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Application of Bamboo Reinforcement in Beam Design

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Abstract : Bamboo has a weaknesses which are vulnerable to bamboo-decay, fungal attack and shrinkage issue. The aim of this project is to apply bamboo in reinforcement in design beam. Hence, the study is conducted by designing a concrete beams using reinforcement treated bamboo strips. The bamboo went through the cutting process with the specifications required. The bamboo is cut into strips with 900 mm length and 20m width before been preserved in boric acid and borax solution. Then, this project is carried out with evaluation of a flexural strength of bamboo reinforced concrete beams according to the BS. The evaluation of bamboo's flexural strength is identified by doing the test using the Flexural Testing Machine. In addition, this study also is to analyse the strength of concrete beams between bamboo strips treated reinforcement and steel reinforcement concrete beams. The analysis is done by doing the test to identify the difference of deflection value of both different percentages of beams, which are 100% steel reinforced concrete and 100% bamboo reinforced concrete. The findings found that, the strength of bamboo reinforced concrete is equivalent to the steel reinforced concrete since maximum deflection of steel reinforced concrete is 90 mm with its ultimate load is 30 Nm while the maximum deflection for bamboo reinforced concrete is 17 mm with its ultimate load is 20 Nm. In a conclusion, bamboo can be considered, as a construction material seems it has better benefits compare to other standard materials as example bamboo provides safe environment and free chemical. The initiative of using bamboo should be increased in Malaysia due to more eco-friendly and the benefits in future.

Keywords: Bamboo, Betung, Construction, Beam

1. Introduction

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The construction sector is known as the industry that really exploits the environment. Concrete is an important building material in construction due to its high compressive strength. As a reinforcing material, it must be combined with steel to satisfy the tensile strength's weak point requirements. Furthermore, in the presence of water and oxygen, steel is vulnerable to rust.

Steel corrosion rates are influenced by the concrete's electrical resistance, moisture content, and the rate at which oxygen migrates through the concrete, which usually causes the steel to corrode. Many researchers these days conduct research to use freely available natural resources such as bamboo. This is because bamboo is an example of a potential natural resource that could be used to substitute steel in reinforced concrete. Since bamboo does indeed have a higher strength than wood and a tensile strength that is half that of steel and can be used to replace steel bars in concrete, bamboo is more compact than steel.

Bamboo basically is known for its ability in construction nowadays as its strength is comparable to the steel. Bamboo is a natural resource that is considered in reinforced concrete with substitute to steel since it is stronger than other natural sources like wood. However, bamboo has its weakness that can affect the product that made from them. Bamboo is recorded that vulnerable to the bacteria and fungi attack and preservation is important or otherwise it affects its accessibility [1]. To overcome the bacteria and fungi attack, the researcher found that the Tannin Copper complex preservation that is formulated that able to protect various fungi to the 100% protection [2]. Bamboo also is easily shrink which needed in exact method to prevent it. Then, bamboo can easily decay which need to preserved accurately using eco-friendly chemical preservations properties as example it can provide high durable in certain conditions by using the bio oil formulation [2].

The main objective is to design concrete beam using reinforcement treated bamboo strips, evaluate the flexural strength of bamboo concrete beams according to the British Standard, BS and analyse the strength of concrete beams between bamboo strips treated reinforcement and steel reinforcement concrete beams.

2. Materials and Methods

In the materials and methods section, it describes about all the information required and the materials used to obtain the required data.

2.1 Materials

In this study, some tools or items is used to carry out this project of bamboo beam reinforcements. Firstly, the type of bamboo that was chosen in this project is Betung bamboo due to its quality and availability. For preservation, borax and boric acid were used as the bamboo strips were soaked for two weeks. The ratio of the preservation was 1:1.5. Afterward, there were cement, hoe, water, aggregates which were sand and stones to form a beam concrete using mould. The flexural machine were used to collect and compare both different percentages of beams. Thus, the details of both flexural strength and their deflection can be compared and improved.

2.2 Methods

This section describes the procedure that is used in this study as shown in **Figure 1.**

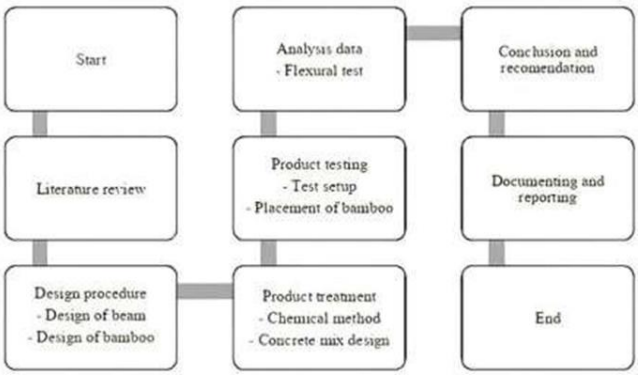

Figure 1 : Flow chart of project design

i) Designs of project

For the project, there are few designs needed to focus on before proceed to the next steps of producing beams as shown in **Figure 2**. Firstly, design building which are manufactured with steel and bamboo as reinforcement and performed a percentage technique of bamboo to replace steel bars. Then, design thebeams with different percentages of bamboo where the first beam is 100% bamboo and the other one is100% steel bars. The concrete be poured into the mould of 150 mm width, 150 mm depth and 1000 mmlength and be submerged into curing water for 28 days after the concretes were casted. Next, design ofbamboo that s all-round since they had ultimate tensile strength same as mild steel at yield points, high strength-to-weight ratio, easy workability, availability of materials and treated chemically due to its lownatural durability. The strong brown bamboo and 3 years old of Betung bamboo was chosen with 1m length and 20 mm width and be preserved using boric acid and borax of ratio 1:1.5 with 1 litre water per kilograms. The Ordinary Portland Cement was used for concrete mix design with the concrete ratiowas 1:1:5: 2:8 with the volume and water-cement ratio of 0.52.

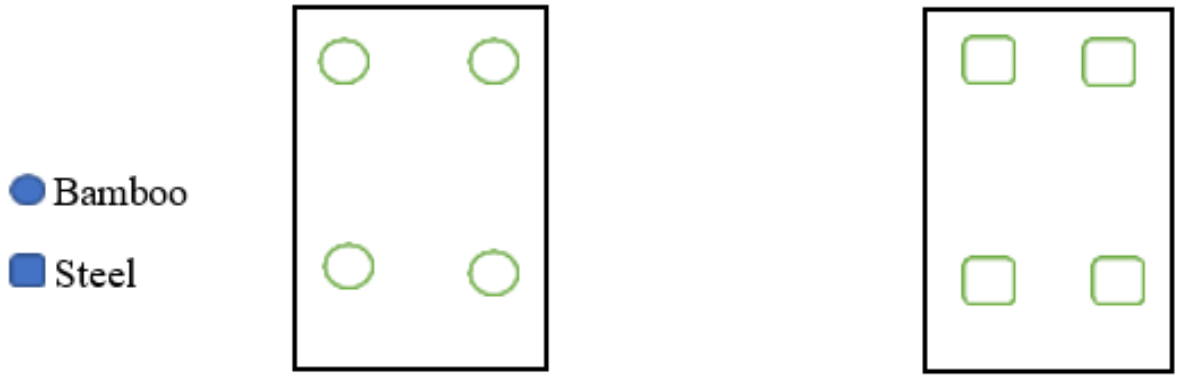

Figure 2: Design of beam bamboo and steel reinforcement

i) Test Setup

Exact mix proportion water-cement ratio was confirmed which are equal to half of the strength requirement to decrease the possibility of cracks that are caused by bamboo's bulges [3]. The bamboo placement supposed to be located at least ½ inches not less than this from the face of the concrete surfaces and alter at the very top and bamboo's bottom while its nodes have to be staggered. The space between bamboos' splints is less than ¼ inch which is the maximum size for aggregate. The reinforcement space and lashes should be equal on short sticks that are located at the right angles of the main reinforcement [4]. The flexural strength test of the beam is shown in **Figure 3**. The beam be placed under the testing machine and supports were placed at the measured location of 125mm inside from each

end of the beamand locate the dial gauge at the midspan to calculate the deflection of the beam and measure the deflection at regular intervals of loading [5].

Figure 3: Flexural Strength Test of Beam

3. Results and Discussion

The test is conducted to identify and compare the strength of two different reinforced beams which are bamboo beam reinforcement concrete and steel beam reinforcement concrete. As mentioned in previous chapter, the sketch of the beams were made before producing the beams reinforced concrete. Based on the calculation and analysis, the issue, consequences and prevention can be recognized. Then, finally conclude the project in order to understand and determine essential and necessary features.The results and discussion section presents data and analysis of the study. This section can be organized based on the stated objectives, the chronological timeline, different case groupings, different experimental configurations, or any logical order as deemed appropriate.

3.1 Preparation of items

For preparation, there are two types of items which are bamboo and steel. Both items are the main substances to carry out the project. For bamboo preparations, the treated Betung bamboo is preserved for two weeks with boric acid and borax with 1:1.5 of ratio is used and its culms is cut into strips which is in 900 mm length and 20 mm width. Otherwise, for steel preparation, rod steel with 12mm diameter have been used to make steel reinforcement beam.

3.2 Flexural result of beams

Table 1: The characteristics of the beam

Measurements	Value (mm)
Length of span, L	1000
Beam width, b	150
Beam depth, d	150

Throughout the experiment. The result of both bamboo and steel bars reinforced concrete are different due to their strength and ability of deflection. Then, recognize the characteristics of the beam

first as the **Table 1.**

Table 2: Deflection data of a steel reinforcement concrete

Ultimate load, P (Nm)	Max deflection, δmax (mm)
10	36
20	67
30	90

The steel reinforced concrete deflection data was collected before compare to the deflection data of bamboo reinforced concrete as shown in **Table 2. Table 2** shows that the steel reinforcement concrete at the ultimate load of 10 Nm, the value of its maximum deflection is 36 mm is recorded.

Based on the difference of deflection value of both steel and bamboo reinforcement concrete, the results proves that the strength of bamboo is equivalent to the strength of steel yet the bamboo deflection's results reach higher value compare to the steel. This result shows that the aim of this project, which is to apply the bamboo reinforcement in beam design is succeed. The findings found that, the bamboo reinforcement concrete creates higher value of maximum deflection which is 172 mm compared to steel reinforcement concrete which is 90 Nm even at the lower value of the ultimate load that is 20 Nmcompare to steel that the value of ultimate load is 30 Nm.

4. Conclusion

This project is succeed in achieving the goals. It can be concluded that the bamboo is suitable for use as support beams in construction. This is because the final test results of bamboo are good. The flexural strength of bamboo reinforced concrete beams is evaluated using a Flexural Strength Testing Machine and provides a good results.

Based on the result obtained, steel reinforcement concrete recorded highest maximum deflection that is 90 mm with its ultimate load is 30 Nm while bamboo reinforcement concrete highest record is 172mm for its maximum deflection with its ultimate load is 20Nm. Hence to get an accurate data, the institution must construct a proper location for the treatment process, regardless of the type of treatment. In addition, the university must upgrade the machines available in the laboratory by increasing the number of machines to ensure that students and users can use the equipment at the designated period without causing harm. The institution must take the initiative to hire personnel capable of repairing the machine in the case of damage. Finally, the exact concrete ratio. Concrete ratios are crucial for ensuring accuracy in the production of concrete. If the concrete ratio is accurate, the concrete's strength can be improved. These improvements would eventually produce high quality bamboo since they are naturally durable and to replace steel as they are mainly used for temporary structures and lower-grade buildings [6].The conclusion should summarize the main findings of the study, and restate the key points inferred from trends observed and discussed regarding the data. Some suggestions should be included to encourage the continuation of the current research.

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