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Slope Stabilization by Using Bamboo

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Abstract: .Slope failure have occur in Malaysia several times and it could be a threat towards people which the slope failure leads to landslide. Analysing and prioritize of the slope we develop a way for slope stabilization. The plan was to made a slope stabilization out of bamboo and discuss on how the plan for the slope model in AutoCAD. The slope stabilization model also need to determine type of joints to be used and ways to install the bamboo block model at the site. The bamboo block stabilization slope model should be able to resist the slope failure and work as a retaining wall. By doing research from several types of sources such as online journal, the idea on how the model of the bamboo was taken from concept of gabion block and crib wall. To achieve the best result of the model, two types of model were presented by using an application that could draw the plan and the detail drawing of the blocks model. The application that have been used in these research are AutoCAD and SketchUp to build the 3D modelling and plan. This study aim to build the best model of bamboo block to use as a slope stabilization, because have a high compressive strength than steel and economical. As the result, the design model achieve and suitable for slope stabilization. The design include the types of the joint that had been choose for slope stabilization and ways on how to install it at the sites.

Keywords: Bamboo, Slope, Stabilization,

1. Introduction

This paper was focus on slope stabilization by using new types of material such as bamboo. This study aims to produce an economical material to replace and innovate existing methods such as iron used. Slope failures occur when driving forces overcome resisting forces. The driving force is typically gravity, and the resisting force is the slope material's shear strength. Increased groundwater, loss of soil strength, blocked pathways, and other factors can all contribute to a hazardous slope on a piece of property. [1].

In recent times, many incidents involving with slope failure have claimed many human lives. For example, such as the slope failure incident that caused a landslide on December 6, 2008, at Bukit Antarabangsa which has resulted in at least 5 people being reported dead. In addition, a study was

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conducted which showed that most incidents of slope failure occur during the monsoon season. This is due to the continuous rain that caused the outbreak of this phenomenon. The factor that Malaysia is above the equator which causes Malaysia to have hot and humid temperatures is also said to be one of the causes. In addition, the study also found that geological conditions, geomorphology, and geological structure should also be considered and should not be considered trivial.

Based on the problem statement, it is the main goal of this study to examine and analyze the problems that occur because of slopes that fail to be strengthened due to factors such as landslides, heavy rains that cause the soil to become soft and unstable. Apart from that, this study also aims to review the effectiveness of strengthening the slope using bamboo. More specifically, this study is based on prepare a design plan using AutoCAD and Determine the method of connection and installation of slope stabilizer bamboo blocks for Model 1 and Model 2.

This project was done to ensure that the slope can be strengthened by using bamboo blocks. This scope involved the process of literature review with respect to slope stabilization and reeds. Sketches for bamboo blocks was also be made to get an accurate picture before the project is implemented. In addition, to produce bamboo blocks that are capable of stabilizing and strengthening the slope, a design plan and model must be made so that calculations such as force and support can be known and estimated. In line with the use of bamboo blocks in stabilizing slopes, appropriate splicing techniques need to be described. Thus, in this way, the bamboo blocks can be arranged in an orderly and positioned accurately and safely based on the calculations and plans that have been made. By the end of the result the expected outcome of these paper was on the plan for the bamboo block model, the types of joints for the bamboo and lastly the way on how the bamboo to install at the slope site.

2. Materials and Methods

The goal of this research is to replace or develop a new technology for slope stabilization. As a result, to assure the success of this project, numerous scientific methods have been used to ensure that the project's findings are successful. The project starts with the formulation of a problem statement. This issue statement is used to determine the difficulties arise on failing slopes, as well as to express the goals and expected outcomes for using bamboo blocks in slope stabilization. Following that, a literature research was carried out to learn about the history of bamboo from various perspectives. Aside from that, the literature study looks at the slope system to learn about the techniques for stabilizing existing slopes as well as the many forms of slope failure.

Following that, various varieties of bamboo block designs were created utilizing programs like AutoCAD to achieve the strongest block types for slope stabilization. In addition, bamboo joints was chosen from a variety of kinds and shapes that are ideal for binding the bamboo blocks together to provide slope stability. As a result, a bamboo block model was constructed, with the design chosen named crib wall and gabion block, as well as bamboo connection. The objective of the bamboo block model created is to gain an analysis and debate of the design that was developed. Finally, a conclusion was reached on the entire procedure undertaken during the project.

The proposal of the slope stabilizer also helps this study to develop a new technology for slope stabilization. The design plan conducted to knowledge the external researchers about the exposure of the new kind of material to use in slope stabilization. The design plan was to help this study to achieve the objective. For the method, divided into 3 part that are the dimensions and detailing of the models, connection and joint for the bamboo blocks and the installation of the models onto the failed slope. The **Figure 1** shows the flowchart of this research starting from the problem statement until the conclusion.

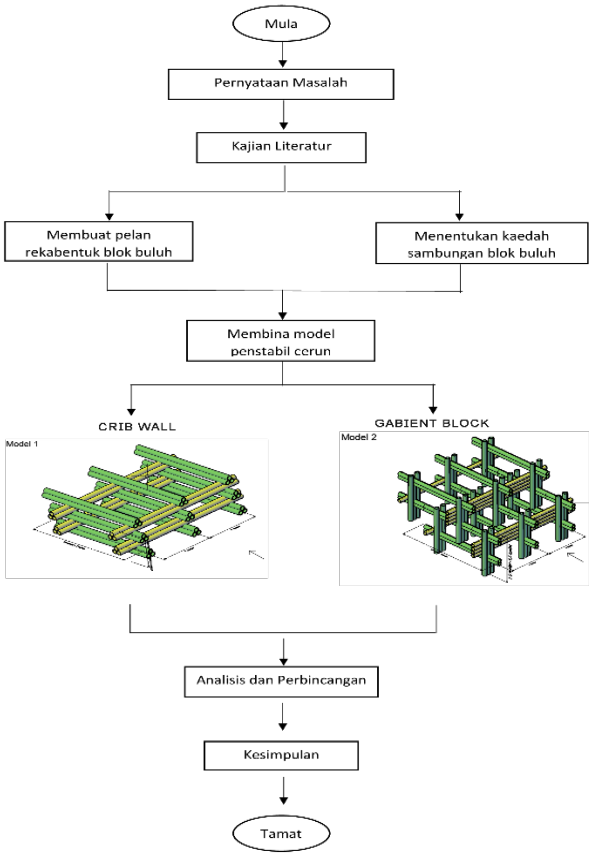


Figure 1: Methodology flow chart

3. Results and Discussion

3.1 Design plan

This bamboo block model is divided into two types and it is a new variation and has improvements in slope stabilization. A plan has been prepared as a reference of how these bamboo blocks are prepared. This plan has gone through several processes in its design to produce a bamboo block plan that meets the required criteria both in connection, installation, and as a retainer for the slope. This bamboo block model can only be used to withstand slope [2] with a height of up to 6 meters only. This is because, the application of this bamboo block as bamboo block is still in an early stage of study. 6 meters is the maximum height that can be used for this project. The plan of model 1 is based on the crib wall concept while model 2 is based on the gabion block. The **Figure 2** shows the plan view of the plan model 1 and model 2 slope stabilizers using bamboo from many sides of the views.

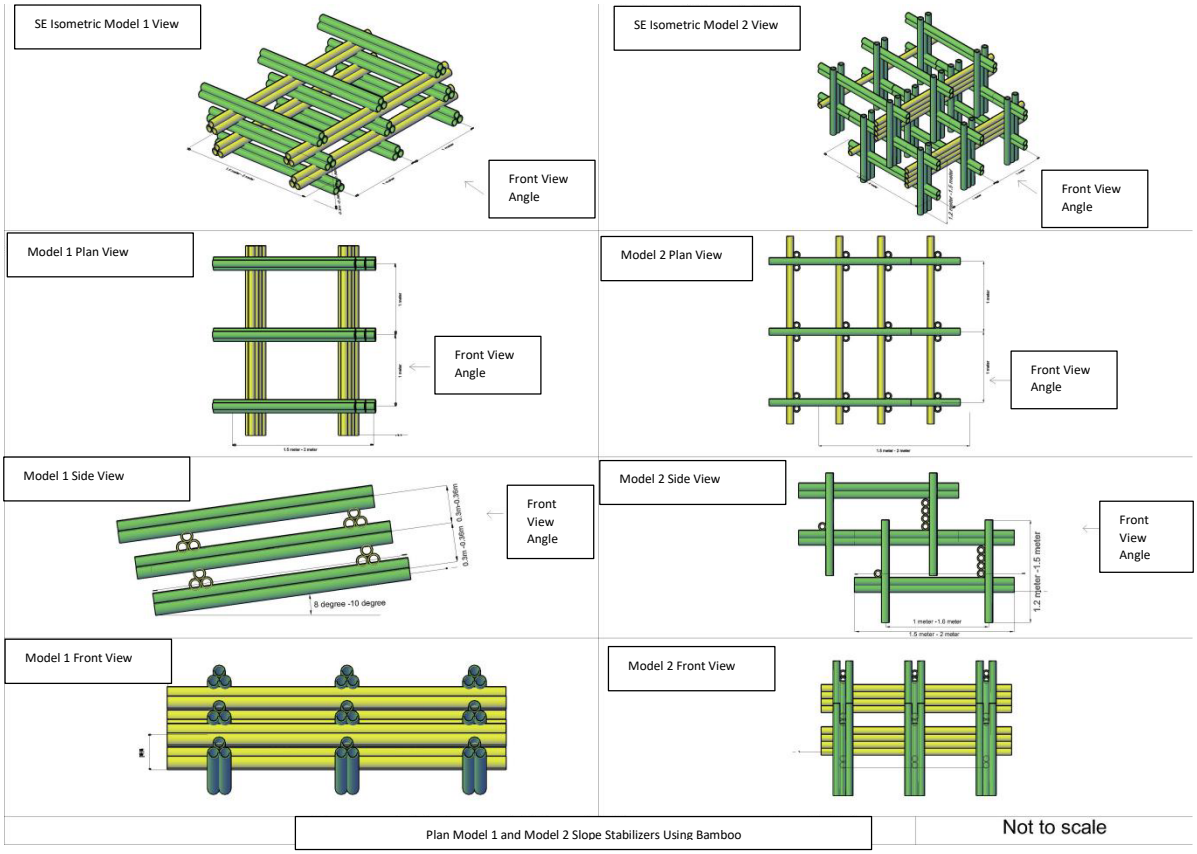
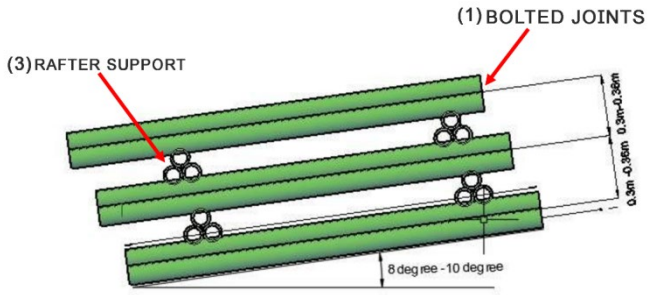


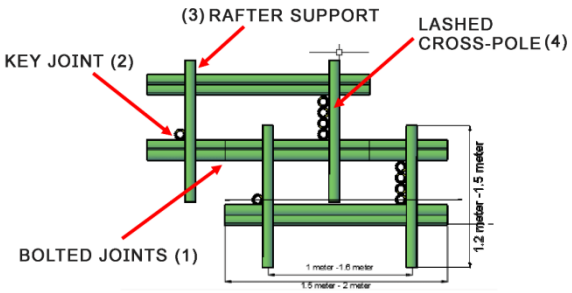
Figure 2: Bamboo block model plan

3.2 Connection for bamboo blocks

Modern use of raw bamboo has higher capabilities. To take full advantage of the properties of bamboo materials, it is necessary to use a more desirable form of structural stress and a more precise form of joint construction [3]. Compared to two traditional joints such as Mortise-Tenon Joints and Lashing Joints, the use of metal connectors as a medium for connecting bamboo can solve the problem of poor durability and components on the joints that are easily slippery. The main difference between modern joints and traditional joints is that the force is transferred to the metal connector first and then to the other bamboo components, while the traditional joint transmits the force directly through the overlapping bamboo [4]. Prefabricated special metal connectors can also create more complex connection forms, to create more types of structures and spaces as well as meet the practical and artistic needs of modern architecture. As in **Figure 3**, the views of slope stabilizers for model 1 and model 2 alongside its connection.



(a)



(b)

Figure 3: **(a) Model 1 Slope Stabilizer from Isometric View (Crib Wall) and (b) Model 2 Slope Stabilizer from Side View (Gabion Block)**

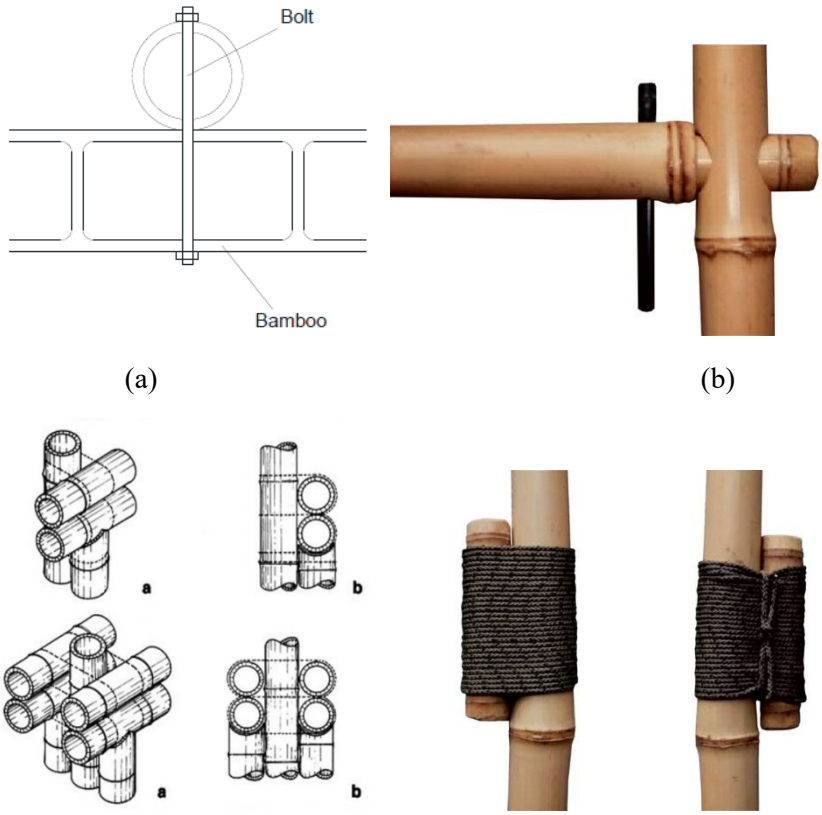
The **Figure 4** shows the connection using for model 1 and model 2 and following are the types of bamboo joints used on both types of slope stabilizers:

1) Bolted Joints

2) Key Joint

3) Rafter Support

4) Lashed Cross-Pole



(a) (b)

(c) (d)

Figure 4: (a) Bolted joints, (b) Key joint, (c) Rafter support and (d) Lashed cross-pole

3.3 Installation of bamboo blocks

Installation is the last step in this project. It is very important to ensure that the slope is successful in resolving the failures experienced. Before the installation is done, the location of the slope failure was identified and excavation was done to obtain the dimensions of the bamboo block model. Installation was started from the first layer to ensure the surface of the bamboo block model is stable. Then, the bamboo block model on the second layer was joined. Soil reclamation work is done to ensure that the slope area remains stable [5] because the soil will act as a force for the bamboo block as in **Figure 5**.

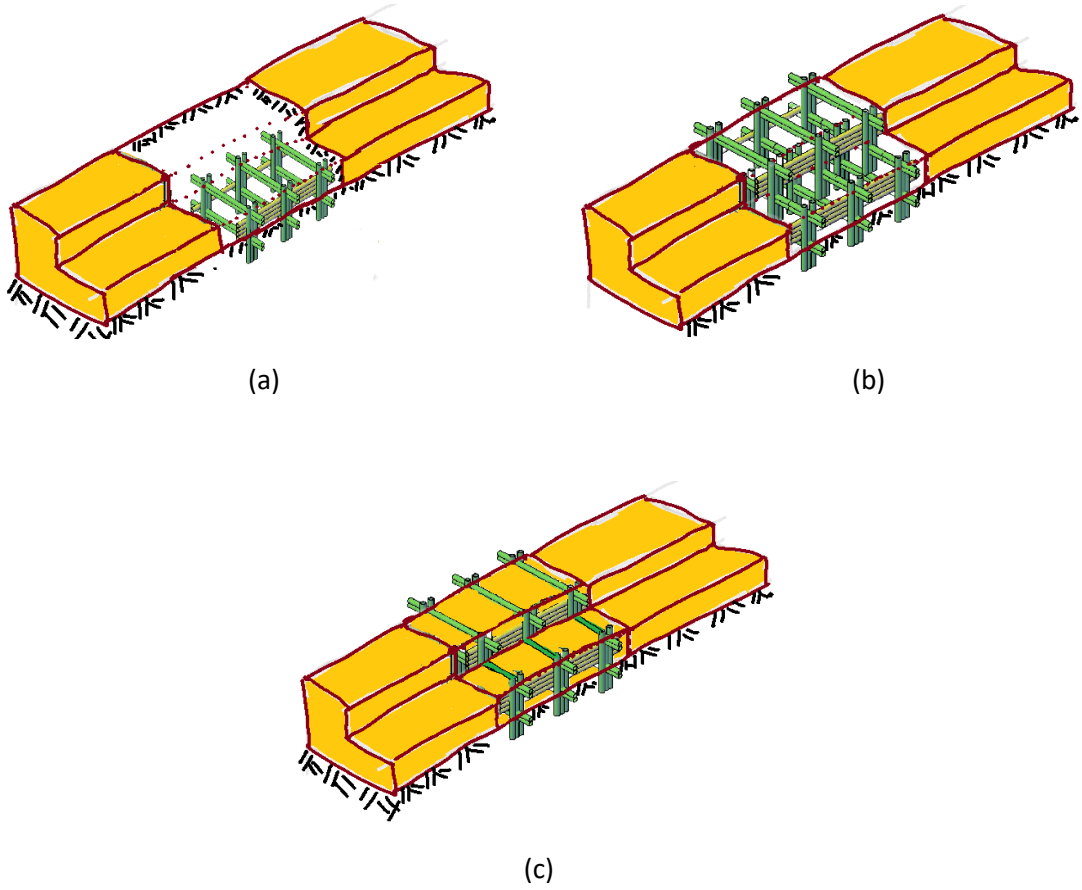


Figure 5: (a) Bamboo installation work on the bottom first layer, (b) bamboo installation work on the top second layer and (c) land reclamation work is done after the bamboo installation work is completed

During the installation work, the soil surface excavated for bamboo block model 1 is 8 to 10 degrees [6] so that deep rotation failure does not occur. In addition, for the final ground level of the bamboo block model 1, there are 2 parts, namely on the ground surface and also on the surface of the bamboo show in figure part 1, part 2 and part 3 model. Meanwhile, for the bamboo block model 2, the bamboo was pinned to ensure that the bamboo block model remains unmovable [7]. It was to ensure that the bamboo block can last longer. For the final ground level for this model, there are 3 parts which are one on the ground surface and each layer of bamboo blocks installed have a final layer of soil. The final result for both bamboo block model are as shown in **Figure 6**.

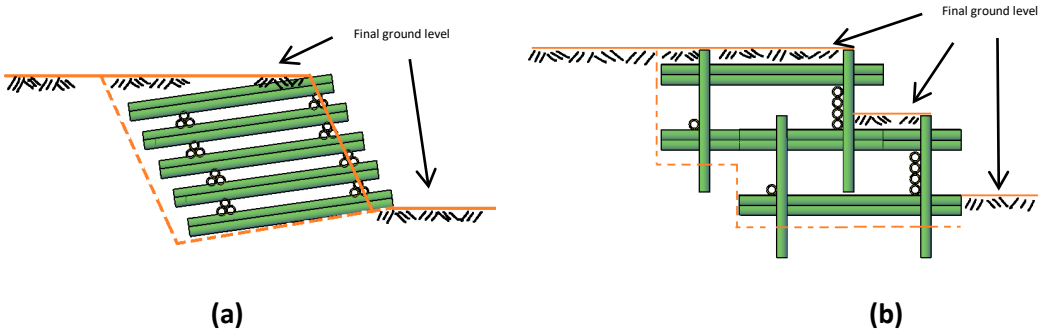


Figure 6: (a) Shows the ground level after the embankment and compacted layer by layer (Bamboo block slope stabilizer model 1) and (b) shows the ground level after the embankment and compacted layer by layer (Bamboo block slope stabilizer model 2)

4. Conclusion

In this study, the slope stabilizer design has been developed by using application AutoCAD and Sktechup. There are two types of slope stabilizers and both of them are used at different places according to the failure conditions on the slope. Next, this study is based only on the design and abilities such design in stabilizing the slope from the occurrence of landslides. Results for use of bamboo in this system are affordable for the long term. The objective of this project has been achieved. In addition, the level of effectiveness of bamboo is assessed based on an external experiment that has been done. In fact, this bamboo is not easily cracked or broken due to its nature strong coupled with its strong bonding system so that the slope can well stabilized.

Acknowledgement

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