Design Screw Conveyor Rice Milling Unit (RMU) Capacity 5 Tons for Parit 1 Api-api Village

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Abstract: Bukit Batu District has Parit 1 Api-api Village. Bengkalis Regency is an area that has an area of ± 68 ha of rice plants. Api-api village is one of the rice production centers that have a potential location for rice cultivation because it still has vacant land. The rice production process in Parit 1 Api-api Village is often hampered by the rice milling unit (RMU) process. The process of transporting grain to the factory is carried out in a very manual way, namely transporting dry grain to RMU by transportation. This of course requires a lot of manpower. One option to assist these activities is to use a mechanical device in the form of a conveyor. This study aims to design and analyze the design of conveyor construction. Autodesk Inventor simulation using linear static analysis. Static analysis is an engineering discipline that determines the stresses in materials and structures that are subjected to static forces or loads. Static analysis uses finite element analysis (FEA) and aims to determine the structure or component, that can safely withstand the forces and loads that have been determined. This condition is reached when the specified stress from the applied force is less than the yield strength of 275 MPa under load. The results of the design are declared "safe" using 6061 aluminum material on a screw conveyor with a maximum von Mises stress of 5.25 MPa with a safety factor scale of 15.

1 INTRODUCTION

The need for agricultural tools and machinery in various fields is currently very much needed, this is related to improving the quality and quantity of the work carried out. Industry has proven that the abundance of natural resources owned is not an absolute guarantee for the prosperity of a nation. The availability of skilled and skilled human resources as well as mastering technology is a dominant factor that can lead a nation to advance in the agricultural industry.

Rice is a basic need for the Indonesian population. As the population increases, causing rice consumption to increase, therefore, it is necessary to increase rice production to meet people's consumption needs by increasing the production system. The production system can be influenced in the rice harvesting process, by accelerating the process of cutting and threshing rice (Ibrahim, 2019).

The rice production process in Parit 1 Api-api village is often hampered by the Rice Milling Unit (RMU) process. The process of transporting grain to the mill is carried out in a very manual way, namely transporting the dried grain to the RMU by carrying it. This, of course, requires an excess of human labor (workload). An option to assist these activities is to use a mechanical device in the form of a conveyor. This study aims to design and analyze the design of conveyor construction.

Conveyor is one part of the combine harvester that serves to carry the rice stalks that have been cut to the feeder and thresher holes. To make an optimal simple harvester conveyor, it is necessary to pay attention to the dimensions of checking the suitability of the dimensions of the conveyor with the planned design with the aim of knowing the conveyor manufacturing process. The simple rice harvester machine in this data analysis method accepts workpieces made using the Solidworks 2016 (Muslimin etc, 2021 application).

The agricultural mechanism in a broad sense aims to increase labor productivity, increase land productivity and reduce production costs. The use of tools and machines in the production process is intended to increase efficiency, productivity effectiveness, yield quality and reduce the burden on farmers.

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2 MANUSCRIPT PREPARATION

The working mechanism of the grain packaging machine in brief is to collect grain from the floor using a screw conveyor. Research analyzes the effect of variations in the tilt angle of the screw conveyor and variations in motor speed on the optimization of the grain packaging machine. Based on the results of experimental field tests that have been carried out, the optimal capacity is obtained at the variation of the tilt angle of the screw conveyor 100 and the motor speed on the screw conveyor shaft 100 Rpm, with the result of a capacity of 1,226 Kg/hour.

2.1 Conveyors

Conveyor is a mechanical system that has the function of moving goods from one place to another. Conveyors are widely used in industry for the transportation of very large and sustainable goods. Under certain conditions, conveyors are widely used because they have economic value in the field of heavy transportation such as trucks and transport cars. Conveyors can mobilize goods in large quantities and continuously from one place to another. The relocation must have a fixed location so that the conveyor system has economic value (Dianto, 2019).

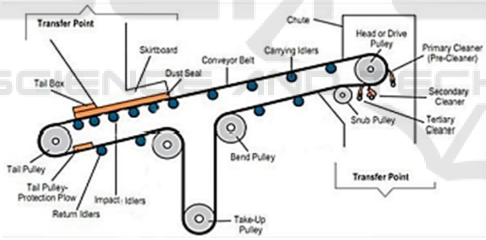

Figure 1: Conveyor. Source: Dianto 2019.

The screw conveyor which is most suitable for transferring solid or granular raw materials. As the name suggests, this screw conveyor consists of a blade that is twisted called a flight. This flight revolves around an axis so that its shape resembles a screw. From the two types of conveyors above, the researcher concludes that the conveyor according to the title raised is the screw conveyor.

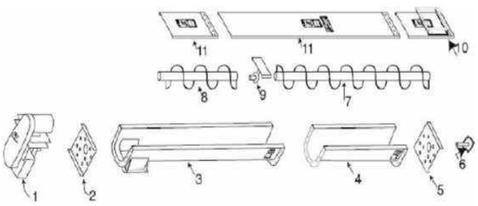

Figure 2: Part of Screw Conveyor.

2.2 Static Stress Analysis

If a component receives the load received slowly, without shock and is held at a constant value, then the stress generated in the component is called static stress. On the load of a structure due to the dead weight of a building (Mott, 2009).

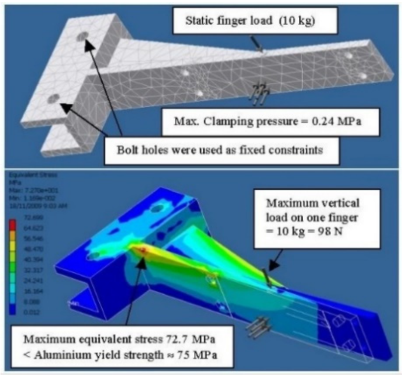

Figure 3: Static analysis FEA. Source: SN. Cubero, 2018.

2.2.1 Stress

Every material (object) is elastic in its natural state. So if the external force acting on the object will experience deformation, this resistance which is united in area is called stress. If an elastic object is pulled by a force, the object will increase in length up to a certain size proportional to the force, which means that there is a certain amount of force acting on each unit length of the object. The force acting is proportional to the length of the object and inversely proportional to its cross-sectional area. The magnitude of the force acting divided by the cross-sectional area is defined as stress.

$$Stress = \frac{Force}{Area} \text{ atau } \sigma = \frac{F}{A} \tag{1}$$

2.2.2 Strain

Strain is defined as the quotient between the increase in length and the initial length. If an object is hanging on a rope, it creates a pulling force on the rope, so the rope provides resistance in the form of an internal force that is proportional to the weight of the load it carries (action force = reaction).

The resistance response of the rope to the load acting on it will cause the rope to tighten as well as stretch as an effect of internal displacement at the atomic level in the particles that make up the rope, so that the rope experiences an increase in length.

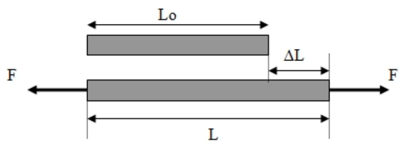

Figure 4: Strain of schematic.

$$Strain = \frac{Elongation}{Steady} \text{ or } \varepsilon \frac{\Delta L}{l_o} \quad (2)$$

2.2.3 Stress Strain Behavior

The test results usually depend on the test object. Because it is very unlikely that we use a structure that is the same size as the size of the test object, we need to express the test results in a form that can be applied to structural elements of any size. A simple way to achieve this goal is to convert the test results to stresses and strains. The stress-strain diagram is a characteristic of the material being tested and provides important information about mechanical quantities and types of behavior.

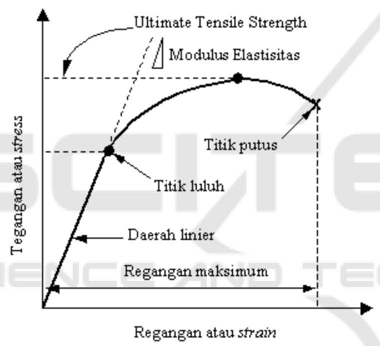

Figure 5: Stress strain curve.

2.2.4 Modulus Young

Stress-strain is a characteristic of the material under test and provides important information about mechanical quantities and types of behavior.

The modulus of elasticity is often referred to as Young's modulus which is the ratio between stress and axial strain in elastic deformation, so that the modulus of elasticity shows the tendency of a material to deform and return to its original shape when given a load.

The modulus of elasticity is a measure of the stiffness of a material, so the higher the value of the modulus of elasticity of the material, the less deformation occurs when a force is applied. So, the greater the value of this modulus, the smaller the elastic strain that occurs or the stiffer it is. The amount of increase in length experienced by each object when stretched is different from one another depending on the elasticity of the material.

It is concluded that the strain (ε) that occurs in an object is directly proportional to the stress (σ) and inversely proportional to its elasticity. This is expressed by the formula:

$$Modulus\ Young = \frac{Stress}{Strain} \text{ or } E = \frac{\sigma}{\varepsilon} \quad (3)$$

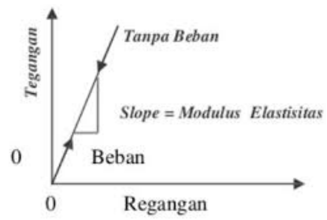

Figure 6: Modulus elasticity (Modulus young).

2.2.5 Finite Element Analysis

Finite Element Analysis (FEA) is a numerical method that can be used to find accurate solutions to complex engineering problems. This finite element method is a method that has been proven to be quite successful so far to be used to analyze the stresses that occur in structures. The basic concept of this method is discretization, which is dividing objects into smaller forms which still have the same properties as the constituent objects.

This method is widely used to solve technical problems and mathematical problems of a physical phenomenon. The types of physical technical and mathematical problems that can be solved using the finite element method are divided into two groups, namely the structural analysis group and the non-structural problems group. The types of structural problems include stress, buckling, and vibration analysis (modal analysis), while non-structural problems include heat and mass transfer, fluid mechanics, and distribution of electric potential and magnetic potential.

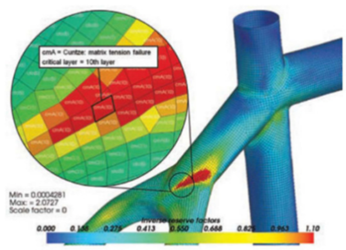

Figure 7: Fail creation komputational FEA.

FEA has become a solution for predicting the strength of a material that cannot be shown in theory and allows designers to see all the theoretical forces that occur in the model.

3 RESEARCH METHODOLOGY

In order to achieve the objectives of the research, it is necessary to arrange research stages. The following is a research flow chart for the design of the conveyor rice milling unit (RMU):

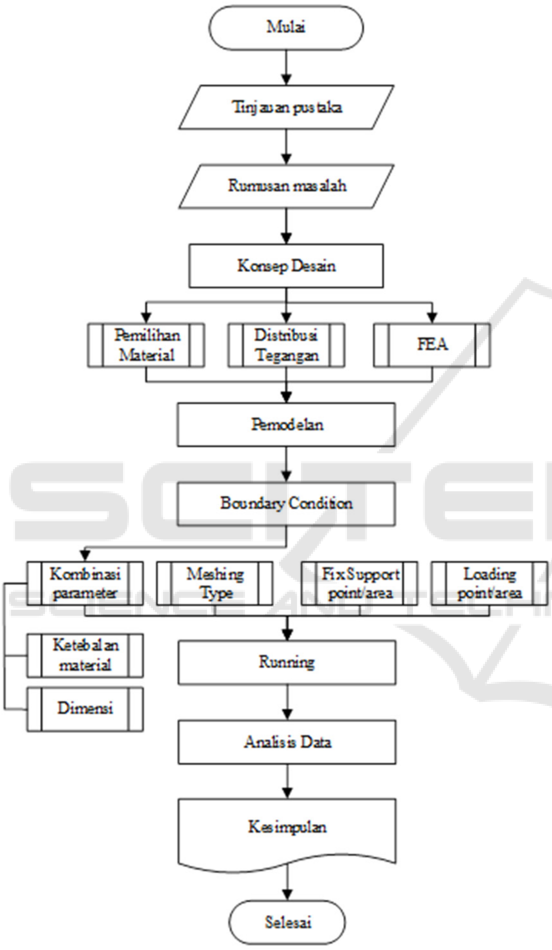

Figure 8: Flowchart of research.

3.1 Research Model

Modeling is the process of forming objects using a computational system, so that the results of the model (part) look real according to the original object. The overall modeling process includes the formation of parts, the assembly process (part assembly) and a two-dimensional (2D engineering drawing) projection model. The output of the modeling is in the form of volume, mass, and so on.

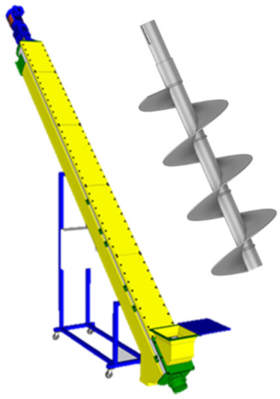

Figure 9: Modeling as initial reference.

In planning a screw conveyor, the first thing to consider is the manufacture of threads on the screw. Initial planning in the manufacture of screw threads is to determine in advance the screw diameter (D) and the diameter of the axle or screw shaft (d). The drawing of the planning for making the screw can be seen in Figure 10.

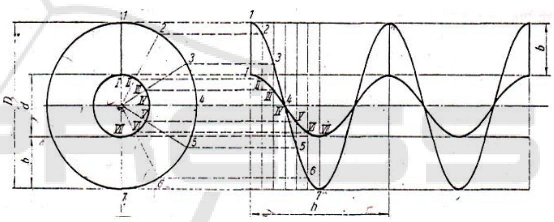

Figure 10: Screw manufacturing planning.

3.2 Material

In this study, the material used is Aluminum 6061 with the following characteristics show in Table 1:

Table 1: Materials properties of Aluminum 6061.

Name	Aluminum 6061	
General	Mass Density	2.7 gr/cm^3
	Yield Strength	275 MPa
	Ultimate Tensile Strength	310 MPa
Stress	Young's Modulus	68.9 GPa
	Poisson's Ratio	0.33 ul
	Shear Modulus	25.9023 GPa

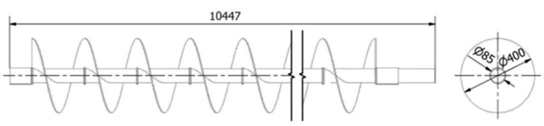

Figure 11: Geometry of screw conveyor (mm).

It is shown in Figure 10 that the geometry is 10447 mm in total length and shaft diameter (d) 85 mm and screw conveyor diameter (D) 400 mm.

Table 2: Number of mesh element and node.

Element	52158
Node	105305

3.3 Boundary Condition

Figure 12 shows the stages of FEA. Numerical methods that can be used to solve structural problems. The FEA simulation process is carried out for an approach to real conditions that occur in materials and structures. Observing and analyzing the load on the components.

Figure 12: FEA method simulation stages.

Figure 13 shows the load point that occurs on the screw conveyor. From the observations, two forces occur, pure bending load and torsion.

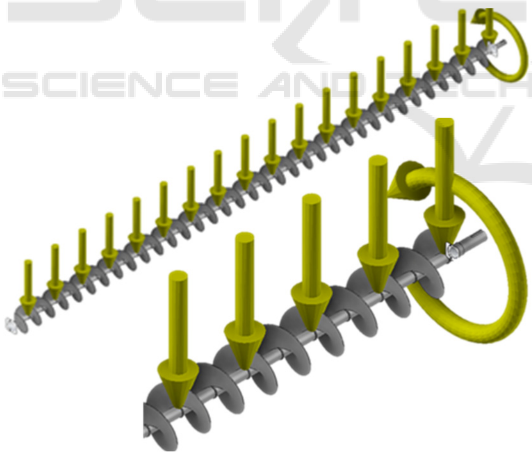

Figure 13: Deflection and moment due at screw conveyor.

4 RESULT AND ANALYSIS

Autodesk Inventor simulation results using linear static analysis. Static analysis is an engineering discipline that determines stresses in materials and structures that experience static or dynamic forces or loads (W. Younis, 2011). The static analysis uses the finite element method and aims to determine the structure or component, can safely withstand the forces and loads that have been determined. The condition is reached when the specified stress from the applied force is less than the yield strength in resisting the load. This voltage relationship is often referred to as a safety factor and is used in many analyzes as an indicator of success or failure in an analysis (Wibawa, 2018).

The characteristics of the material will be known if it is given a load. The purpose of this study was to observe the effect of the load on the Aluminum 6061 material applied to the screw conveyor. The maximum allowable stress limit in this design refers to the yield strength value of CFRP, which is 275 MPa.

4.1 Von Mises Stress

The Von Mises stress results use color contours to indicate the calculated maximum and minimum stresses. Aluminum 6061 on the screw conveyor is declared to begin to yield when the von Mises stress reaches the yield strength value.

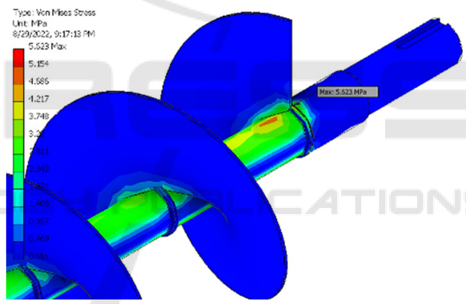

Figure 14: Maximum von Mises stress zone.

It is observed from Figure 14 that the overall construction of Aluminum 6061 can support the load very well, which is 5,623 MPa which is still far below the yield value.

4.2 1st Principal Stress

The value of the 1st principal stress is the normal tensile stress of a plane where the shear stress is zero. 1st principal stress to determine the zone of maximum tensile stress that occurs on the screw conveyor due to the interaction of loading and support as shown in Figure 15. From the computational results, the 1st principal stress value is only 7.067 MPa.

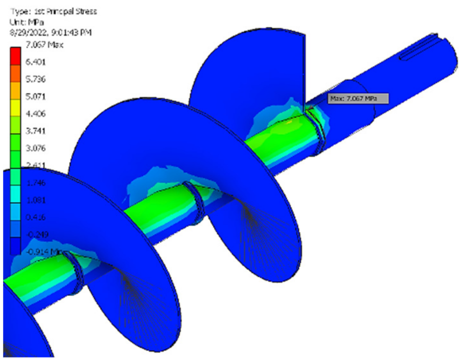

Figure 15: The maximum tensile stress that occurs on the conveyor.

4.3 3rd Principal Stress

Figure 16 shows the maximum yield of the 3 rd Principal Stress is 1.169 MPa. The 3rd Principal Stress functions to determine the normal compressive stress that occurs in the frame where the shear stress is zero. The distribution of compressive stress occurs in almost all areas of the screw conveyor.

Figure 16: Zone 3rd Principal Stress.

4.4 Displacement

Displacement provides information on changes in the shape of the screw conveyor from its original shape. The computational results found the whole deformed part. Maximum deformation 5.27 mm. Deflection is quite large influenced by the load and the length of the shaft which reaches 10 meters supported by each end. Changes in the shape of the skeleton are not permanent or are still in the elastic zone. Illustration shown Figure 16 is shown in color for easy identification.

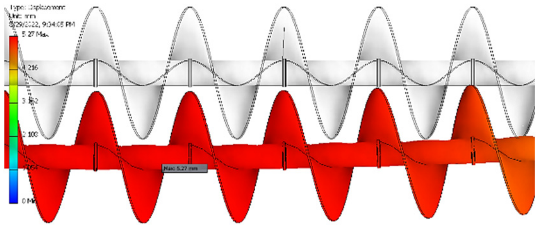

Figure 17: The maximum deformation that occurs in the conveyor is influenced by the length and pure bending.

4.5 Safety Factor

The safety factor of the 6061 aluminum screw conveyor can be measured, calculated, and predicted. If the safety factor equation is the ratio of yield strength to maximum stress (actual stress), the value must be greater than 1.0.

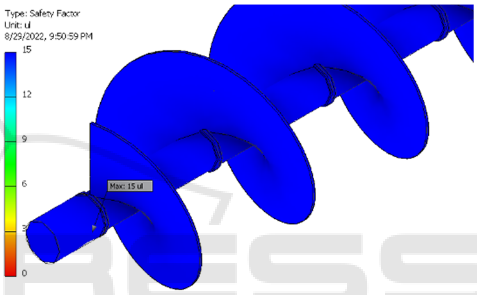

Figure 18: Safety factor material conveyor aluminum 6061.

Figure 18 illustrates that from 18 points and 1 moment applied, the results of a safety factor scale of 15 show that the Aluminum 6061 material conveyor is very "safe".

5 CONCLUSIONS

Based on the analysis of the aluminum 6061 material applied to the screw conveyor, it can be concluded that:

1. When using 6061 aluminum material with a density of 2.7 gr/cm3, the total weight of the screw conveyor becomes 187 kg.
2. The maximum von Mises stress that occurs in one of the zones is 5.623 MPa but overall it is still very safe below the yield strength limit of 275 MPa.
3. The deflection that occurs is quite large in the center of the screw conveyor. The maximum deflection is 5.27 mm, this condition is influenced by the applied load and the length of the shaft is 10 meters supported at each end so that there is a deflection.

4. Further development needs to be combined with several types of materials so that the ability of the frame is under the applied load but lighter weight. So it is more efficient in the production process.

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