Tuijin Jishu/Journal of Propulsion Technology
ISSN: 1001-4055
Vol. 45 No. 1 (2024)

Utilization of Tali Bamboo Reeds as Field Truss Components with the FRP Connection Method

Budiono

Faculty of Engineering Civil Engineering Study Program, Universitas Pakuan Bogor, Indonesia

Abstract

Indonesian bamboo is widely used as a raw material for constructing simple houses and traditional pedestrian bridges, generally in rural areas. Bamboo is used not only for construction but also for furniture, household utensils, and crafts, and young bamboo is used as vegetable material. The main objective of this research is to obtain technical information about the strength and stiffness of bamboo Tali and their connections using FRP (Fiber Reinforced Polymer) as a component of a simple planar frame structure. This study aims to describe the advantages of bamboo Tali as a structural material in building structures in general, especially the strength and safety of FRP (Fiber Reinforced Polymer) joints on planar frames. The method used in this study is an experimental test method carried out at the Structural Laboratory, which is under the Soil and Concrete Mechanics Laboratory, Faculty of Engineering, Pakuan University. From the results obtained, the 2-layer FRP connection is strong enough to withstand the maximum load and needs further testing. Continuation of the interframe connection. 3 Splicing with FRP (Fiber Reinforced Polymer) allows it to be used as bamboo Tali joints for field frames.

Keywords: Tali Bamboo Reeds, Fiber Reinforced Polymer

1. INTRODUCTION

Indonesian bamboo is widely used as a raw material for constructing simple houses and traditional pedestrian bridges, generally in rural areas (Supomo et al., 2019). Bamboo is employed not only in construction but also for furniture, household utensils, and crafts (van Dam et al., 2018). Young bamboo is utilized as a vegetable material. The primary objective of this research is to obtain technical information about the strength and stiffness of bamboo Tali and their connections using FRP (Fiber Reinforced Polymer) as a component of a simple planar frame structure. This study aims to describe the advantages of bamboo Tali as a structural material in building structures in general, with a particular focus on the strength and safety of FRP (Fiber Reinforced Polymer) joints in planar frames.

The method employed in this study is an experimental test carried out at the Structural Laboratory, which is under the Soil and Concrete Mechanics Laboratory, Faculty of Engineering, Pakuan University. According to the results obtained, the 2-layer FRP connection is sufficiently robust to withstand the maximum load and warrants further testing, particularly regarding the continuation of the interframe connection. Splicing with FRP (Fiber Reinforced Polymer) in a 3-layer configuration allows it to be utilized as joints for bamboo Tali in field frames

From the aforementioned problems, this study gathered information on technical data from relevant research sources. Numerous studies on the physical and mechanical properties of bamboo, including Tali bamboo, have been conducted. Consequently, the findings from these studies serve as secondary data. To assess the strength of the connection within the bamboo Tali truss, a plane truss structure was created as an integral unit. In the truss model, loads were applied to the joint points until the test object model was either broken or destroyed.

In the testing of the plane truss model, assumptions were made at the connection points, treating them as joints. Besides evaluating the model's strength, measurements of the deflection that occurred were also carried out. To determine shear force and deflection in the plane truss model, analysis was conducted using the structural analysis program SAP2000.

The primary objective of this research is to obtain technical information about the strength and stiffness of bamboo Tali and their connections, using FRP (Fiber Reinforced Polymer) as a component of a simple plane frame structure. The anticipated outcome is that this study's results can provide a comprehensive overview of the advantages of Tali bamboo as a structural material for building construction in general. Moreover, it is expected to ascertain the strength and safety of FRP joints (Fiber Reinforced Polymer) within field stem frames.

The utilization of Tali bamboo as an alternative material for constructing simple plane trusses, short-span roof trusses, pedestrian bridges, and other applications is envisioned.

2. LITERATURE REVIEW

2.1 Bamboo

2.1.1 General properties

Bamboo is a family of *Bambusoideae*, including a grass family (*Graminea*) member, which grows in tropical and subtropical regions. Bamboo is generally in the form of a hollow cylinder and is divided into segments (internodes) which are bounded by nodes (nodes). Its growth is high-speed (Kumar et al., 2021). For its utilization, it is necessary to pay attention to its age because the older the bamboo, the greater its specific gravity and mechanical strength. The maximum specific gravity of bamboo is reached at the age of 3 years. After that, the specific gravity does not increase anymore. Thus, the use of bamboo for construction is generally 3 years to 6 years old. In Indonesia, one of the most widely used types of bamboo is Tali bamboo or Apus bamboo (*Gigantochloa apus Kurz*), especially in Java. Tali bamboo generally grows in dense clumps.

Research results from LPPMIBP (Nugroho et al., 2013) showed that the physical pTalirties of the segments of the Tali bamboo were worse than the nodes, in contrast to the ampel bamboo, which tended to be better at the segments than the nodes. For all mechanical properties, the Tali and Ampel bamboo internodes were better than the book. The elastic modulus value of the bamboo reeds is 110% smaller than the bamboo slats, and the fracturing modulus value of the bamboo reeds is 230% smaller than the bamboo slats. On the contrary, the value of compressive stress parallel to the fiber (?tk//) of bamboo reeds is 15% greater than that of bamboo slats.'

There are a total of 1,250 species of bamboo in the world, and about 159 species are in the territory of Indonesia. 88 of the 159 species in Indonesia are endemic to Indonesia.

Reporting from Tribun Jabar, one of the founders of the Indonesian Bamboo Business Association (PERPUBI) organization said that in the West Java area, there are 40 species, and the best-known types are Betung, Haur, Gombong, and Tali bamboo. Tali Bamboo reed can reach 22 meters at the base with a segment length of 20-60 cm, a diameter of 4-15 cm, and a wall thickness of up to 15 mm, and the leaves are 13-49 cm x 2-9 cm (Widjaya, 2001 in (Bachtiar, 2008))

2.1.2 Physical and Mechanical PTalirties of Tali Bamboo

From the results of previous research several characteristics physique Tali bamboo has been widely carried out and published, such as in the Indonesian Journal of Agricultural Sciences 2013 (www.https://lppm.ipb.ac.id), for tensile testing, compression test without book, compression test with book, shear through compression test and shear through tensile test. Bamboo as a natural material has varying physical and mechanical properties, both due to the influence of species, where it grows and due to the influence of age. In addition, even in a single bamboo stalk there is variability, both vertically (base, middle, tip) and horizontally (skin/outside, inside) and the influence of the presence of books (Bachtiar, 2008).

Bamboo as a natural material has varying physical and mechanical properties, both due to the influence of species, where it grows and due to the influence of age. In addition, even in a single bamboo stalk there is variability, both vertically (base, middle, tip) and horizontally (skin/outside, inside) as well as the influence of the presence of books. In planning bamboo as a component of a spatial truss, it is necessary to calculate the forces acting on each bamboo as a component of the planned structure. In order to accurately calculate the bar forces, a structural analysis program is used. To run this program, input is needed in the form of physical and mechanical properties of the material to be used, such as density, compressive strength, tensile strength, and modulus of elasticity.

Physical properties of Tali bamboo, first, testing the density of Tali bamboo aged 3 years from the Depok area was carried out on dry air volume and furnace dry weight. The results of the density test on the base and middle samples can be seen in the table below, and these results show that the density of the central bamboo is about 15% greater than the density of the bamboo at the base (Bachtiar, 2008)

Tabel.2.1. Tali Bamboo density

Sample	$P_{average}$(g/cm3)	ρ_{max}(g/cm3)	ρ_{min}(g/cm3)	SD	CV(%)	n
Middle	0,77	0,86	0,69	0,06	8,01	5
Base	0,66	0,78	0,60	0,07	11,02	5
combined	0,71	0,86	0,60	0,08	11,69	10

Source: (Bachtiar, 2008) (Note: SD = standard deviation, CV = coefficient of variation, n = number of samples)

The density value obtained is greater than the density value of the research by Syafi'i (1984) in Surjokusumo and Nugroho (1994), who obtained a density value of 0.65 g/cm3. Likewise, compared with the results of (Nuryatin, 2000) which obtained density values for the base and tip sections of 0.365 g/cm3 and 0.496 g/cm3, respectively. Syafi'i and Nuryatin's research used Tali bamboo samples from Dramaga, Bogor. Based on the research that has been done, the density at the base is smaller than the density at the top. The combined sample density value is used for structural calculations, namely 710 kg/m3 (equivalent to 0.71 g/cm3) (Bachtiar, 2008).

Based on the mechanical testing results, the mechanical properties of Tali bamboo were analyzed in the early stages by simple descriptive statistics and presented in tables and graphs. Furthermore, data that is considered to represent the population was analyzed based on AC 162 (Acceptance Criteria for Structural Bamboo) issued by ICBO (International Conference fo Building Officials) in 2000 in California (Bachtiar, 2008). Bamboo material data from various sources can be seen in the table below.

Table 1. Mechanical properties of Tali bamboo

Mechanical Properties	Wet		Air Dry	
	With books	no books	With books	no books
MOR (N/mm2)	102	71,5	87,5	74,5
Compressive Strength (N/mm2)	24	23,5	37,5	33,9
Shear strength r(N/mm2)	7,68	5,99	7,40	7,65
Tensile strength //(N/mm2)	294		299	

Source: Wijaya (1995) in (Bachtiar, 2008)

Table 2. Physical and mechanical properties of Tali bamboo slats

Nature	Base	end	Average
Specific gravity	0,37	0,49	0,43
Thickness loss (%)	19,85	12,48	16,16
Width Shrink (%)	19,19	12,69	15,94

Compressive Strength //(Kg/cm2)	302,06	312,01	307,03
Tensile Strength //(Kg/cm2)	1312,79	1480,18	1396,48
MOE(kg/cm2)	123.598	153.385	138.492

Source: (Nuryatin, 2000) in Gin(Bachtiar, 2008)

Table 3. Tensile strength and compressive strength of Tali bamboo

Part	Tensile Strength(Mpa)	Compressive Strength(Mpa)
Base	144	215
Middle	137	288
End	174	335

Source: Morisco (2005)

Table 4. Tensile strength and compressive strength of Tali bamboo

Mechanical Properties	Research Results (kg/cm^2)	Permit voltage (kg/cm^2)
tensile stress	1000-4000	300
Press Voltage	250-1000	80
bending stress	700-3000	100
MOE	100.000-300.000	100.000

Source: Purwito (2005)

Table 5. Tensile strength and elastic modulus of Tali bamboo

Magnitude	Average	
	With books	no books
Teg.bending limit(Mpa)	80	124
Tensile limit strain(x10-6)	7.099	8.885
Flexural modulus of elasticity (Mpa)	5.908	12.133
Tensile Elastic Modulus(Mpa)	8.908	15.225

Source: Morisco (2006)

Apus bamboo can grow in the lowlands and mountains, with a stem height of 8-13 m, an internodes distance of 45-65 cm, a diameter of 5-8 cm, and a thickness of 3-15 mm. The color of the bark of Apus bamboo stems is dark green to black. This type of bamboo is strong, tough, and straight so it is suitable for building materials. Besides that, the long fiber and strength produce a stable weave. According to (Sulthoni, 1988), because of its bitterness, Apus bamboo is the most resistant to insects, even if it is not preserved

Table 6. MOE based on research by Idris et al (1981) in Haris (2008) in Rahmazudi (2014)

Bamboo	MOE (Kg//cm^2)
Andong (*Gigantochloa psedoarundina*)	96.616 -121.395
Tali (*Gigantochloa Apus Kurz*)	57.515-121.334

For bamboo material data that will be used for the analysis process with the help of SAP2000 software as follows:

Other data physical properties bamboo Tali (Apus) MOE = 3.2 GPa and Poisson's ratio, v = 0.36 (Manuputty & Berhitu, 2010).

For material data into SAP2000:

MOE= 138492 Kg/cm^2

v= 0.36

MOR= 102000 kg/cm^2

Voltage permission // =1396.48 kg/cm^2

Berat volume = 0.59 – 0.67 g/cm^3 = 670 kg/m^3

2.2 Field Bar Frame

2.2.1 General Overview

Civil construction buildings require a wide span, especially roof structures in open spaces, or simple bridges, canopies, and other buildings. A truss structure is required if using a single beam will result in large enough dimensions.

Truss construction is composed of rods connected to one another to hold external forces together. This truss construction can be a plane (flat) or two flat planes (space).

The truss construction is composed of several triangles, and this is because the triangular shape is the strongest compared to the other shapes. In the triangular shape, the change of place due to external forces is smaller than in other shapes, so this shape makes the triangular shape firmer and curry. The triangular shape is used as a component forming the truss construction.

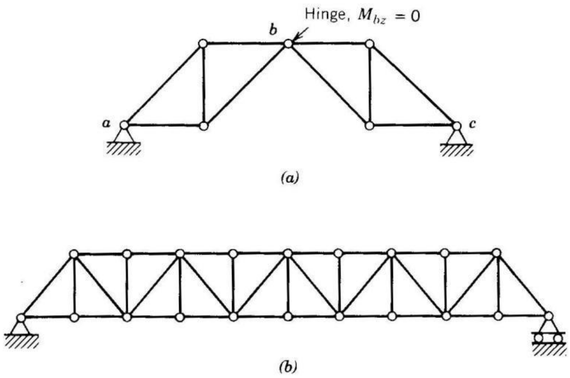

Figure 1. Field rod frame

Figure 2. Truss on the roof structure

2.2.2 Analysis of Bar Force on the Plane Truss Structure

The assumptions made in the analysis of the truss structure are as follows;

1. Perfect (frictionless) joints connect the rods at the ends.

Almost all elements are not connected by joints, such as welded or bolted. Even if a joint model is made, friction cannot be avoided. Nevertheless, this assumption oversimplifies a great deal and gives reasonably accurate results.

2. Loads and reactions only work at the joint point.

This assumption can be fulfilled by placing the supports of the sub-structure at the joint points only so that the irregularly located loads are transmitted only to the joint points. However, this arrangement often needs to be fulfilled for practical/economic reasons.

3. The longitudinal axis of the stem is straight and coincides with the line connecting the joint points.

To prevent eccentricity, the axes of the sections connected at one joint point must intersect at one point.

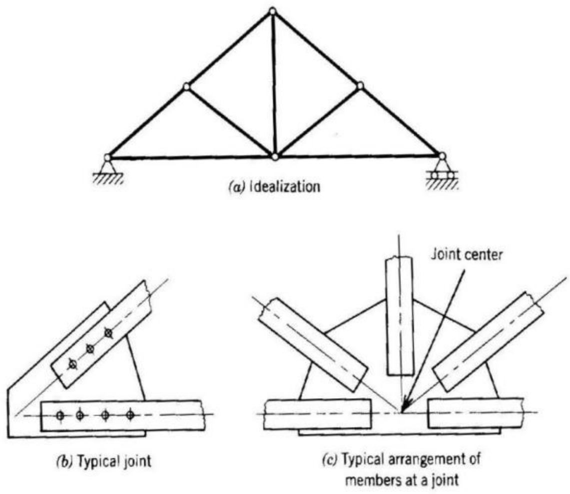

Figure 3. Assembling points on the trunk frame

From the assumptions above that have been fulfilled, the truss members only carry axial forces, and no bending moments or shear forces arise on the members in a truss. The style notation in the field bar frame can be seen in the image below;

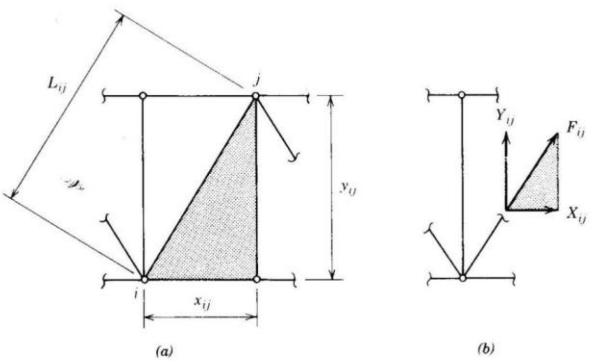

Figure 4. Style on the Truss

The axial force acts in the direction of the rod so that it can be broken down into components based on the direction/angle of the rod, namely the shape of a triangle of forces similar to the triangle of the rod.

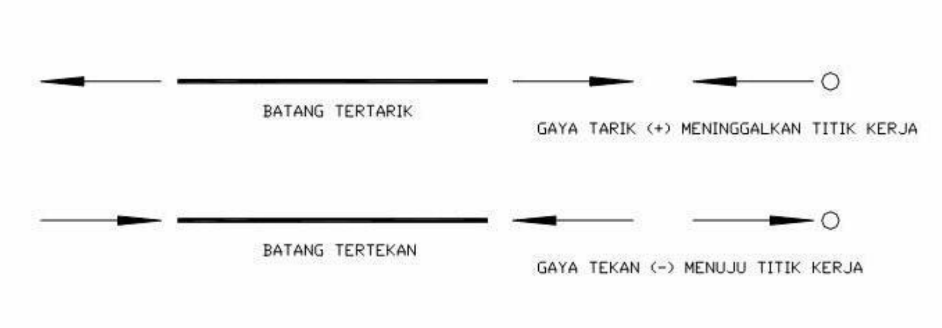

Figure 5. Tensile and compressive forces at the collection point

Force analysis on plane trusses can use manual analysis or the SAP2000 structural analysis program (Structural Analysis Program).

2.2.3 Analysis of Strength and Stiffness of Plane Truss

Strength analysis on truss is divided into two parts, namely tensile strength analysis;

$$\sigma_{tr} = \frac{N}{A_{netto}} \leq \sigma_{ijin}$$

N = is the tensile force of the rod

Anetto = net cross-sectional area of the stem

For the analysis of compression rods, the stress that occurs is influenced by the buckling factor of the truss

$$\sigma_k = \frac{N_k}{A} \leq \sigma_{ijin}(tekan)$$

So that the stress due to bending of the rod, becomes;

$$\sigma_{tk} = \varpi \frac{N}{A} \leq \sigma_{ijin}(tekan)$$

Where w = is the buckling factor

$$\sigma_{cr} = \frac{P_{cr}}{A}$$

$$P_{cr} = \frac{\pi^2 EI}{L_k^2}$$

$$P_{cr} = \frac{\pi^2 EAi^2}{L_k^2}$$

$$\sigma_{cr} = \frac{\pi^2 EAi^2}{AL_k^2}$$

$$\sigma_{cr} = \frac{\pi^2 E}{(L_k / i)^2}$$

So that

E = Modulus of Elasticity of Bamboo

A = cross-sectional area of bamboo

i = radius of inertia

Llk = bending length of the stem

I = moment of inertia

For the stiffness of the truss, it is affected by the magnitude of the deformation of each member where the deformation of the truss is used by Hooke's formula:

L= Initial length

D_l = rod deformation

2.2.4 Bamboo Connection

Traditional joints on bamboo trusses in rural areas use traditional connections, generally using nail connections, rattan fiber Tali and pegs. The use of bamboo nails is easy to split, unless the bamboo is drilled first. This connection relies on shearing between the bamboo and the Tali so that in general rota, palm fiber or Tali are made of bamboo skin, so the shrinkage affects the strength of the connection.

Connections at this time based on research results, several types of connections have been made, such as connections with steel plates, connections with steel tape or tape fiberglass.

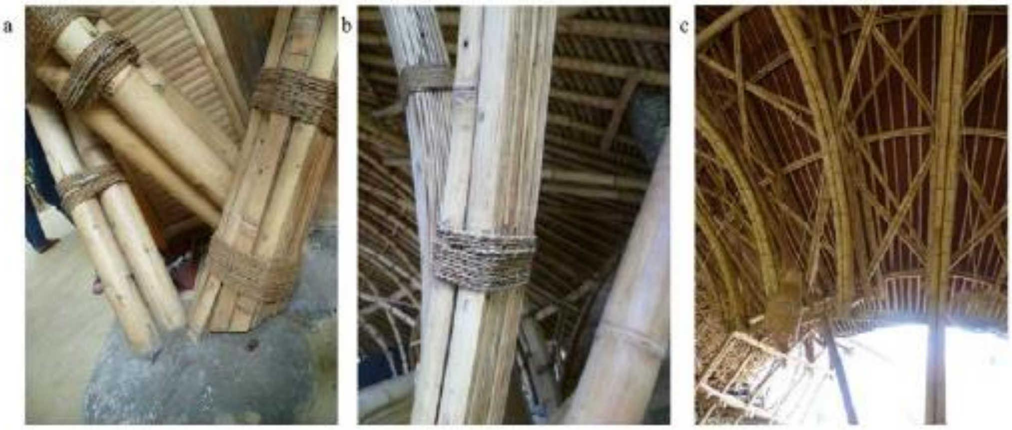

Figure 6. Bamboo connection using Tali

Figure 7. Bamboo connection using Tali

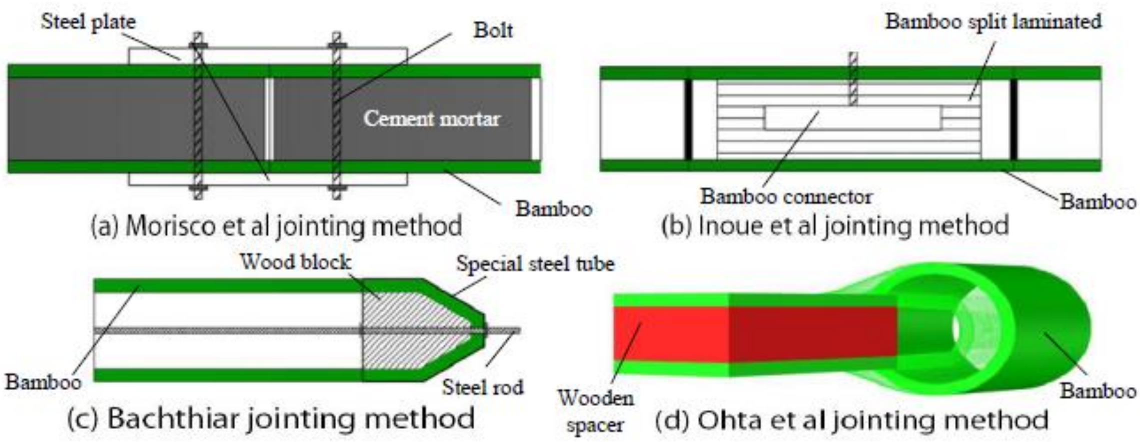

Figure 8. The bamboo connection uses a steel plate

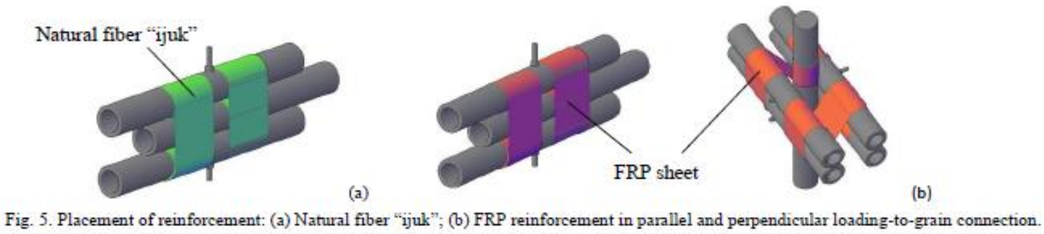

Figure 9. The bamboo connection uses palm fiber and FRP

Figure 10. The bamboo connection uses FRP

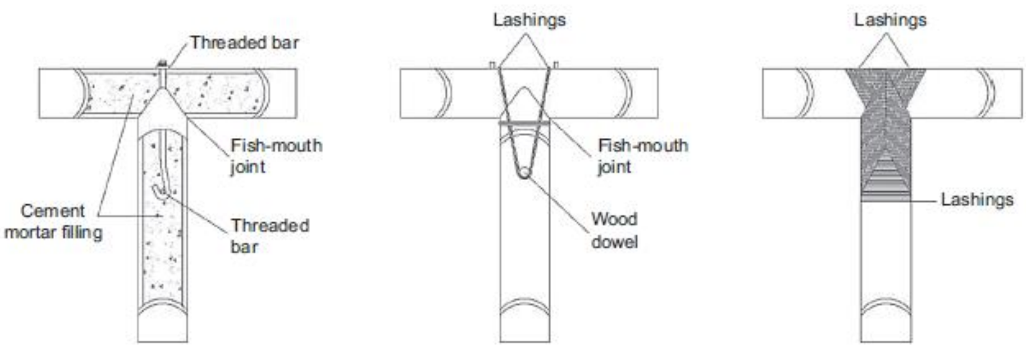

Figure 11. Connection with reinforcing steel

Figure 12. Connection with reinforcing steel and cement filler

2.2.5 Fiber Reinforced Polymer (FRP)

FRP is lightweight, has a very high tensile strength (7-10 times higher than steel), and is easy to implement. FRP can be made of 3 (three) composite materials, namely Carbon, Glass, and Aramid. The reinforcement of the truss connection is planned to use glass fiber material with a combination of epoxy resin so that it becomes a composite material.

FRP is more straightforward to implement in the field because there is no need to dismantle existing structural elements so that it can speed up construction work (Pangestuti, 2009).

CFRP is carbon fiber which is defined as a fiber that contains at least 90% carbon by weight. Carbon fiber does not show corrosion or crack at room temperature. The function of reinforcement with the CFRP system is to increase strength or provide increased flexural, shear, axial and ductility capacities. The way to install CFRP is by wrapping it around the perimeter surface of the reinforced structural elements using an epoxy resin adhesive. The working system is the same as conventional transverse reinforcement. (Achmad et al., 2013)

Fiber Reinforced Polymer (FRP) is lightweight, non-corrosive, and can withstand high tensile strength. FRP can be made of 3 (three) composite materials, namely Carbon, Glass, and Aramid. This study used fiber glass Fiber Reinforced Polymer (FRP).

The principle of using FRP is the same as Steel Plate, some materials with terms on the market are as follows, and the FRP material used is:

-Carbon FRP (CFRP)

-Aramid FRP (AFRP)

- Glass FRP (GFRP).

CFRP is generally used in reinforcement with consideration of tensile strength, stiffness, durability and creep pTalirties.

CFRP is available in the form of: Plate (strip), Fabric (wrap), Rod (reinforcement), below is a stress and strain comparison chart for several FRP materials.

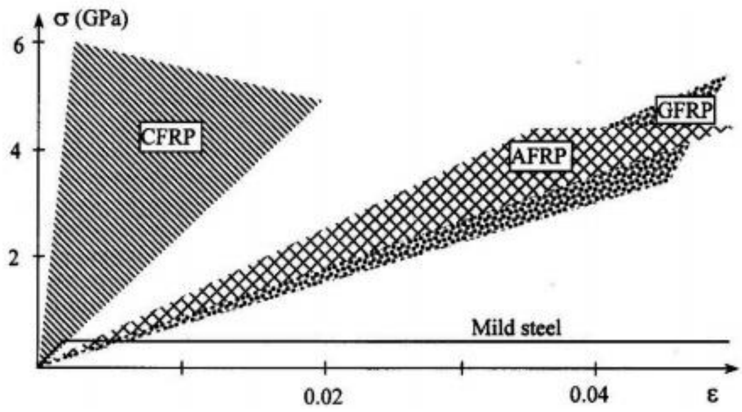

Figure 13. Stress - Strain Diagram

For adhesive materials, adhesive glue is used on the market. Nowadays, various types of adhesive glues and methods are produced according to their uses, such as acrylic, epoxy, melamine, polyester and others.

Epoxy resin cannot be a good choice from an economic point of view because the price is relatively high compared to the price of polyester resin. However, it is straightforward to use and durable in terms of strength. Therefore, the price of goods made from epoxy is higher than those made from polyester resin.

Epoxy resin, which has a much clear yellowish colour, adheres well and firmly to wood surfaces and will not require a final coat (finishing), unlike polyester resin. Not only on wood, but this epoxy resin also has a strong bond on almost all surfaces, including the surface of polyester resin, making it suitable for finishing materials.

The hardiness and elasticity of epoxy resin, which exceeds other resins, makes it popular in the defense sector, such as making kevlar and even bullet-proof glass, and is even more popular in the shipping industries. Many forums discuss using epoxy resin as essential in shipping, although some choose to use polyester resin. However, it is better to use epoxy resin because it is safer and more practical, of course, at a high cost.

Another characteristic of epoxy resin is that it does not have a strong odour like polyester resin, making it safer and more comfortable indoors. Of course, interior items made from epoxy resin are better than polyester resin, such as table wood veneer eat, coffee tables, countertops in the kitchen, and other decorations. This clear epoxy resin is also very much marketed for jewelry crafts such as elegant frames, key chains, necklace eyes, and even artificial ring stones, which have been so popular in Indonesia for some time.

3. METHODS

The method used in this study is an experimental testing method, which will be carried out in the structure laboratory, which is in one activity under the soil and concrete mechanics laboratory, Faculty of Engineering, Pakuan University. In this study, the object used is a plane truss structure with joint joints laminating of FRP material (Fiber Reinforced Polymer) woven roving WR 400 and adhesives using adhesives Polyvinyl Acetate (PVAc), or adhesive epoxy resin Non. Sag, where the adhesive is a polymer with powerful pTalirties, is often used as a base material to manufacture glue for fabric, paper and wood. PVAc is odorless, non-flammable and solidifies faster. Tests performed with centre-point loading test, namely test 1 (one) vertical load on the plane truss model.

RESEARCH FLOW DIAGRAM

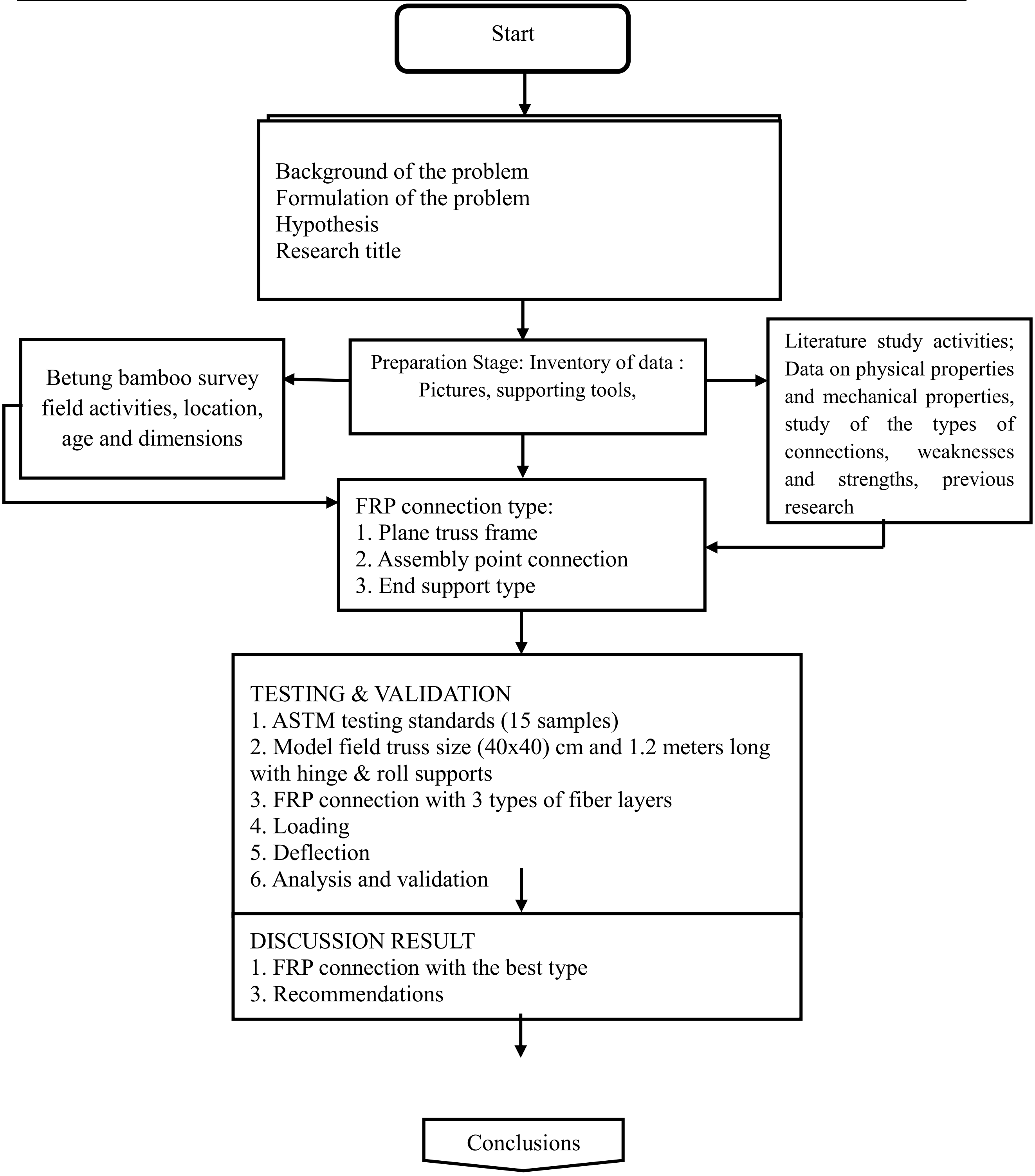

Figure 14. Research flow chart

This study used 3 (three) plane truss models, each consisting of 3 (three) sample specimens. In one type of model 1, the test object uses a laminated connection type with 1 (one) layer of FPR, type 2 uses 2 (two) layers of FRP lamination, and type 3 uses 3 (three) layers of FRP lamination.

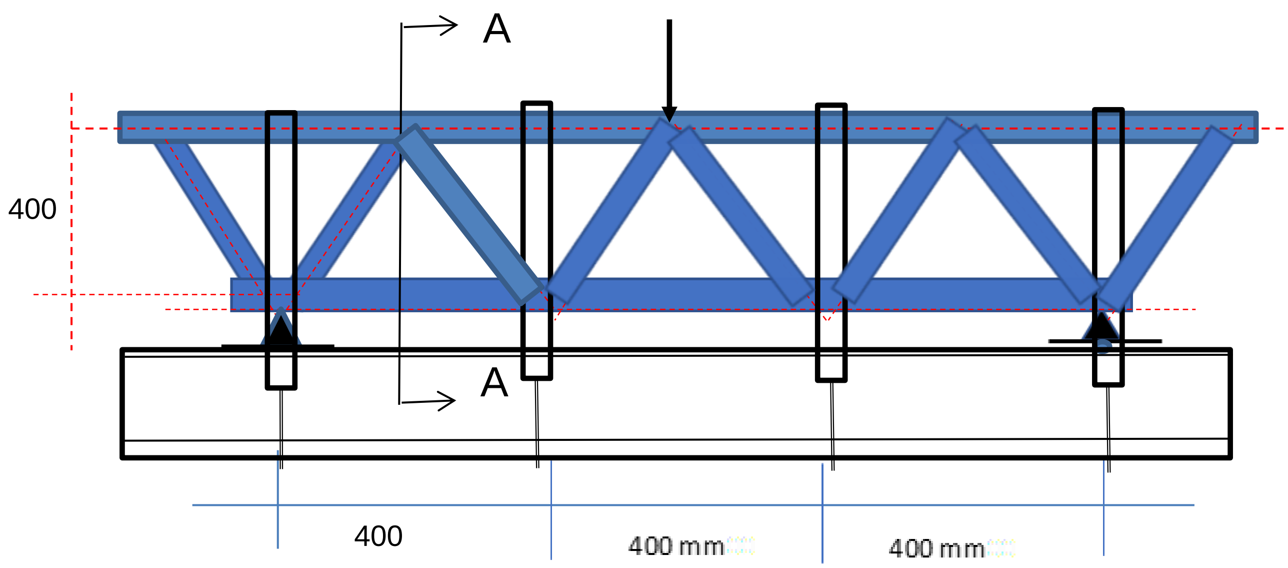

Figure 15. Test object with concentrated load

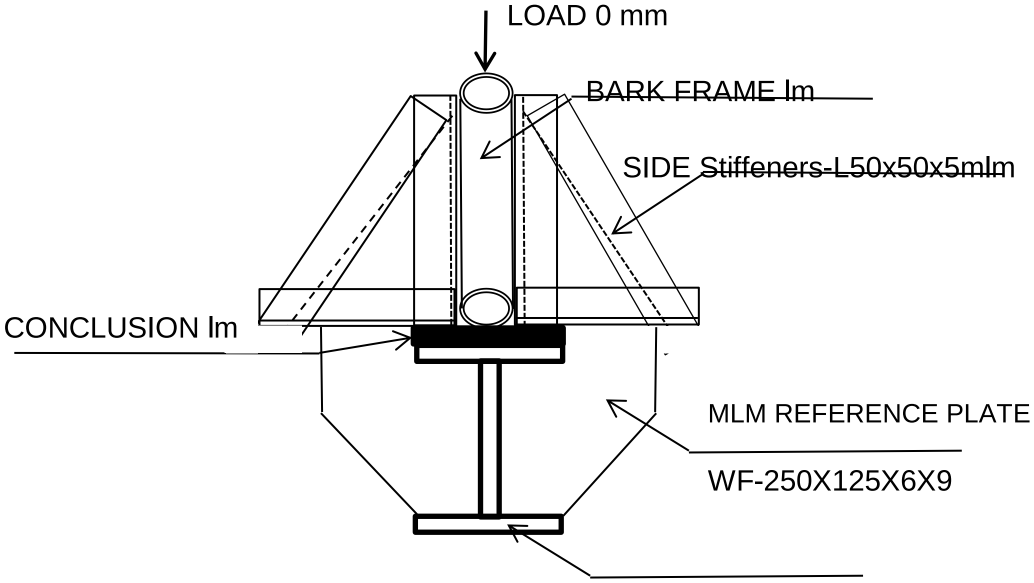

Figure 16. A-A cut

4. RESULT

4.1 Test Results for Bamboo Stem Frames with FRP Connections

In the experimental test of bamboo Tali truss with a centric meeting point and the connection method with several layers of FRP, the sample specimens of the truss consisted of 3 types of truss, namely 1-layer, 2 layer and 3-layer FRP connections for each type of truss totaling 5 objects trials. In the loading test on the truss with left and suitable side stiffeners, the twisting effect does not occur. The distance between the trusses is 40 cm with the loading using a bending testing machine Digital Compression Machine ASTM C-39 23 2000 kN capacity with reading Dial Gauge done at every 5 kN load increase.

Table 7. Test Results of Truss with 1 layer FRP Connection

Test Objects	Maximum Load (kN)	Maximum Deflection (cm)
S1	18	2,5
S2	15	2,5
S3	20	3,0
S4	18	3,0
S5	14	2,0
Average		

Source: test results

Table 8. Test Results of Truss with 2 layers of FRP Connection

Test Objects	Maximum Load (kN)	Maximum Deflection (cm)
E1	27	3,5
E2	24	3,0
E3	22	2,5
E4	23	2,5
E5	30	4,0
Average		

Source: test results

Table 9. Results of Truss Testing with 3 layers of FRP Connections.

Test Objects	Maximum Load (kN)	Maximum Deflection (cm)
F1	25	3,5
F2	28	4,0
F3	26	3,5
F4	20	2,5
F5	20	2,0
Average		

Source: test results

CONCLUSION

The study results show that the physical properties of the bamboo Tali section are worse than the book section, in contrast to Ampel bamboo, which tends to be better. In part of the book section. For all mechanical properties, Ampel and bamboo Tali were better than books. The elastic modulus value of bamboo culms is 110% smaller than that of bamboo slats, and the modulus value of bamboo slats is 230% smaller than that of bamboo slats, while the compressive stress parallels to the fibers (?tk).//) is 15% greater than that of bamboo slats". 1. Connections using FRP (Fiber Reinforced Polymer) can be used as joint connections on bamboo Tali for plane trusses. 2. From the results obtained, the 2-layer FRP connection is strong enough to withstand the maximum load. 3. Need further testing for the frame-to-frame connection

REFERENCES

1. Achmad, K., Agoes, S. M. D., & Tavio, T. (2013). Metode Eksperimental Struktur Kolom Beton Bertulang Tahan Gempa Menggunakan CFRP Sebagai Eksternal Confinement. JTT (Jurnal Teknologi Terpadu), 1(1).
2. Bachtiar, G. (2008). Pemanfaatan Buluh Bambu Tali Sebagai Komponen pada Konstruksi Rangka Batang Ruang.
3. Kumar, M., Kaur, H., Verma, R., Negi, R., Sharma, I., Upadhyay, S. K., & Singh, R. (2021). Taxonomical Diversity, Socioeconomic and Ethnomedicinal Significance of Bambusa Schreber 1789 (Poaceae: Bambusoideae) in Forest Research Institute (FRI), Dehradun (Uttarakhand), India. Asian Journal of Biological and Life Sciences, 10(2), 346–351.
4. Manuputty, M., & Berhitu, P. T. (2010). Pemanfaatan material bambu sebagai alternatif bahan komposit pembuatan kulit kapal pengganti material kayu untuk armada kapal rakyat yang beroperasi di daerah Maluku. Jurnal Teknologi, 7(2), 788–794.
5. Nugroho, N., Bahtiar, E. T., & Anas, A. (2013). Ciri Bilah Bambu dan Buluh Utuh pada Bambu Tali dan Bambu Ampel. Jurnal Ilmu Pertanian Indonesia, 18(3), 154–158.
6. Nuryatin, N. (2000). Studi analisis sifat-sifat dasar bambu pada beberapa tujuan penggunaan [Tesis]. Bogor (ID): Institut Pertanian Bogor.
7. Pangestuti, E. K. (2009). Penggunaan carbon fiber reinforced plate sebagai bahan komposit eksternal pada struktur balok beton bertulang.
8. Sulthoni, A. (1988). A simple and cheap method of bamboo preservation. Proceedings of the International Bamboo Workshop, Cochin, India, 14, 209–211.
9. Supomo, H., Djatmiko, E. B., Nugroho, S., Baihaqi, I., Kurt, R. E., & Tezdogan, T. (2019). THE USE OF BAMBOO SLATS LAMINATE AS A RENEWABLE CONSTRUCTION MATERIAL FOR EAST JAVA TRADITIONAL FISHING BOAT. Journal of Ocean Technology, 14(1).
10. van Dam, J. E. G., Elbersen, H. W., & Montaño, C. M. D. (2018). Bamboo production for industrial utilization. Perennial Grasses for Bioenergy and Bioproducts, 175–216.