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Strength Analysis of Frame Structure Loading in Planning Using Solidworks Static Simulation Study

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Abstract. The main focus of this research is to design the frame of the various chips chopper machine that is sturdy according to the needs and has a long life. The design and simulation were carried out using the Solidworks 2020 software. The material used to make the frame structure was ASTM A36 Steel with a density of 7850 kg/m^3. The mass of the chopper machine frame that has been made is 6,383 kg. By giving two kinds of loading F_1 and F_2 of 18.718 N and 29.4 N, the resultant displacement for F_1 and F_2 is 0.1088 mm and 0.0124 mm, respectively, and the maximum Von Mises Stress value is 9.846 x 106 N/m^2 and 1.330 x 106 N/m^2, respectively. Based on these results, according to the theoretical calculation of maximum shear stress, the maximum Von Mises stress value caused by external forces for both is very much smaller than the Yield Strength Material value (2,500 x 108). So that this frame structure is declared safe and can be continued into the manufacturing process of various chips chopping machines according to the workload.

Keyword: Frame; Solidworks; Stress; Design; Static Simulation

1. Introduction

Indonesia is listed as the fourth most populous country after China, India, and the United States [1]. Indonesia's development in various sectors is a trigger for the nation's economic stability. This includes the movement of the MSME sector which continues to progress.

Attention from all parties, both government and academics is needed to continue to encourage this sector. The MSME sector which is currently very stable and has positive opportunities for improvement is in the field of agribusiness and processing of agricultural products. In addition to technological progress, economic growth is also influenced by production factors such as population, labor, and capital accumulation [2]. Technological advances play an important role in the development of the MSME sector in Indonesia. Production capacity can be increased by technological advances in this field.

The length of the cassava chopping process using manual tools makes the chip-making business experience problems in increasing the amount of production [3]. In the chopping process, if you use manual equipment, the shape and size will be different, so that the chopping process becomes less efficient. In addition, the process of chopping using manual equipment takes a long time. This is also in line with Shigley, et al who stated that to minimize the obstacles faced by Home Industry players, it is necessary to improve the slicing of raw materials that have sufficient slicing machine capacity and have uniform thickness of the slices [4].

Technological advances in the MSME sector are often embedded in appropriate technology that can help the processing of raw materials to be faster. In designing appropriate technology, it is carried out in several stages starting from determining the list of requirements, making and selecting concepts, designing components, and making detailed technical drawings [3].

In designing the machine, it is necessary to have a calculation that is in accordance with the needs so that there is no excess capacity [5]. To increase the efficiency of the machine, this tool must have a suitable frame in terms of construction and function. Therefore, it is necessary to design a frame to meet the level of construction safety. It is necessary to select the appropriate material according to the application conditions in designing a structure [6]. Material stiffness is not the only criterion considered in structural design, but the strength of the material is as important as other material properties such as hardness and toughness which are the criteria for determining material selection [7].

The strength of the structural material can be calculated and simulated through tensile test experiments using a numerical approach [8]. In the field of engineering and engineering, software is generally used to help resolve cases that have been determined [9]. Various kinds of analysis can be performed using this software including analysis of static loading on the frame.

The results obtained from the analysis of static loading on this frame are in the form of an approach using numerical analysis. Accuracy really depends on how to break down the model and combine it. [10] The purpose of this research is to determine the feasibility of the various chip chopper machine frame according to the design and material that has been selected by taking into account the static loading that occurs in the frame using Solidworks 2020 software. In this research, it can be found that various chips chopper machine frames are suitable for the needs so that they will be able to maximize product efficiency and minimize failure and high production costs.

2. Materials and Methods

This research will focus on the analysis of static loading on the frame of the various chips chopper machine. The design and analysis were made using the Solidworks 2020 software. The design of the engine frame is a process that starts from the need for loading data and the number of production failures due to lack of calculations until the final design according to needs. The design process begins with literature study, data collection and ends with a simulation of the design results.

The simulation process pays attention to important steps with the aim of achieving the expected results. These steps include the following. (1) Making the frame based on the needs and literature studies that have been carried out (2) Selection of the analysis model to be used (3) Determining the frame material to be used (4) Applying force to the desired points according to calculated estimates (5) Determine fixed geometry or frame fulcrum (6) Perform meshing process (7) Run simulation of static loading calculation on frame (8) View and analyse simulation results. The final result of the simulation of static loading on the frame of the various chips chopper machine is a solid frame design and in accordance with field needs. The steps used in this study can be seen in Figure 1.

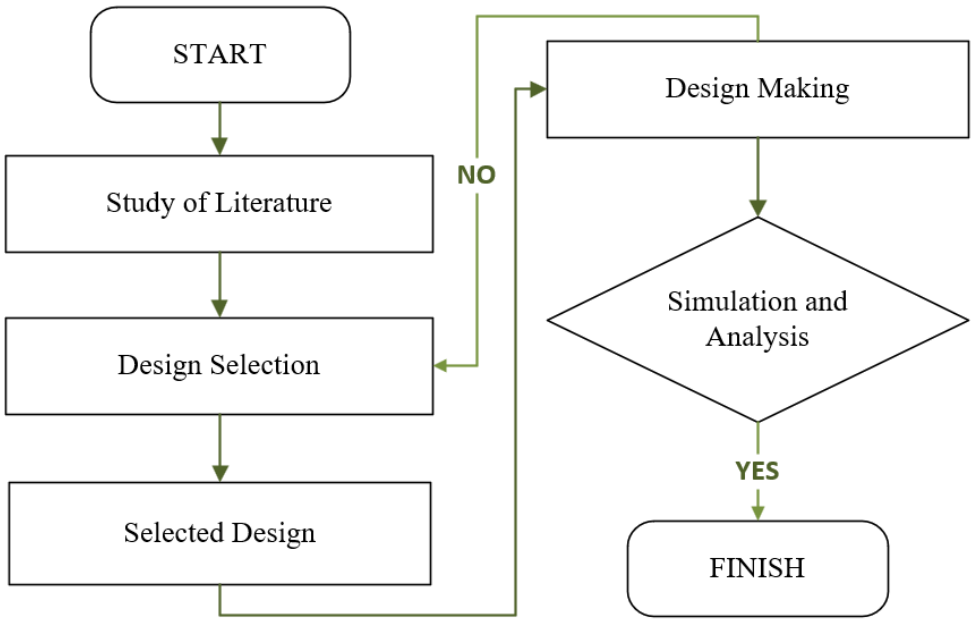

Figure 1. Research Flow Chart

2.1. Design Specification

In the manufacture of the engine frame required materials that match the needs in order to obtain good quality, long service life, and low prices. This is the most basic thing as a consideration for making the engine frame. The frame material used is ASTM A36 steel with a mass density of 7850 kg/m3. This material is in the form of an angled profile with a profile size of 35 mm x 35 mm and a thickness of 2mm. The basis for choosing ASTM A36 is because this material is not easy to collapse, is sturdy, and has strong resistance [5], so it is expected that the frame will have a longer service life. The properties of the material are shown in Table 1.

Table 1. Properties of Material

Model Reference	Properties	
	Name:	ASTM A36 Steel
	Model type:	Linear Elastic Isotropic
	Default failure criterion:	Unknown
	Yield strength:	2,5e+08 N/m^2
	Tensile strength:	4e+08 N/m^2
	Elastic modulus:	2e+11 N/m^2
	Poisson's ratio:	0,26
	Mass density:	7.850 kg/m^3
	Shear modulus:	7,93e+10 N/m^2

Figure 2. Chip Chopper Machine Frame Design

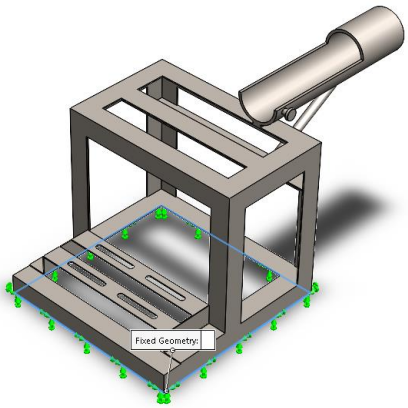

Figure 3. Fixed Geometry of Rangka Mesin Perajang Keripik

2.2. Load Analysis

The purpose of calculating the load that occurs on the frame is to determine the force that occurs in the frame and the reaction received by it. Based on the estimated calculation of the planned loading data collection on the various chip chopper machine, it is known that the mass of the electric motor is 1.91 kg (m_1), the mass of the pulley, the pulley holder, the pulley cover, the output (m_2) is 3 kg. In the simulation of static loading calculation, the load will be divided into two according to the frame design, namely W_1 and W_2. To find out the magnitude of the force received by the frame, we can calculate it as follows.

$$F = m \times g \qquad (1)$$

Where F is denoted as the force exerted by the frame in Newtons (N), m is the mass imposed on the frame (kg), and g is the gravitational force of the earth (m/s2), so that:

$F_1 = m_1 \times g$
$F_1 = 1.91 \text{ kg} \times 9.8 \text{ m/s}^2$
$F_1 = 18.718 \text{ N}$

And

$F_2 = m_2 \times g$
$F_2 = 3 \text{ kg} \times 9.8 \text{ m/s}^2$
$F_2 = 29.4 \text{ N}$

For more details, the loading positions of the forces F_1 and F_2 can be seen in Figure 4 and Figure 5.

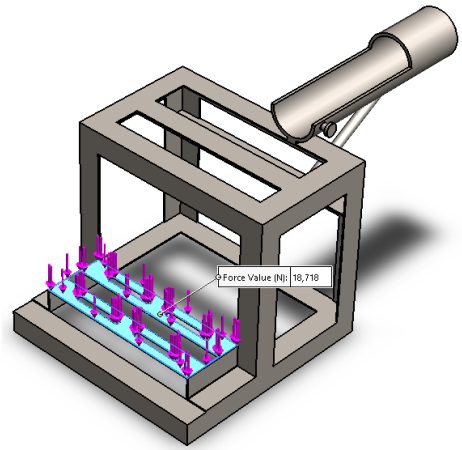

Figure 4. External Loads of F_1

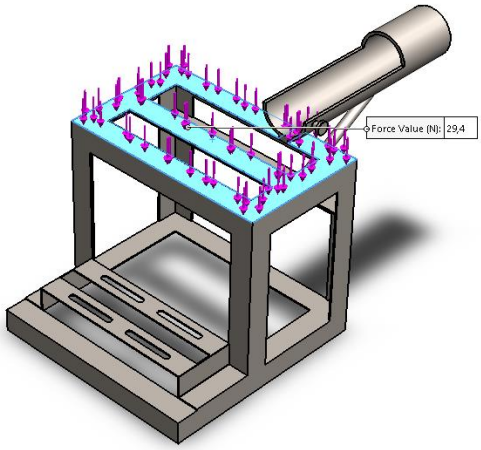

Figure 5. External Loads of F_2

3. Results and Discussion

. Simulation results for the profile of the electric motor mount frame (F_1). Based on the simulation results that have been carried out, the overall mass of the frame that has been designed using ASTM A36 Steel material is 6,383 kg. Maximum bending occurs in the centre of the electric motor mount with a displacement value of 0.1088 mm (Figure 6). The bending that occurs is very small. While the value of Von Misses Stress from the simulation results is 9,846 x 10^6 N/m^2, where this value is below the value of the Yield Strength material used, which is 2,500 x 108 N/m^2 (Figure 7).

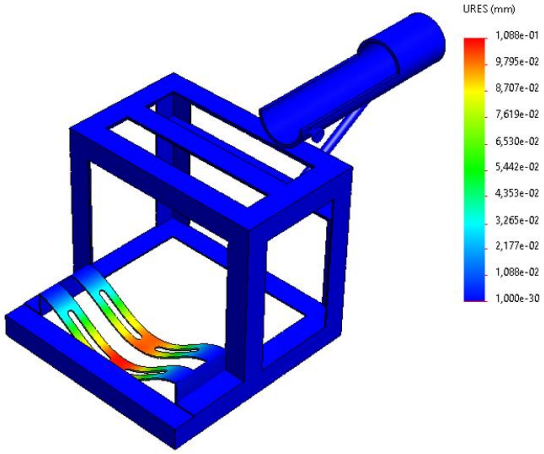

Figure 6. Resultant Displacement

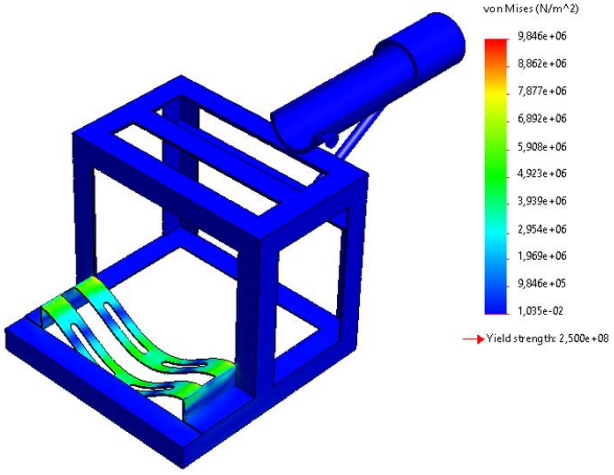

Figure 7. Von Mises Stress

As for the loading on the F_2 frame, maximum bending occurs with a displacement value of 0.0124mm (Figure 8) and the value of Von Misses Stress is 1,330 x 10^6 N/m^2, where this value is below the value of the Yield Strength of the material used, which is 2,500 x 10^8 N/m^2 (Figure 9).

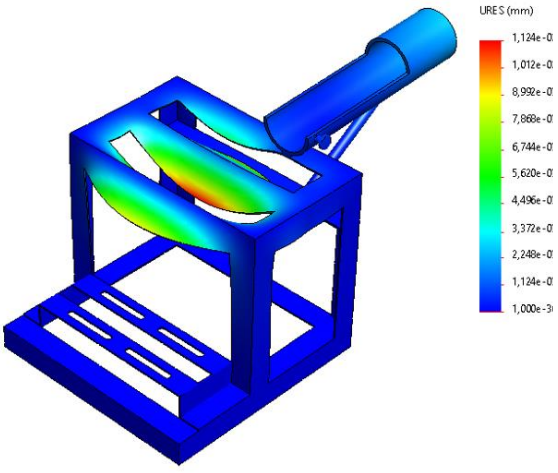

Figure 8. Resultant Displacement

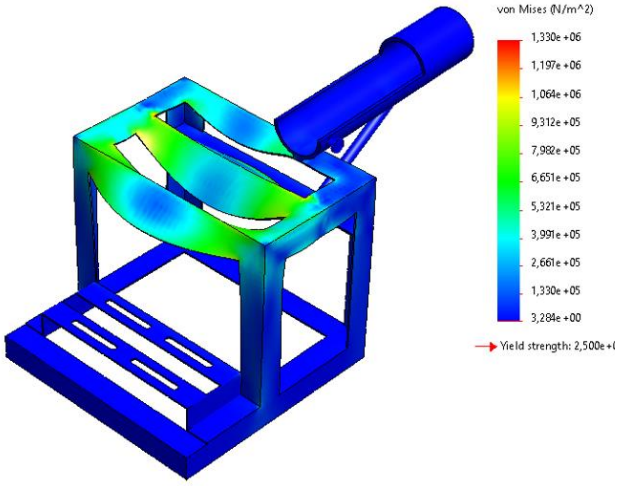

Figure 9. Von Mises Stress

4. Conclusion

Based on the results of the research that has been carried out, the following conclusions are obtained (1) The mass of the various chip chopper machine frame according to the design that has been made is 6,383 kg (2) The load given is divided into 2 (F_1 and F_2), which are 18.718 N and 29.4 N, respectively. (3) The resultant displacement simulation results for F_1 and F_2 are 0.1088 mm and 0.0124 mm, respectively. Based on the results of this simulation, the maximum deflection that occurs is very small, so that the structure can be categorized as safe against the load received. (4) The maximum Von Mises Stress value is 9,846 x 106 N/m^2 and 1,330 x 106 N/m^2, respectively. Based on these results, according to the theoretical calculation of shear stress failure maximum stress Von Mises value The maximum stress caused by the external force for both is very much smaller than the Yield Strength Material value (2,500 x 108 N/m^2). Therefore. This frame structure is included in the safe category to proceed to the manufacturing process of various chips chopping machines according to the workload.

5. Acknowledgement

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6. References

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