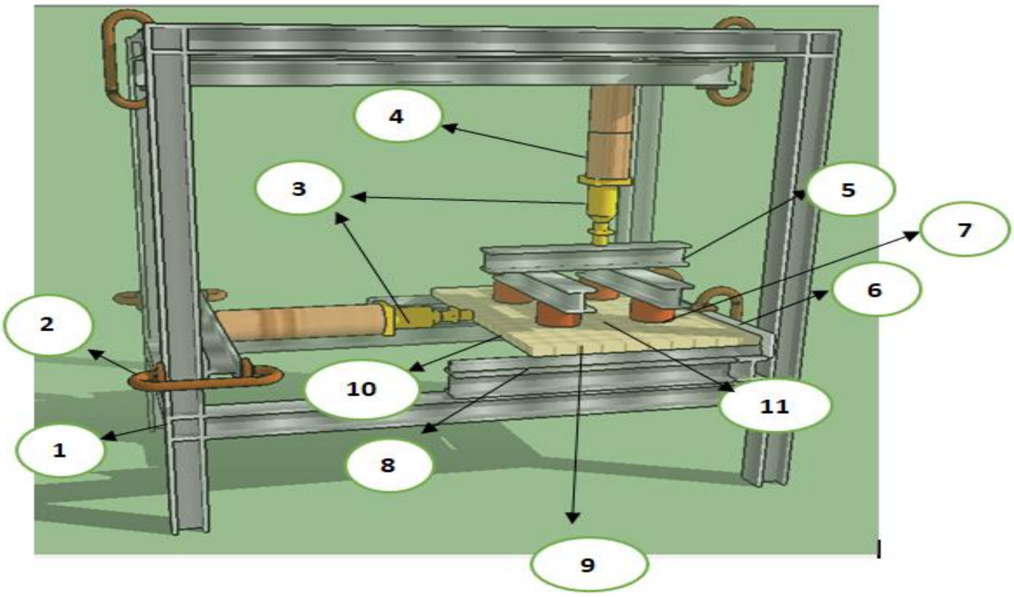
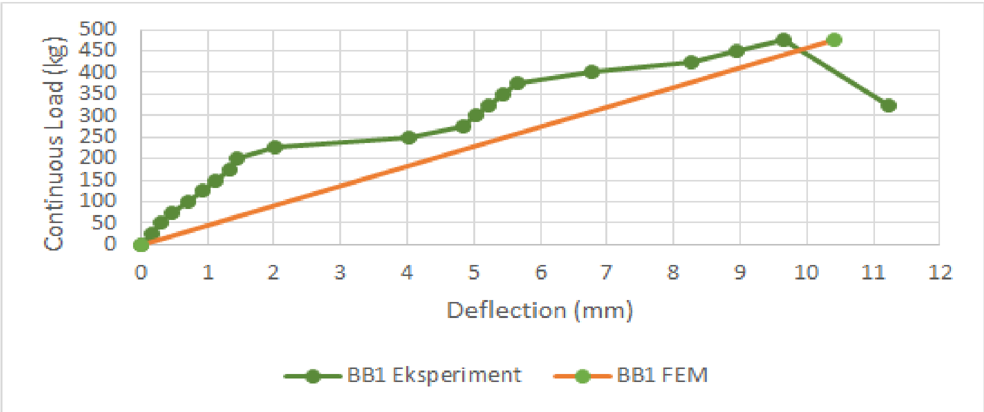


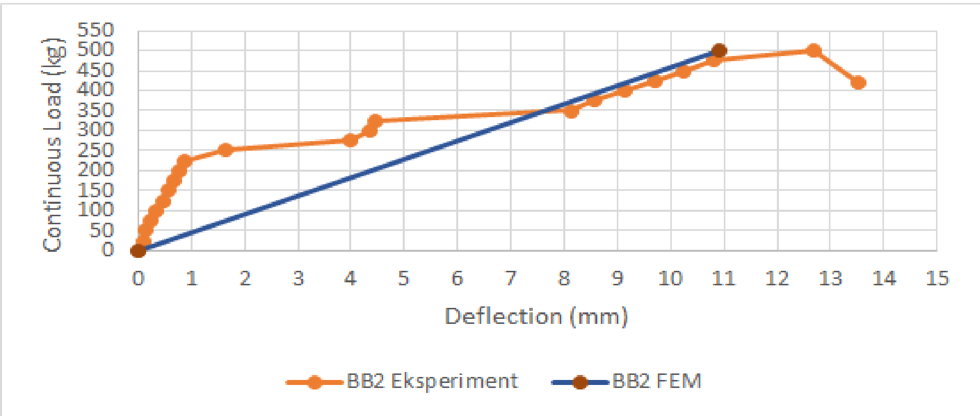
Figure 1: Setting up test

3. RESULTS AND DISCUSSIONS

From the data that has been collected through theoretical calculation results and empirical facts in the test research can be expressed in the following comparison:



(a)



(b)

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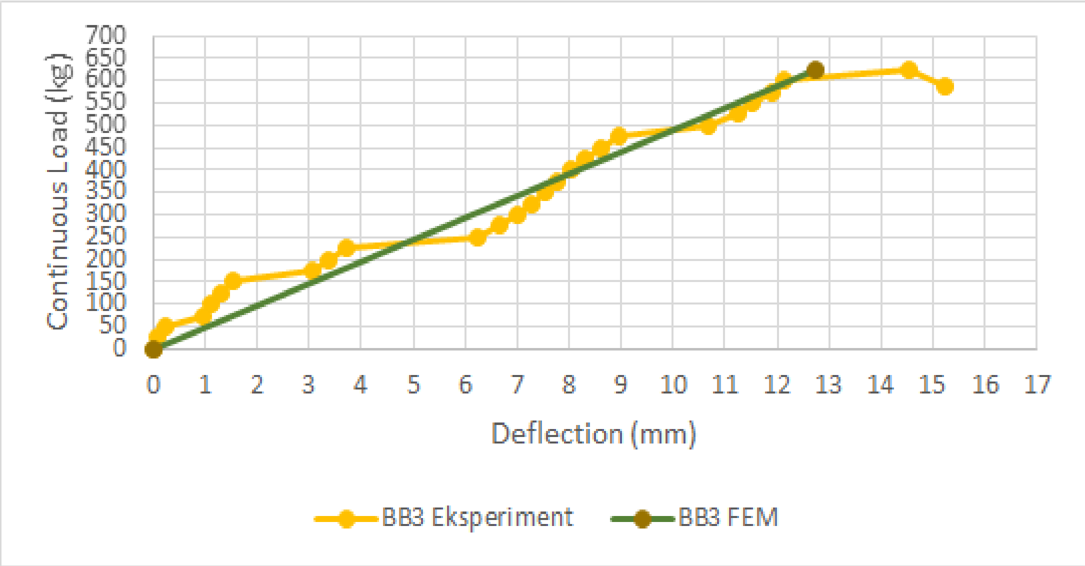

(c)

Figure 2 : Comparison of theoretical and experimental analysis results of deflection (a) BB1 (b) BB2 (c) BB3

From the above data it can be concluded that the elasticity of the material affects the value of the load received because in hooke law the load value (P) is directly proportional to voltage (σ) and elasticity (E). Here also there is a relationship between theoretical calculations and empirical facts reaching the displacement up to 14.6%. The amount of displacement can be affected by the adhesive factor between the concrete and the reinforcement where in the abaqus software there is no intersection between the reinforcement and the concrete.

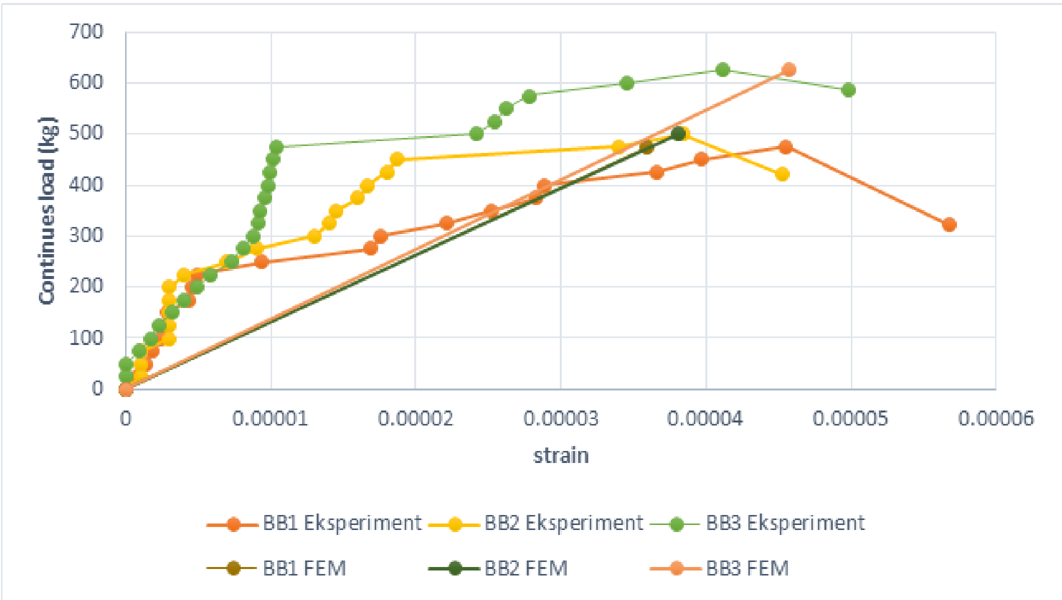

Figure 3 : Comparison of theoretical and experimental analysis results of the strain

(a) BB1 (b) BB2 (c) BB3

From the comparison of strains between bamboo reinforcement and concrete, it can be concluded that the presence of other factors that result in theoretical strain is less than the experimental strain. One of the influencing factors is the lack of interlocking between bamboo and concrete reinforcement.

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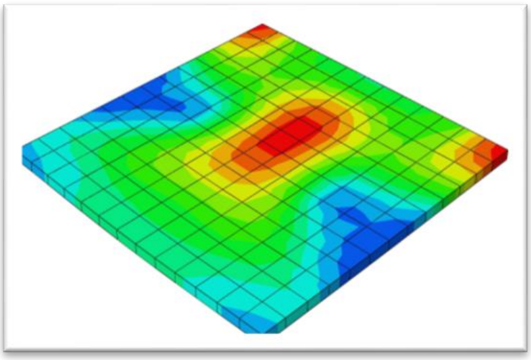
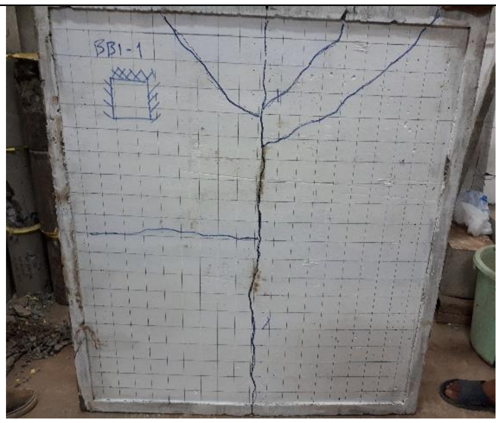
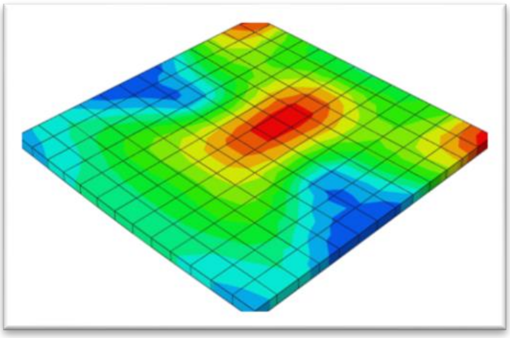
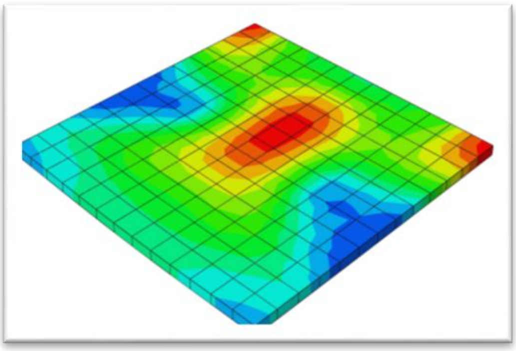
	Crack Pattern (FEM)	Crack Pattern (Eksperiment)
BB1		
BB2		
BB3		

Figure 3 : Comparison of theoretical and experimental analysis results of the crack pattern Between BB1 , BB2 and BB3

From the comparison of the above cracking pattern it can be concluded that the crack pattern is the same as the direction of the yield line shown by the abaqus software analysis. Concrete plates with steel reinforcement have many hair cracks due to interlocking factors between steel reinforcement with stronger concrete than bamboo reinforcement with concrete.

4. CONCLUTION

In conclusion, the findings of this study showed for the type of material having the same elasticity (E), then the acceptable maximum load value (P) will be proportional to the cross-section area (A). then if a continuous load (P) is given and the cross-sectional area (A) is fixed then the strain (ε) will remain the same so that the strain value becomes fixed.The whole specimen had a similar crack pattern of flexure crack caused by flexure loading by following the yield line pattern.

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