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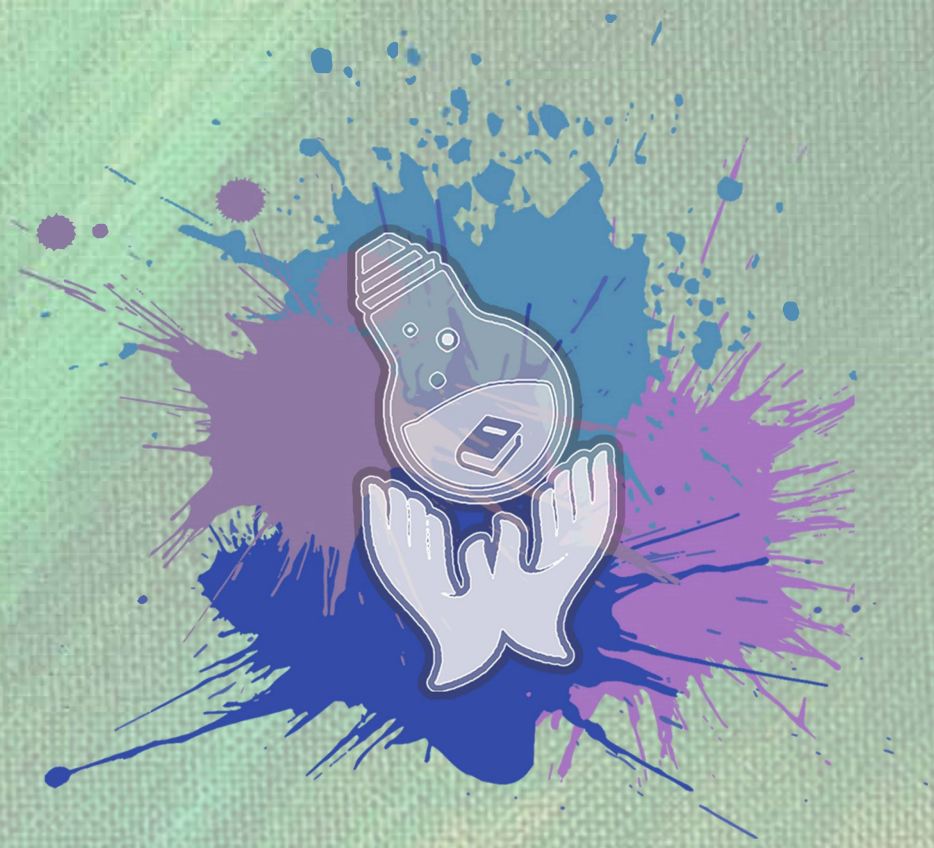

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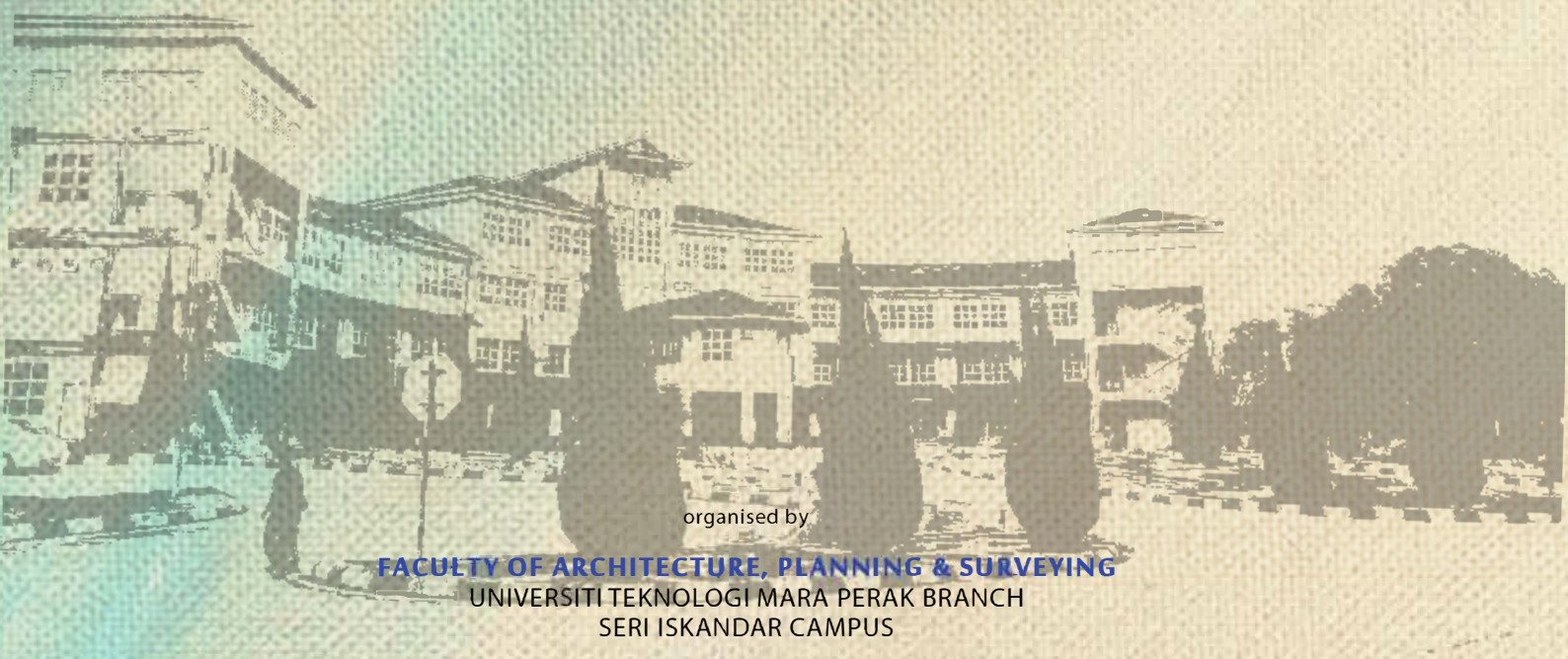

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# VISUALIZING 3-D WIND LOAD SYSTEM IN BAMBOO FRAME DESIGN FOR POST-DISASTER SHELTER

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***Abstract:***

A natural disaster is a major adverse event resulting from the natural process of the earth that will occur in unexpected time. There are many losses of life and property damage during natural disasters. One of the solutions is to construct a house in shorter period is constructing the emergency shelter for disaster victims. The analysis on bamboo emergency shelter has been carried out by using different wind speed. The computation of visualization of the 3-D wind load system in bamboo frame design has done by means of engineering software. The ANSYS fluent software is used for computational fluid dynamic (CFD) analysis. The simulation of wind load on emergency shelter is to identify the pressure distribution on its surface.

***Keywords:***

Emergency shelter; bamboo; computational fluid dynamic (CFD); wind speed; pressure distribution

## 1.0 INTRODUCTION

The natural disasters increase during the last decade. Most of the time in a post-disaster situation will result in an increasing number of homeless people and in an urgent situation, homeless people need for a place to live with protection, security, comfort and seclusion. Setting of pre and post-disaster activities are important to reduce the future hazard risks in a disaster. In addition, one of the solutions to construct a house in shorter period is constructing the emergency shelter for homeless (Félix et al., 2015). The 5.9 magnitude of earthquake rocked in Kundasang, Mount Kinabalu and Ranau on 5 June 2015 killed 18 people. There are about 52 buildings experiencing the structural failure (Jabatan Kerja Raya JKR Ranau, 2015). Besides, the Ministry of Science, Technology and Innovation (MOSTI) shown that the frequency of earthquake has increased to the highest frequency of the year annually, from 39 in April 2013, 70 in August 2014 and 101 in June 2015. Moreover, the construction industry produced a lot of carbon dioxide in the atmosphere. The production of one ton of cement will emit more than one ton of carbon dioxide in the atmosphere. (Engineering and Delhi, 2014). In this research, the objectives that need to be accomplished are to identify and investigate the type and the advantages of using bamboo for the emergency shelter and to simulate the bamboo shelter design in 3-D and testing the structure, including visualizing the wind load of the emergency shelter.

## 2.0 LITERATURE REVIEW

This study proposed the visualizing 3-D wind load system in bamboo frame design for post-disaster shelter. Research on the problems in this stage is important to find out a suitable material to use for the emergency shelter and the simulation of wind load on the structure.

### *2.1 Bamboo*

Bamboo is the woody plant can grow up faster than other woody plant in the world. Bamboo trees can be easily found in every continent mostly in Asia. In the construction industry, bamboo is important material that easier found in rural areas. This plant is able to reduce the greenhouse effect, as well it is known as one of sustainable material (Awaludin & Andriani, 2014).

### *2.2 Wind Speed*

Wind load can influence on the building design and infrastructure. A strong wind effect can cause damage to buildings or other structures. Malaysia has set up the code of practice on wind loading for building structure.

### *2.3 Computational Fluid Dynamic (CFD)*

Computational Fluid Dynamics (CFD) is used for providing the structural design engineer with wind pressure data. In the process of structural design, the calculation of wind loading is important. The wind flow characteristics such as visualization, the pressure distribution was studied in this model that have a small scale through wind tunnel experiments (Fouad et al., 2018).

## 3.0 METHODOLOGY

The methodology described the type of data collection method involve a technical visit to Forest Research Institute Malaysia (FRIM) and seminar of Bamboo Nation 3.5. The method used in visualizing 3-D wind load system in bamboo frame design in for post-disaster shelter was conducted by using ANSYS fluent software.

## 4.0 ANALYSIS AND FINDINGS

The 3-D bamboo emergency shelter was designed using SketchUp and analyzed the pressure distribution on its surface by using ANSYS fluent software.

### *4.1 Design of Bamboo Emergency Shelter*

The conceptual development of bamboo frame structure is derived from a simple mechanism of how origami (paper-folding art) folds and unfolds, the form of a square is developed into a concept of a deployable structure. The main idea and concept is originally from Bamboo Nation 3.5 program. By using Sketchup, the 3D drawing was produced to give a visualization of the structure. Table 1 shows the comparison of dimension in case of prototype and the model.

Table 1 Model and prototype dimensions

| Parameter | Model (mm) | Prototype (m) | Scale |
|---|---|---|---|
| Length | 266.67 | 4 | 1:15 |
| Width | 266.67 | 4 | 1:15 |
| Total Height | 333.33 | 5 | 1:15 |

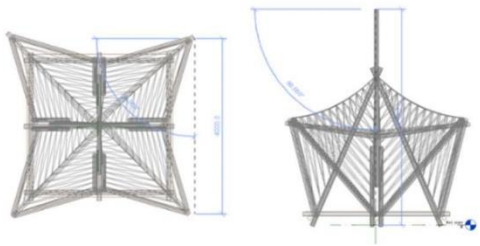

Figure 1: Parameter of the prototype emergency shelter

Figure 1 gives the visualization of a parameter of the prototype an emergency shelter. The actual size of the prototype is 4000m x 4000mm and the height of the prototype is 5000mm.

### *4.2 Simulation of Wind Load of Emergency Shelter*

CFD need subdivision of the domain into a smaller non-overlapping subdomain for solving the wind flow within the structure. Table 2 and Figure 2 shows, size of the domain.

Table 2: Parameter of the domain

| No | Length | Parameter (m) |
|---|---|---|
| 1 | Length X | 4.7897 |
| 2 | Length Y | 11.745 |
| 3 | Length Z | 5.5439 |

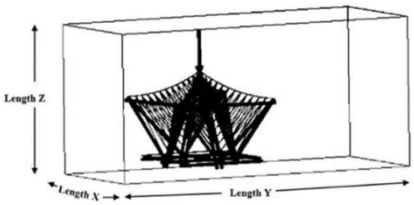


Figure 2: Size of the domain.

### *4.2.1 Wind Load Analysis*

The wind pressure measurements are made by different wind speed, from the lower wind speed to the highest wind speed. By referring a Malaysia standard (MS1553) wind loading building structure code, three wind speed has been selected. Table 4.3 shows, result of the wind load simulation.

Table 3: Result of wind load simulation

| WIND SPEED (��/��) | PRESSURE DISTRIBUTION ON THE SURFACE OF STRUCTURE | |
|---|---|---|
| | MAX +VE | MAX -VE |
| 25.8 | 8.758 | 4.673 |
| 32.2 | 13.651 | 7.298 |
| 35.7 | 16.784 | 8.983 |

Based on the Table 3 it can be observed that the highest wind speed will experience the maximum positive surface pressure distribution. Streamline of wind velocity and contour of pressure distribution as shown in Figure 3:

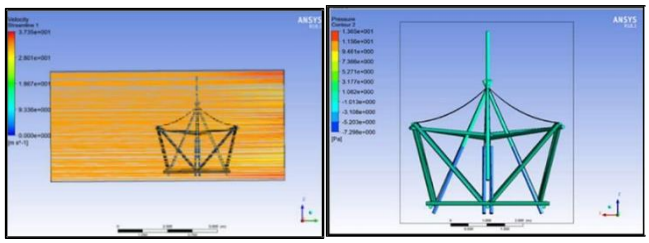

Figure 3: Velocity streamline and contour of pressure distribution

## 5.0 CONCLUSION

From the study carried out the following broad conclusions are arrived. The suitable bamboo species in Malaysia that can be used as material for the emergency shelter frame is Buloh Semantan, Buloh Betong and Buloh Beti. The wind load simulation has been successfully generated and gone through the analysis using ANSYS fluent software. After generating the wind speed through the ANSYS fluent software, the highest wind speed produces the maximum positive surface pressure distribution which is 16.784 Pa and maximum negative surface pressure distribution which is -8.983 Pa. The pressure contours and velocity streamlines have been determined with the help of CFD analysis. From the wind load simulation, this study finds that the structure can withstand with the maximum wind speed.

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