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Research Articles

Mold Strength Analysis of Press Machine Composite Brake Using FEM Method on Train Brakes

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A B S T R A C T

Press machine is a mechanism that works by compressing objects. It is powered by hydraulic machines, electric motors, or human power. Usually in the railway industry, presses are used in the manufacture of composite brake pads for railways. This study was conducted to find out how strong the mold of the composite brake press machine is if given the maximum load by hydraulics, this study also analyzes the mold of the press machine which plays an important role in the manufacture of composite brake linings using the Finite Element Methods (FEM). Therefore, the mold of the press must have sturdy characteristics and can withstand a lot of loads so that the structure will not deform while the process is in progress. The conclusion is that the maximum voltage amount in the mold is 33596928 N/m^2 (using ASTM A36 as the reference material) which does not cause major deformation of the mold and is still considered safe.

1. INTRODUCTION

A train accident in Argentina in February 2022 plummeted hitting the station due to unable to stop due to damage to the brakes, as a result of which 49 people were killed (Muhaimin, 2012). Carbon-based composites are in demand and development especially for automotive brake components, trains and flight fittings. This carbon-based composite has high strength, wear resistance, heat resistance, and has a low density, so it is very suitable to be used as a brake block material for transportation facilities. The development of the Railway Industry increases the number of needs for supporting components, one of which is train brake pads. With the development of technology, all human activities must be carried out efficiently and effectively in order to obtain fast and maximum results, so the manufacture of brake pads that were previously made manually or with human power is now automatic with machine power. Press Machine is a machine or tool that functions to compress an object, the source of power can come from hydraulic machines, human power, electric motors, and others. Mold is a component in the press that plays an important role in the formation of objects or materials to be pressed, so that the mold on the press machine must have sturdy properties and not change shape. Therefore, before the mold is made, it must be analyzed first so that the mold when used does not experience deformation that is not allowed by standards.

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2. LITERATURE REVIEW

2.1. Mold

Mold is a mold that has a cavity with a function as a place for melting material (plastic or metal), forming according to the shape of the mold cavity profile. Mold consists of two parts of the plate, moveable plate and stationary plate. Movable mold section plate mounted on *moveable plate* and stationary mold section plate mounted in *stationary platen*.

2.2. Stress

Stress is the ability to with stand the intensity of force at a certain area of an object. When an object with a certain surface area is given a force with a magnitude and direction, the object's ability to withstand the force exerted is called stress.

2.2.1. *Normal Stress*

The intensity of the force exerted on the iris of an object perpendicular or normal to its surface area is also called normal tension. Thus it can be formulated normal strain as follows:

$$\sigma = \frac{F}{A} \tag{1}$$

Where:

F = A force that acts perpendicular to the leadership [N]

A = The area of the object in question [m^2]

σ = The intensity of the force exerted on the iris of an object perpendicular [N/m^2]

2.2.2. Shear Stress

The intensity of the force acting parallel to the plane of a certain surface area, where the shear stress can be formulated as follows:

$$\tau = \frac{V}{A} \tag{2}$$

V = Components that are parallel to the cut, or often called shear forces [N]

A = The area of the given object of force [m^2]

τ = The intensity of the force acting parallel to the plane of the surface area [N/m^2]

2.3. Meshing

Meshing is one of the methods of breaking a model into small elements to facilitate numerical calculations on software CAE (Computer Aided Engineering).

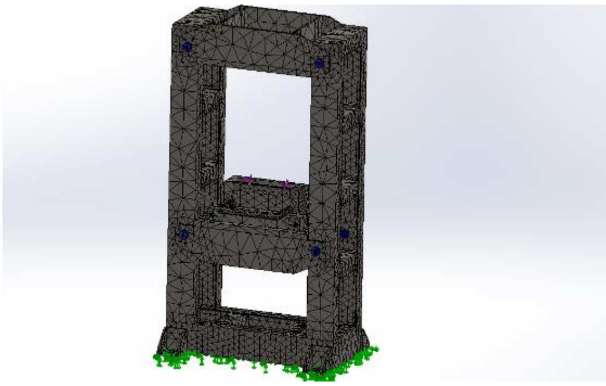

Figure 1. Meshing Example

2.4. Ultimate Tensile Strength

"*Ultimate Tensile Strength*" is the Maximum Voltage acceptable to a material before it is broken/ *breaking.*

2.5. ASTM A36 Steel

ASTM A36 is a standard material specification for carbon steel shapes, plates, and bars of structural quality for use in the construction of nailed, bolted, or welded bridges and buildings, and for general structural purposes.

2.6. Safety Factor

Safety of Factor is a comparison between large *yield strength* with great *design stress* of each material and its value must be greater than one.

2.7. Deflection

Deflection is a long increase in value caused by centralized or distributed loading.

3. METHODOLOGY

3.1. Flowchart

This study aims to determine the strength and rigidity of the press mold that has been made, and can find out the voltage that occurs in the press machine mold. The process flow diagram shows the stages to be carried out in the study is depicted in Figure 1.

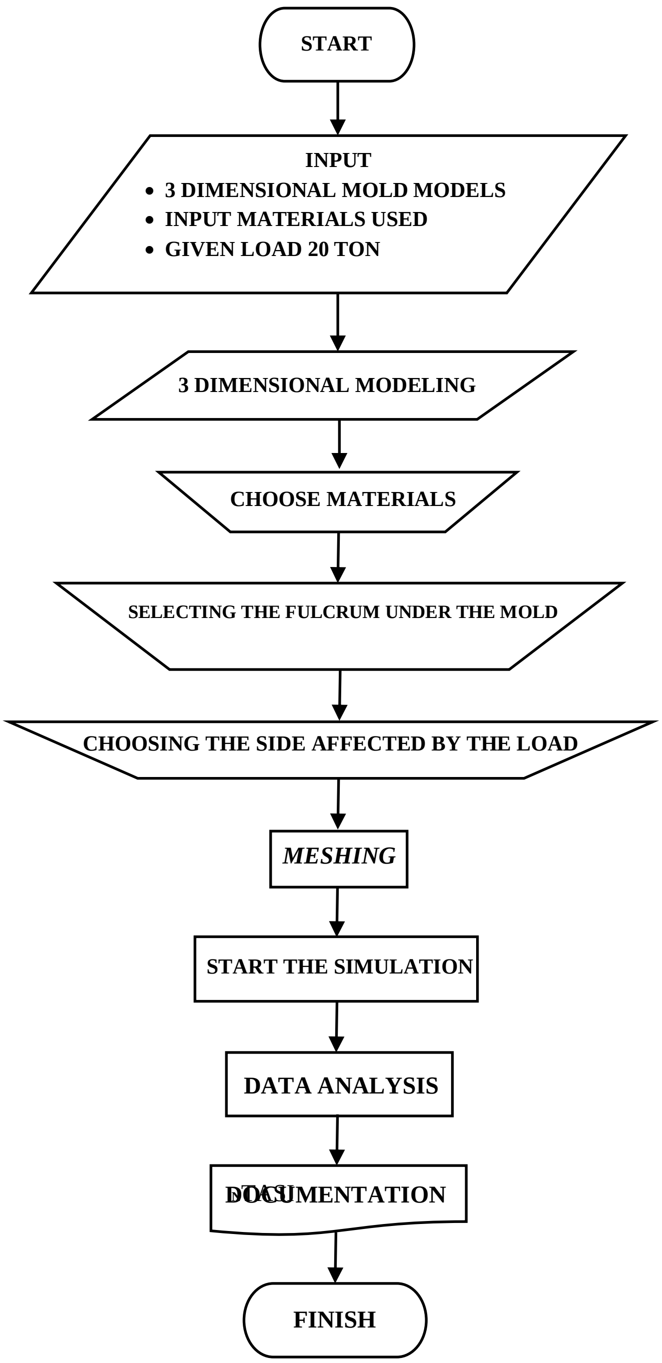

Figure 2. Flowchart of research

3.2. 3 Dimension Modeling

At the 3 dimensional modeling stages, it is made to be able to run on FEM simulations. The dimension modelling is shown in Figure 3.

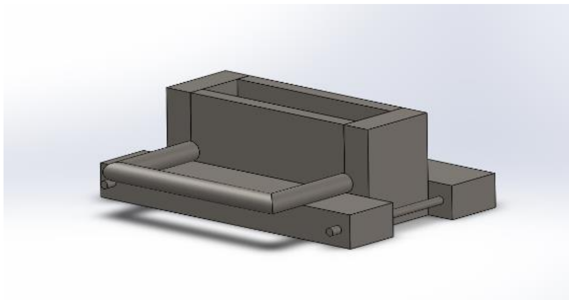

Figure 3. Dimension Modeling

3.3. Analysis Using FEM

At this stage, the model that has been modeled in 3-dimensional form is given a predetermined load and then given a fulcrum and a simulation is carried out with the results of the stress that occurs in the mold.

3.3.1. Simulation Mode Selection

On the top toolbar there is "*Simulation*" to start the analysis on *mold*, after "*klik"* the bar will then appear icon "*Simulation FEM*" next followed by "*klik*" *new study* to start the analysis.

3.3.2. Choosing Materials

Toolbar "*apply material"* its usefulness to apply the material to *mold*, the trick is to "click*"* *icon* then a material table will appear, after that it is continued by selecting the material to be applied to the mold after "click" the material to be applied to the mold then "clicking" "apply" and clicking "Close" and the material has been applied to the entire mold.

3.3.3. Fixture (Choosing a fulcrum)

Fixture is another term for the fulcrum in the FEM method, the pedestal on the mold is placed at the bottom of the mold. For a separate press machine this mold rests on the table of the press machine.

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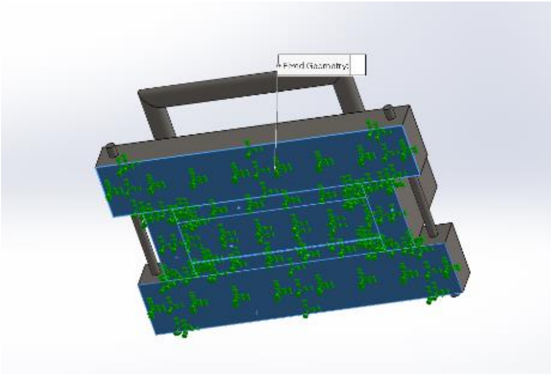

Figure 4. Pedestal Under the Mold

3.3.4. *Load*

After giving the type of material and the fulcrum on the mold, it is then given the value and position of the load on the mold is 20 tons or equal to 200000 N assuming g = 10 m/s^2 against the mold. Figure 5 shows loading condition on the mold.

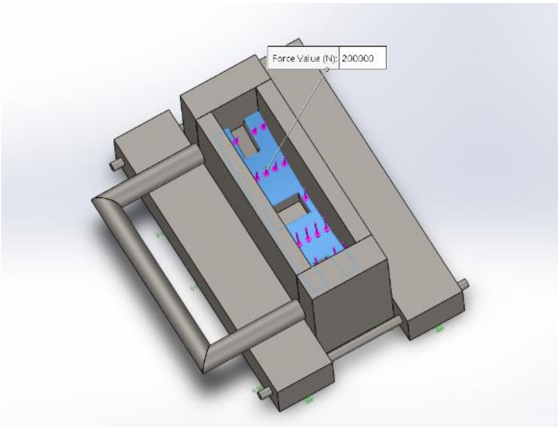

Figure 5. Loading on Molds

The method to do it is by click "External Load" then continues by clicking "force" after that proceed by selecting the part that will receive the force, and then input the force of 200000 N in the "force value" column.

3.3.5. *Meshing*

Next is the meshing stage. The meshing stages in the FEM method aim to turn the mold into small elements that are integrated with each other. The trick is to "click" "create mesh" on the left panel then right click on the mouse on the mesh icon. Since in this mold there are components that are small and have many arches so that if you use the standard mode mesh there will be an error in the meshing process so that the mesh is selected in the mode "*curvature – based mesh"*.

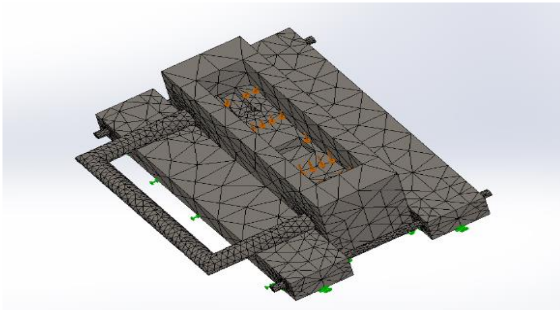

Figure 6. Process Results on Mold

3.3.6. *Starting the Simulation*

After the "mesh" process in the previous stage, then run the simulation by "clicking" "run this study" on the toolbar. After "clicking" the Run This Study, the software will start the analysis process and simulation results in the form of (*Stress)*.

4. RESULTS AND DISCUSSION

4.1. Results

The simulation results using solidworks show the stress value that occurs due to the loading given to the print.

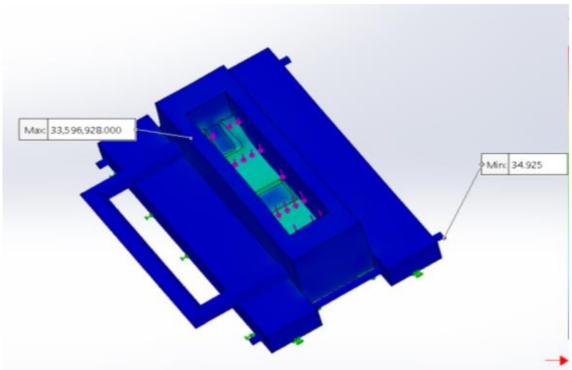

Figure 7. Stress in Mold

The resulting minimum voltage value is = 34925 N/m² and the maximum stress = 33596928 N/m². Then the results that are focused on the bottom of the mold show a maximum deflection value of

0,004 mm, in fact the maximum value of deflection can occur due to overloading the mold.

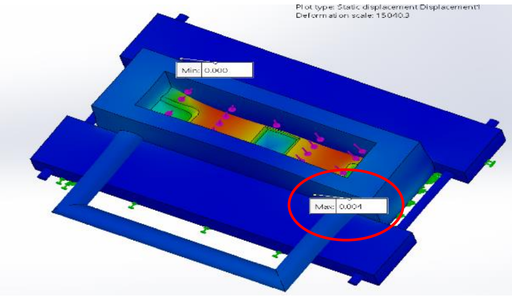

Figure 8. Deflection on Mold

For safety factor, a minimum value of 7,441 is obtained where the number states that this mold is safe to use.

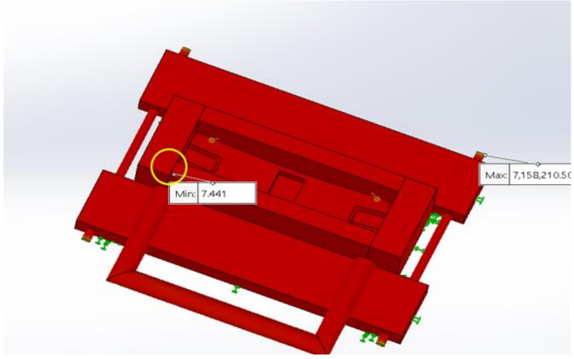

Figure 9. *Safety Factor On Mold*

The mold of this composite break press machine uses ASTM A36 material, where the material has a large Ultimate Tensile Strength value.

Physical Properties	Metric	English	Comments
Density	7.80 g/cc	0.282 lb/in³	Typical of ASTM Steel
Mechanical Properties	**Metric**	**English**	**Comments**
Tensile Strength, Ultimate	400 - 550 MPa	58000 - 79800 psi	
Tensile Strength, Yield	250 MPa	36300 psi	
Elongation at Break	20 %	20 %	in 200 mm
	23 %	23 %	In 50 mm.
Modulus of Elasticity	200 GPa	29000 ksi	
Bulk Modulus	160 GPa	23200 ksi	Typical for steel
Poissons Ratio	0.26	0.26	
Shear Modulus	79.3 GPa	11500 ksi	
Component Elements Properties	**Metric**	**English**	**Comments**
Carbon, C	0.25 - 0.29 %	0.25 - 0.29 %	
Copper, Cu	0.20 %	0.20 %	
Iron, Fe	98 %	98 %	
Manganese, Mn	1.03 %	1.03 %	
Phosphorus, P	<= 0.040 %	<= 0.040 %	
Silicon, Si	0.28 %	0.28 %	
Sulfur, S	<= 0.050 %	<= 0.050 %	

Figure 10. ASTM A36 Material Specifications (Personal Documentation)

5. CONCLUSION

After conducting an analysis using the FEM method, it can be seen that the voltage that occurs in the mold has no effect, which means that even though the mold is under stress, the overall mold remains safe and strong for use, judging from the maximum stress valueof 33596928 N / m^2, then the minimum safety factor value obtained is 7441 where the value is included in the safe category.

BIBLIOGRAPHY

[1] E. Popov and Z. Astaman. "Tegangan Normal Dan Tegangan Geser" in *Mekanika Teknik*. California, Jakarta: Erlangga, 1984, pp. 5-6, 140-141, 192.

[2] P. A. Tipler and M. Gene. "Center Of Mass," in *Physics For Scientist And Engineers*, 6th ed., P. A. Tipler, & M.Gene. New York: W. H. Freeman and Company, 2008, pp. 149-50.

 https://doi.org/ 10.25077/metal.6.2.126-131.2022

[3] A. R. Fuad. "Meshing," in *Mahir Solidworks simulation CAE*, Sleman: Deepublish, 2020, pp.13.
[4] Achmad Rachmadi, Fadli. *Modifikasi dan Analisa Chassis Kendaraan Roda Tiga Menggunakan Software Solidworks*, Itenas: Bandung, 2020.
[5] Joseph, E. Shigley., Charles, R. Mischake., Richard, G. Budynas. *Mechanical Engineering Design*, 7th ed. McGraw-Hill. Education: United, States of America, 2003.
[6] Sunaryo. *Sistem Kontruksi Slider Mold*, UMY: Yogyakarta, 2015.
[7] Fardianyah Arif. *Analisis Sifat Mekanik Pipa Carbon Steel Grade A A106 dan Grade B A53 Untuk Proses Produksi Pada Kilang LNG*, Institut Sains dan Teknologi Nasional: Jakarta, 2018.

NOMENCLATUR

F = A force acting perpendicular to the surface [N]
A = The area of the object in question [m^2]
σ = The ability to withstand the intensity of force on the area of an object [N/m^2]
V = Components that are parallel to the cut, or often called shear forces [N]
τ = The intensity of the force acting parallel to the plane of the surface area [N/m^2]