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STRUCTURE SYSTEM FOR FLOOD DISASTER EMERGENCY SHELTER ON PEATLANDS WITH A PARAMETRIC APPROACH

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ABSTRACT

Kalimantan Island has had minimal risk of flooding, but this condition has changed due to extreme natural damage. As a result, in 2021, many provinces were affected by floods. One example is the province of South Kalimantan. The Center for Disaster Information and Communication of the National Disaster Management Agency (BNPB) released on January 17, 2021, ten districts/cities affected by flooding in South Kalimantan Province, namely Tapin Regency, Banjar Regency, Banjar Baru City, Tanah Laut City, Banjarmasin City, Hulu Sungai Regency Central, Balangan Regency, Tabalong Regency, South Hulu Sungai Regency, and Batola Regency. Eighteen thousand two hundred twenty-two people were displaced due to flooding. These victims were spread across six regencies/cities, namely the cities of Banjarmasin, Banjarbaru, Banjar Regencies, Tanah Laut, Barito Kuala, and Hulu Sungai Tengah. Therefore, the local government is trying to provide emergency shelter after the flood. However, post-disaster needs are very complex in the process, such as the character of peatlands that require special structural knowledge to build them, the difficulty of access during disasters, the lack of availability of building materials in disaster conditions, and the high demand for housing. To answer the need for multi-parameters in the process of designing unloading structures for post-flood emergency shelters, a parametric approach is needed that will significantly change the design approach such as testing several parameters at once, controlling the dimensions-quality-quantity of materials, being able to perform analysis and simulation tests in one flow—integrated work.

KEYWORDS *Kalimantan, Post Disaster, Peat Land, Parametric*

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INTRODUCTION

Kalimantan Island is an island that has had minimal risk of flooding, but due to extreme natural damage, this condition has changed. As a result, in 2021, many provinces were affected by floods. One example is the province of South Kalimantan. The Center for Disaster Information and Communication of the National Disaster Management Agency (BNPB) released on January 17, 2021, ten districts/cities affected by flooding in South Kalimantan Province, namely Tapin Regency, Banjar Regency, Banjar Baru City, Tanah Laut City, Banjarmasin City, Hulu Sungai Regency Central, Balangan Regency, Tabalong Regency, South Hulu Sungai Regency, and Batola Regency (DR, 2021). There were 18222 people who were displaced due to flooding, these victims were spread across six regencies/cities, namely the cities of Banjarmasin, Banjarbaru, Banjar Regencies, Tanah Laut, Barito Kuala, and Hulu Sungai Tengah (A, 2018). Therefore, the local government is trying to provide emergency shelter after the flood. However, in the process, post-disaster needs are very complex, such as the character of peatlands that require special structural knowledge to build them, difficulty of access during disasters, lack of availability of building materials in disaster conditions and high demand for housing (Karaoğlan & Alaçam, 2019). To answer the need for multi-parameters in the post-flood residential design process, a parametric approach is needed which will significantly change the design approach such as testing several parameters at once, controlling the dimensions-quality-quantity of materials, being able to perform analysis and simulation tests in one integrated workflow. Therefore the problem to be examined in this study is How to manage post-flood housing planning on peatlands? How to address specific building construction needs on peatlands? How to design disassembled building structures by involving the latest technology as an effort to reduce dependence on building materials in disaster locations?.

Indonesia is a country prone to disasters, one of which is flooding which occurs due to extreme geographical conditions and natural damage. Therefore, this research aims to develop knowledge and technology in the field of construction capable of solving disaster problems from a technological science perspective through an interdisciplinary approach capable of managing research so as to provide benefits to the wider community. The aim of this study is to produce a model of a rapid raft structure system for post-flood housing on peatlands with a design parametric approach that can be used by flood-affected communities in Indonesia. In the form of prototypes and visual-scripting.

This Literature Review begins with an explanation of the potential for flooding on the island of Kalimantan. According to Arielle Emmett According to Arielle Emmett, not many people know the potential for natural disasters in Indonesia. 90 percent of reported natural disasters are weather related, with the main causes being rain, floods, tornadoes, fires and landslides. Related to potential disasters, Bambang Supriyadi has classified natural disasters that have occurred in Indonesia with the attributes of Floods, Earthquakes and Landslides. Disasters are grouped into 3 clusters consisting of high, medium and low disasters. High disaster classifications are: Aceh, West Java, Central Java and East Java. Medium medium classification is West Sumatra, Bengkulu, Bangka Islands, Riau Islands, DKI Jakarta, DI Yogyakarta, Bali, West Nusa Tenggara, North Kalimantan, Gorontalo, West Sulawesi, Maluku, North Maluku and West Papua. Low classifications are North Sumatra, Riau, Jambi, South Sumatra, Lampung, Banten, East Nusa Tenggara, West Kalimantan, North Kalimantan, Central Sulawesi, South Sulawesi, Southeast Sulawesi and Papua (Supriyadi, Windarto, & Soemartono, 2018) Although South Kalimantan is not included as an area with disaster risk natural, but the results of data processing made by Kompas Research and Development explained that the area of Kalimantan's forest cover was shrinking (Kompas, 2021). Research conducted by Stephanie Wegscheider shows that from 1990 to 2020 the trend of deforestation in all of Kalimantan has decreased but deforestation in North and West Kalimantan has increased so that conditions explain that disasters that occur in each province of Kalimantan need to be reviewed from a variety of different perspectives (Wegscheider et al., 2018). So it cannot be denied that Kalimantan has the potential to be affected by flooding. When a flood occurs, many people's houses are damaged, therefore shelter and shelter are needed. (Barton & d'Errico, 2012) Rahman explained in his writing that there are three categories of shelter used to accommodate victims, namely community flood shelters, shelters that utilize school buildings as shelters for evacuation (school-cum-shelters) and individual shelters used for small groups or families. (Flood-proof individual homesteads). According to Rahman, areas that have a long-term flood risk require flood management that is more than just controlling floods, therefore the awareness to provide flood prevention shelters is included, but each solution is highly dependent on local conditions. In practice, post-disaster victims often do not get proper housing and social and health problems often arise. This happened due to a lack of understanding of the situation and condition of the victim. In research made by Tonja Klansek and such shelters for Bihari refugee victims of Bangladesh floods. The use of bamboo and tarpaulin materials creates differences in perceptions between user needs and development technical needs regarding housing needs. Such as public kitchens and private kitchens which aim to avoid the danger of fire, but victims need private kitchens for their needs. There have been many previous studies to respond to this flood disaster. Beginning with the use of bamboo materials, it was also used with the aim of meeting construction needs, but due to urgent time, bamboo materials were of poor quality (Nadal, Zapata, Pagán, López, & Agudelo, 2010).

David Rockwood wrote in his research that three things are the goal of providing good post-disaster housing, namely building quality, cultural response and projects that are able to generate jobs for affected victims through the use of prefabricated technology (Rockwood, da Silva, Olsen, Robertson, & Tran, 2015). According to Gunawardena's research, long-term solutions are needed to provide post-disaster housing. The work process using a modular system can be cut by up to 50 percent. Of course this is relevant if it is linked to the need for post-disaster housing provision (Gunawardena, Ngo, Mendis, Aye, & Crawford, 2014). However, in practice, prefabrication technology often requires further adjustments, such as the dome house located in Ngelepen, Yogyakarta. Priasmara Putra Marindrha's research shows that the form of spatial adaptation that occurs there is the addition of space outside the house such as the addition of new spatial functions and the addition of area. The socio-economic aspect is a factor that causes additional space outside, this is due to a change in the status of an agrarian environment to become a tourist village (Marindrha, 2018). David Rockwood uses a modular approach in making post-flood residential houses in the Pacific Region using FRC (Fiber Reinforce Concrete) printed materials but conventional concrete transportation and concrete molding methods for remote areas are considered ineffective. As in Füsun Cemre Karaoglan's research, it was stated that many factors influence disaster resolution and in practice disaster conditions are often difficult to predict (Karaoglan Cemre & Alaçam, 2018). This study describes the potential of a computational approach in the design of architectural formations through a certain set of rules and an algorithmic approach. Of course it takes an effort to realize this. Salta in his research explained advances in fabrication technology which resulted in a shift from the phenomenon of mass production to mass customization (Salta, Papavasileiou, Pyliotis, & Katsaros, 2020) Nebal Al Azzawi conducted research with a digital fabrication approach that produced post-flood housing in Bekka Valley Lebanon using basic materials paper as covering material folded with honeycomb formation. In this project, it can be seen that the advantages of this design are the light weight of the dead load and the flexibility of the shape (can be in the form of a box and the shape of the letter L with a certain radius) (Al Azzawi, Amir, Tiwari, & Mushtaha, 2020). In terms of material use, Rina Yadav conducted preliminary research on Moso bamboo (Phyllostachys pubescens) in combination with processed materials and used tires which have the potential to be basic shelter materials. This is shown in Figure 15 which explains the significant compressive strength, tensile and immersion tests, but there is no further journal regarding its application (Yadav, Chen, Shao, & Song, 2021).

RESEARCH METHOD

The research method that will be used is quasi-experimental. This method is an experimental activity that carries out treatment, evaluation of the impact of activities, experimental units that are not carried out randomly to produce comparative studies in an effort to conclude changes due to treatment. In this stage, the formation strength analysis process will be carried out which will then be carried out through the Finite Element Analysis method which will be the basis for making a scalar structure model. Finite Element Analysis (FEA) or often referred to as Finite Element Method (FEM) is a numerical method for solving partial differential equations. In the engineering world, mathematical equations are often needed to describe a system, often in this modeling it contains partial differential equations that are very difficult or even impossible to solve using analytical equations. Using FEA, this system of equations can be solved into small sub domains, or elements that are connected to each other by nodes. Algebraic equations can also be made for each of these nodes to then obtain a solution. Today, FEA is a technique commonly used by engineers to solve engineering problems. This method allows engineers to simulate the model to find problems that may occur before the physical model is created. Solutions from this modeling can also be used to verify experimental results or field assessments to reduce the total cost and time of field experiments that must be used. Before entering the FEA process, Geometry planning is carried out. The geometry used in this simulation is a light-weight structure made of plywood with a thickness of 3 mm.

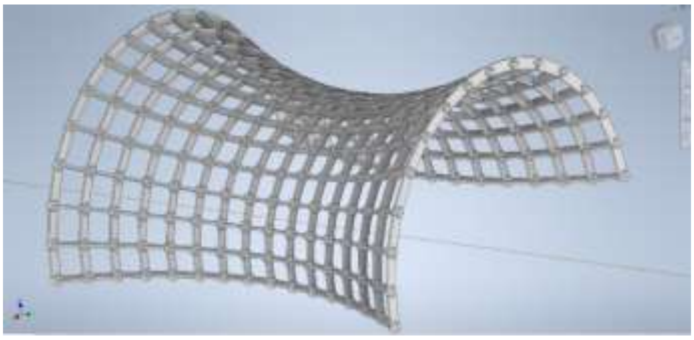

Figure 1
Geometry Model

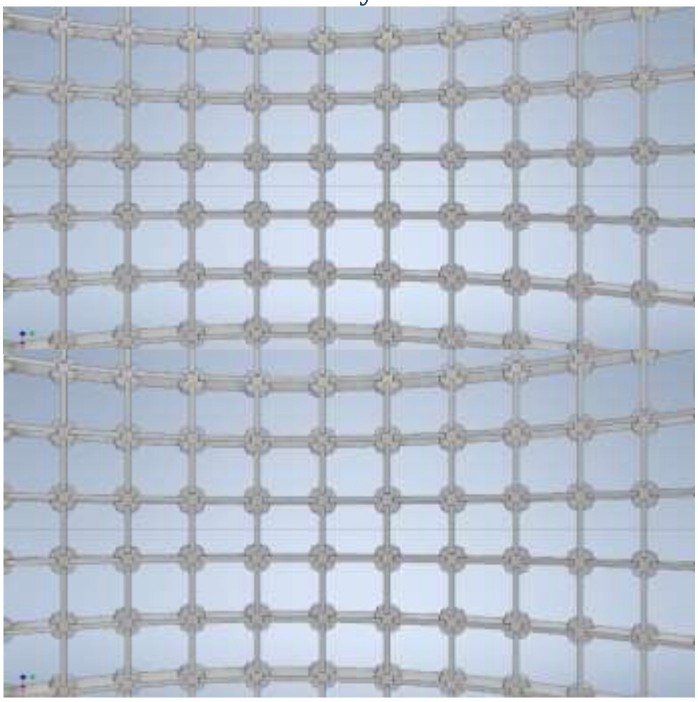

Figure 2
Connections To The Structure

In order for this geometric model to be calculated by a computer, the volume of the model needs to be converted to a mesh. Meshing or discretization of FEA is the process of converting a continuous solid domain into a discrete computational domain with a finite number of elements so that structural equations can be solved using the FEA numerical method. Then, meshing is made using automatic tetrahedral on each geometric component because of its superiority in being able to form elements by tetrahedral mesh for more complicated geometries. This setting helps increase the accuracy of the mesh with elements that fit the geometry well.

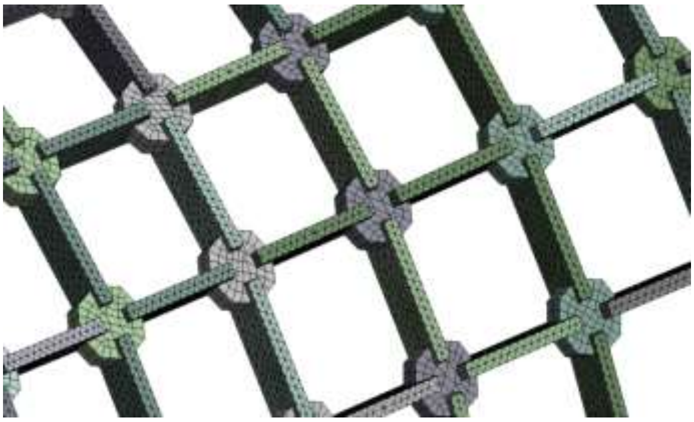

Figure 3
Meshing details

The next step is to do the calculations. In this simulation, the Structural Static Mechanical APDL solver is used. The main parameters used are Material, Contact, Fixed Support and Pressure. The material used is Oak Wood which conforms to the criteria of plywood which is common in Indonesia. Contact is the meeting of the surface of two dissimilar objects. This setting will affect how these two surfaces are treated when in contact. In this simulation, contact bonded is used, which means that both surfaces are bonded and transfer forces to each other.

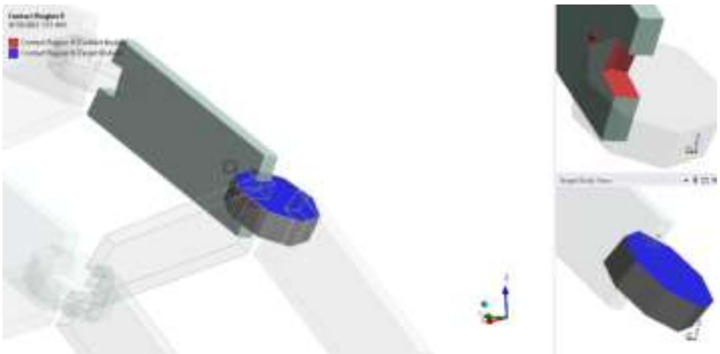

Figure 4
Contact

Fixed Support keeps certain parts of a geometry from deforming due to movement about its entire axis. Fixed supports in this geometry are defined at the bottom of the structure.

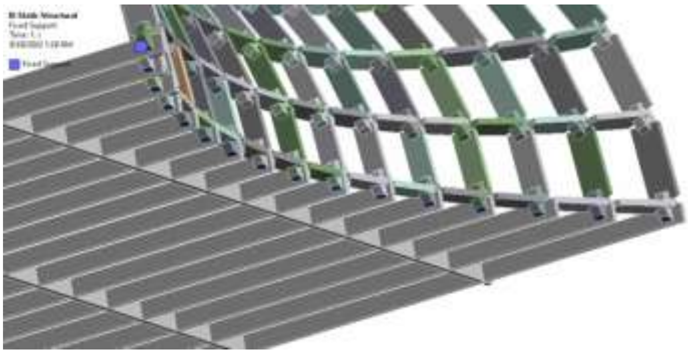

Figure 5
1:1. Scale Model

Through the consideration of this simulation, this stage is continued with the process of creating a scalar model to test the existing simulation calculations. Like in this picture:

Figure 6
1:1. scale modeltis 1:1

RESULTS AND DISCUSSION

The scale used in the results obtained is 500 thousand times to see a clearer effect. It can be seen that the greatest total deformation occurs in the center region of the structure. This is because in addition to the gravity of the total center structure in the middle, the area in the middle is the area farthest from the support so that the largest deformation occurs in the center of the structure. Maximum value for the total deformation that occurs in the horizontal bar with the greatest length. While the structure above it can be considered to have a relatively smaller deformation. This is due to the connection and structure so that the forces formed can be distributed more evenly. The contours of the equivalent stress and strain equivalent tend to be the same because these two values are directly proportional. The maximum value of both is formed at the same location, namely in the area near the support. This is the result of the reaction force exerted by the loading of the structure whose internal forces are transferred through the connections of the structure. It can be seen that the pre-designed joints can cope with the loads placed on the structure.

CONCLUSION

Through FEA simulation and scalar modeling, it can be concluded that the formation and construction system can overcome the loads that occur due to dead loads. However, additional simulations and further studies are still needed to be able to see more extreme loadings to predict the ability of more critical structures.

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