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Effective and efficient design and manufacture of a plastic waste press machine

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Abstract: In Madiredo Village, which is located in Pujon District, Malang Regency, there are many business programs. The problem is that these efforts result in a wide range of waste, including up to 5 tons per day of residential waste and other corporate waste. The debris was gathered from the Bengkaras Hamlet, Madirero Village Reduce, Reuse, Recycle (TPST 3R) Integrated debris Management Site. However, a lot of plastic garbage has still leaked out of the packing. The objective is to create a press machine (press) with an electric motor so that packed plastic trash and levers (used when the power goes out) no longer require manual work. The process involves designing and producing waste press machines, particularly for cardboard, plastic trash, and old bottles. Use of the 2016 version of Solidworks for the simulation design. The lowest stress, 2.038 x 104 N/m^2, and the highest Von Misses stress, 2.825 x 108 N/m^2, are determined by the modeling findings. The biggest displacement or deflection is 1.737 x 10 mm, while the smallest displacement is 0 mm. The values of the strain range from 1.880 x 10-7 to a minimum of 6.00 x 10-4. Safety factor has a value greater than 1 A 1 horsepower AC motor is used in the press machine's construction. Three different distance stopper pressing variables—33 cm, 35 cm, and 37 cm—as well as various types of waste plastic bags, plastic bottles, and cartons/cardboard are used to test the pressing performance. The results show that pressing plastic trash at a distance from the pressing stopper of 37 cm, a mass of 167 kg, a time of 2.2 minutes, and a compressive force of 6546.4 N/m^2 may pack or package well for garbage in plastic bags.

Keywords: Von Misses stress; plastic waste press machine; Madiredo community; solidworks 2016; pressing performance test

1. INTRODUCTION

Madiredo Lake, Apple Picking Tourism, Processed Apples, and Panjilaras Written Batik are just a few of the noteworthy locations and enterprises that can be found in Madiredo Village in Pujon District, Malang Regency. The issue with all of the aforementioned company activities is the variety of garbage that results from them, not to mention the addition of domestic waste and other enterprises outside of those mentioned above. The village of Madiredo produces 5 tons of garbage every day. The waste is disposed of at the Reduce, Reuse, Recycle (TPST 3R) Integrated Waste Management Site in Bengkaras Hamlet, Madirero Village, where it is sorted and chosen into different categories, including plastic waste, glass waste, bottle cap waste, and used goods waste [1]. The packaging of plastic garbage is still done by hand, which demands a lot of labor, and the outcomes are still less than ideal (messy) (Figure 1). Such outcomes complicate transportation because there is still a lot of plastic debris lying about from the packaging [2].

A numerical analysis of the planning of a plastic press machine with a capacity of 3.5 tons utilizing an AC electric motor with a power of 15 kw at 3000 rpm was done in several studies on press machines [3]. Each support pole is made of four U profiles with ST 37 material and uses a support column frame, pressure plate, and hydraulic cylinder cross section. The strength obtained by each support pole is 109.375 kg/mm^2 240 kg/mm^2, indicating that the design is workable.

Another study shows that a press machine is designed to be able to reduce the volume of plastic waste that originally took up quite a bit of land, specifically 4 m^2 with a total waste weight of 221 kg. Using this machine, it is able to process each time it is pressed, suppressing up to 50 kg with a

dimension of 1 m^2, meaning from 221 kg is only 4 times pressing [4]. The 200 psi pressing machine has the power to press a load of 50 kg, and it only takes the machine around 10 minutes to work to suppress a load of such weight [5].

Figure 1. The results of the packing are still messy and many are scattered

The engineering method employed in the design and production of this machine includes a literature review, analysis of the plastic pressing requirements, pneumatic press design concepts, capacity calculations, and pressing simulation analysis. The machine is a 400 x 550 mm plastic bag press machine with a pneumatic system drive. The production stage involves numerous steps, such as creating working drawings, cutting materials, putting together the pressing system, and testing the press machine to determine how well it performed during the manufacturing process [6]. This 400 x 550 mm plastic cutting and pressing machine has a pressing capacity of 500 presses per hour, heaters that use 500 watts of power and two stripe heaters that use 250 watts each, and it uses pneumatic cylinders with piston rods that are 8 mm in diameter and 20 mm in diameter [7][8].

This study aims to design and produce an electric motor-powered press machine for plastic trash. The design/design, manufacturing/manufacturing of it utilizing an electric motor and a lever, so that if there is a power outage, is the state-of-the-art of this research.

2. METHOD

2.1 Design/design of plastic waste pressing machine

Redrawing is required in order to design a model plastic waste pressing machine using Solidworks 2016. Since it is difficult to make improvements if drawings from AutoCAD are imported straight into Solidworks software, Solidworks software is used to redraft the AutoCAD drawing data in this instance [9]. Additionally, this redrawing is done to reduce the likelihood that the model import procedure may encounter unreadable areas in the Solidworks software. A screw is used in the construction of a machine for pressing plastic trash, and the pressing mechanism is operated manually when the power is off and by an AC motor driving dynamo [10].

2.2 Simulation of static loading on the body

Von Misses Stress, Displacement, Strain, and Safety Factor data are displayed using static loading simulation. The analysis's findings are presented as maximum and minimum values that are immediately visible on the Solidworks Simulation 2016 display.

3. RESULTS AND DISCUSSION

The results of the design of a plastic waste pressing machine using a screw are shown in Figure 2 [7][11].

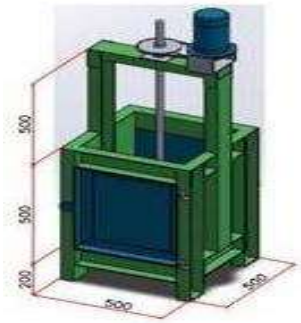

Figure 2. Design of a plastic waste press machine

3.1 Von Mises Stress

The distribution of stress across all components is illustrated by von Missis stress. By examining the three resultant stresses, also known as the Principal Stress, you can gauge material failure [11]. Figure 3 illustrates the von Mises stress results for the maximum value, 28 25 x 108 N/m^2, and the minimum stress, 2.038 x 104 N/m^2.

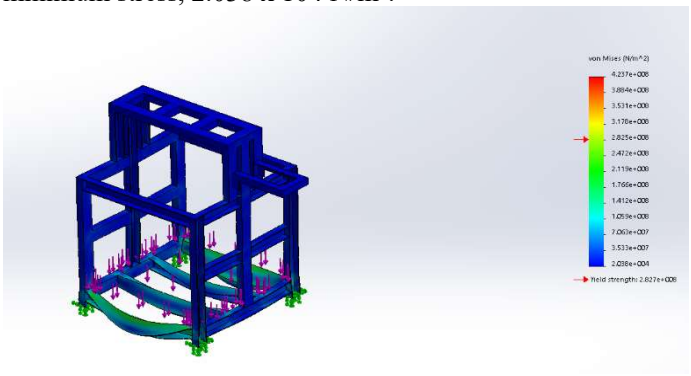

Figure 3. Simulation results of Von Mises stress values for maximum and minimum values

3.2 Strains

The ratio of the rod's original length to its enhanced length. There are elastic regions where stress and strain have a linear relationship [12]. Figure 4 displays the outcomes of the strain with a maximum value of 6.00x10-4 and a low value of 1.880x10-7.

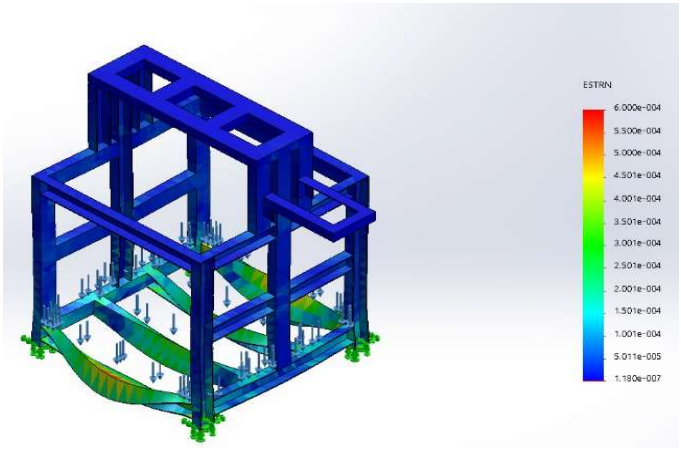

Figure 4. Simulation results of strain values for the maximum and minimum values

3.3 Displacement

When a vertical loading simulation is performed on a specific component on a rod or shaft to estimate its static strength, displacement and deflection are changes in shape [13] [14]. Figure 5 displays the greatest displacement results of 1.737 x 10 mm and a minimum of 0 mm.

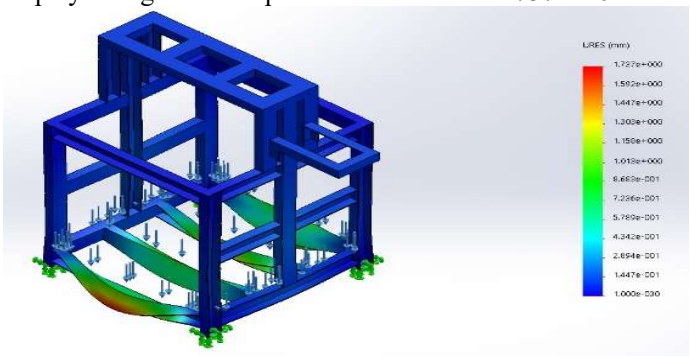

Figure 5. Displacement value simulation results for maximum and minimum values

3.4 Security Factor / Safety Factor

A comparison between design strength and material strength is the safety factor. A design is considered safe if the value is greater than 1, and is considered to be in an unsafe situation if the value is less than 1, according to the minimum safety factor value restriction of 1.00 [15]. The formula reads as follows:

$$Safety\ factor = \frac{Material\ strength}{Design\ Strength} \quad (1)$$

Figure 6 illustrates the safety factor calculation findings, which range from a maximum value of 1.223 x 10 to a minimum value of 1.014 x 104. A 1 HP AC motor is used by the finished press machine in the meantime [16], Table 1 lists the types of waste plastic bags, plastic bottles, and cardboard/cardboard used in **Figure 7** testing of pressing performance utilizing three distinct pressing stopper distance variables, namely: 33 cm, 35 cm, and 37 cm. The outcomes display machine.

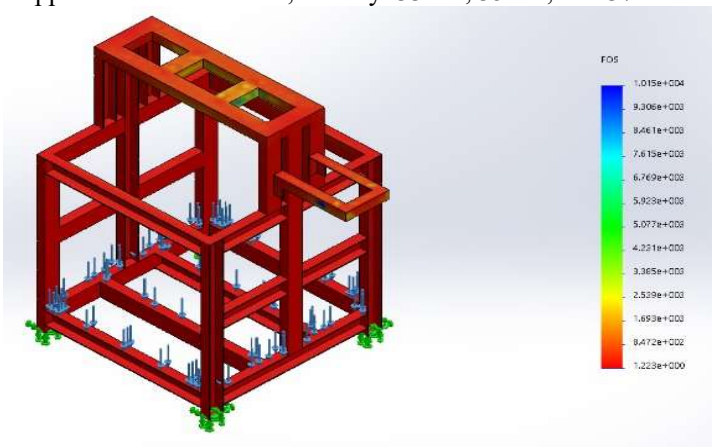

Figure 6. Simulation results of the Safety Factor for the maximum and minimum values

With a pressing stopper distance of 37 cm, a mass of 167 kg, a time of 2.2 minutes, and a compressive force of 6546.4 N/m^2, pressing plastic garbage in a can or package is effective for waste in plastic bags [17].

Figure 7. The finished product of a plastic waste press machine using a 1 Hp AC motor.

Table 1. Results of pressing 3 types of waste, namely plastic bag waste, plastic bottle waste, and used cardboard

No.	Material type	Stopper distance (cm)	Mass(kg)	Time (minute)	Press Results/Pressure(N/m^2)	Information Results
1	Plastic bottles	33	210	1,49	 8.233	Not good
		35	470	1,54	 18.424	Quite good
		33	65	1,40	 2.548	Quite good
2	Plastic bags	35	93	1,55	 3.645,6	Quite good
		37	167	2,2		**Good**

					 6.546,4	
		33	120	1,49	 4.704	Not good
3	Cardboard/Carton	35	150	1,55	 5.880	Quite good
		37	285	2.1	 11.172	Quite good

Results Description:
(1) Good = Maximum pressing, neat packing of plastic waste.
(2) Pretty Good = The pressing is not optimal, the packaging of plastic waste sheds a little after being pressed.

(3) Not Good = The pressing of plastic waste packaging is not optimal, the waste experiences loss after being pressed

3 CONCLUSION

The study's findings indicate that data in the form of maximum and minimum values for Von Misses stress, strain, displacement, and Safety Factor may be produced while designing plastic waste press machines using Solidworks 2016 software. With a stopper distance of 37 cm, a mass of 167 kg, a time of 2.2 minutes, and a compressive force of 6546.4 N/m^2, the manufacturer of the machine can pack/package well for plastic bag type garbage.

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