# Design and Static Test of Machine Paving Block Mix EFB with Simulation

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**Abstract.** Brick or paving block is one of the building materials made from a mixture of cement, sand, or similar adhesives, reduce the use of sand which is currently increasing, it is necessary to develop paving blocks with additional biomass waste. Biomass waste from Palm Oil, namely empty oil palm fruit bunches, (EFB) which can be used fiber palm empty fruit bunches (EFB), in the utilization of Fiber EFB for the manufacture of paving, blocks require the use of the right tools in the printing p. In contrast, the use of tools and material selection needs to be done in the production process. the design process, and simulation analysis to avoid product failures and work accidents. In contrast, the compressive strength in the paving block molding process reaches 15000 $N/m^2$ – 40000 $N/m^2$. This is to produce maximum paving blocks in the process of simulating the tool's strength using simulation, stress , strain, displacement, and safety factor values obtained.In comparison, the pressure value is 15000 $N/m^2$ with a maximum stress value of 3.621 $+10^7$ $N/m^2$ at a safetyfactor of 1.46 + 10, where the maximum deformation is 0.1589 mm, and the strain is 0.01081mm. At a pressure of 40000 $N/m^2$, the maximum stress value is 5.866 + $10^7$ $N/m^2$ at a safety factor of 9.035 , where the maximum deformation that occurs is 0.2591 mm, and strain is 0.01. In this,s case the material is still in a safe condition seen in the stressanalysis value and the stress of the material used.

**Keywords:** Design, Analysis, EFB, machine, Paving Block.

## 1 Introduction

The paving block is one of the building materials where the paving block (concrete brick) is a mixture of portland cement or similar adhesive materials, water, sand, and cement [1]. Good quality paving blocks will have a high compressive strength value between 300 $kg/cm^2$ – 350 $kg/cm^2$ to withstand the load [2][3]. Paving blocks currently exist in the community in the form of rectangular, hexagonal, worm, Trihek, Crassblock, Kansten, Antique, or Bishop, depending on the desired needs [4]. Making paving blocks requires pressure in the compaction process, with compressive strengths in molding ranging from 15,000 $N/cm^2$ – 40,000 $N/cm^2$, depending on the product produced and its use [6][7].

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The machine design has been widely used with the help of computer equipment, such as Solidworks software, CAT CAM, Autocad, and Ansys [8]. Solidwork is an engineering software that can assist in the design process and simulation of machine strength, where the results are in the form of 3D images [9].

Utilization of waste biomass has been widely used in the manufacture of building materials to reduce the amount of sand used. On the other hand, the addition of waste biomass such as bagasse for bricks, charcoal for paving blocks, and empty fruit bunches for the manufacture of fiberboard partitions [11], in this case, the utilizatifiber biomass waste is very functional and helpful. in adding a mixture of building materials.

The abundance of palm oil products in the world produces a lot of waste, such as empty oil palm fruit bunches, shells, fiber, leaves, stems, and twigs, of which 30 - 40% is still not fully utilized [13]. The use of Palm Oil Empty Fruit Bunches has been widely used as fuel, mixed materials, and fertilizers, but the supply is still abundant and has not been exhausted after being used, causing problems such as unpleasant odors and pests that can damage oil palm plants. Therefore, the waste of Oil Palm Empty Fruit Bunches needs to be developed in its utilization [14].

The results of the description above indicate the need to develop the use of oil palm empty fruit bunches to minimize oil palm waste, especially oil palm empty fruit bunches. So that researchers are currently researching the Design and Analysis of Paving Block Printing Machines. This is done to produce a machine that is safe when printing Paving Blocks with the addition of Empty Palm Oil Bunches.

## 2 Methodology

This research method uses computation, where the design and analysis process uses Solidworks software. The implementation was carried out at the Mechanical Engineering Workshop, Faculty of Engineering, Medan State University, Indonesia. In the implementation of this research, several stages were carried out, which can be seen in the diagram in Figure 1.

This research process is carried out by starting a study of literature, machine design, and planning, where computationally using Solidworks software, as for the use of material input, fixed geometry, mash, gravity, and Pressure, to generate values Stress, Strain, Displacement, and Factor Of Safety. after the value is obtained then, the feasibility is analyzed to determine whether the designed machine design is suitable for use or not, this is done to avoid the failure of the paving block product and work accidents, if it is not feasible, then the design and analysis process is repeated.

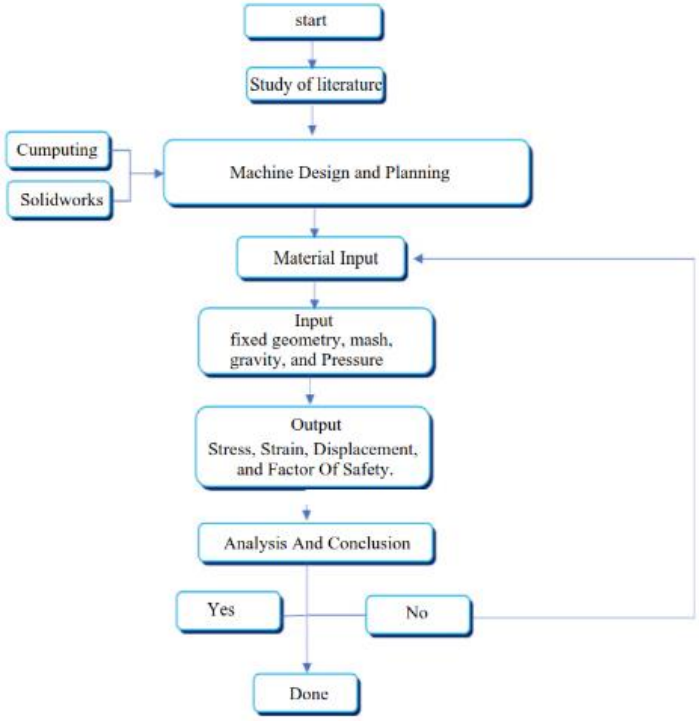



**Fig 1.** Research Steps

## 3. Results And Discussion

The paving block machine designed is shown in Figure 2, where this machine is designed and analyzed for the process of forging paving blocks from a mixture of Oil Palm Empty Fruit Bunches, where the raw materials for Oil Palm Empty Fruit Bunches are processed into fiber and then mixed with sand and cement, the resulting mixture is then brought to the machine for the compaction process. At the same time, this machine system uses pneumatic in the forging and also produces paving blocks. This pneumatic system simplifies and speeds up the paving block production process.

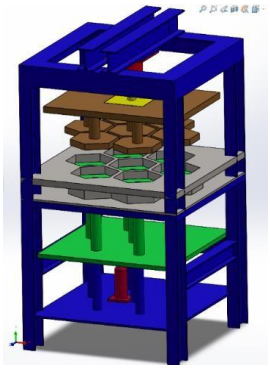


**Fig 2**. Paving Block Printing Machine Design

This paving block compression machine is designed to produce 7 paving blocks in one process, with a thickness of 7 cm, a square shape of 6, a width of 20 cm, and a center hole of 4 cm. This hole is made to function for grass plants. , and water channels in its use, while the machine measures 220 mm x 220 mm x 1600 mm, which uses a pneumatic system in molding and removing paving blocks. The process of 1 time paving block production takes about 5 minutes. The design of this machine uses ASTM A 36 material on the base of the mold and AISI 1045 Cold Draw Steel as the frame. This material was chosen because the raw material is easy to obtain, while the characteristics of the material are in table 1.

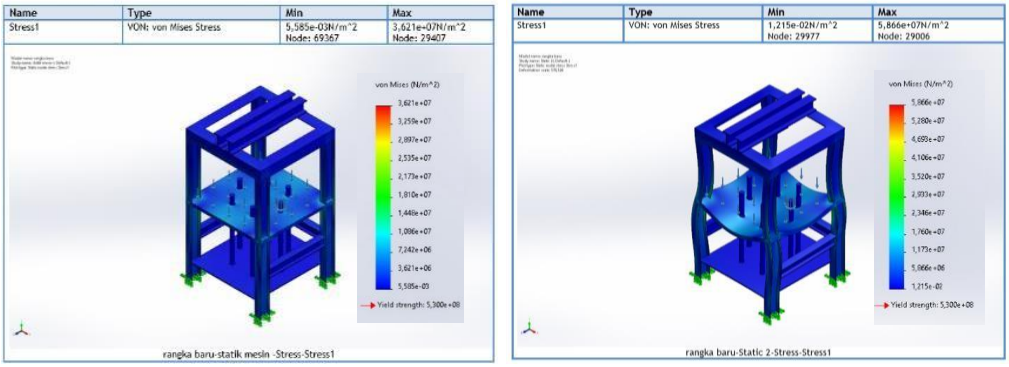
**Table 1.** Material Characteristics

| No | Information | Material Type | |
|---|---|---|---|
| | | **ASTM A 36** | **AISI 1045 Stell, Cold Draw** |
| 1 | Yield Strength | $2{,}5 \times 10^8$ N/m$^2$ | $5{,}3 \times 10^8$ N/m$^2$ |
| 2 | Tensile Strength | $4 \times 10^8$ N/m$^2$ | $6{,}25 \times 10^8$ N/m$^2$ |
| 3 | Elastic Modulus | $2 \times 10^{11}$ N/m$^2$ | $2{,}05 \times 10^{11}$ N/m$^2$ |
| 4 | Poisson's Ratio | 0,26 cm (2,6 mm) | 0,29 cm (2,9 mm) |
| 5 | Shear Modulus | $7{,}93 \times 10^{10}$ N/m$^2$ | $8 \times 10^{10}$ N/m$^2$ |
| 6 | Tolerance | 0,142568 cm (1,42568 mm) | |
| 7 | Element Size | 2,85136 cm (28,5136 mm) | |

The characteristics of this material are the maximum acceptable resistance value seen from the yield strength of the material, namely ASTM A 36 of 2.5 x $10^8$ N/m$^2$ and AISI 1045 Steel, Cold Draw of 5,3 x $10^8$ N/m$^2$, with changes in shape. The maximum is seen from the Poisson ratio of ASTM A 36 2.6 mm, and AISI 1045 Steel, Cold Draw 2.9 mm. The strength of this material has been determined from the production of the material. In the simulation of material strength, it is necessary to know the maximum material strength allowed in its use.

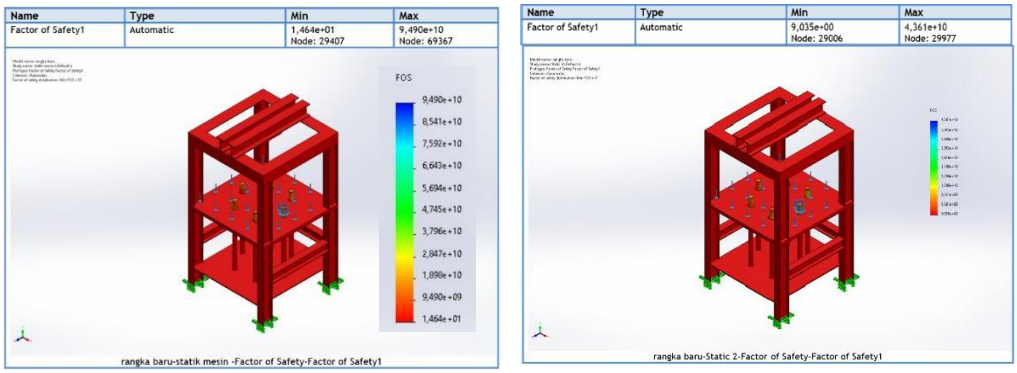
This research uses SolidWorks software in the design and simulation of material strength analysis. The material strength analysis process uses a static test with two types of compressive strength, namely 15000 N/m$^2$ and 40000 N/m$^2$. This emphasis is carried out to see the results of the stress, factor of safety, displacement, and the highest and lowest strain values from frothy

minor paving blomoldinging pressure to the most significant pressure. The results of the static analysis obtained are:



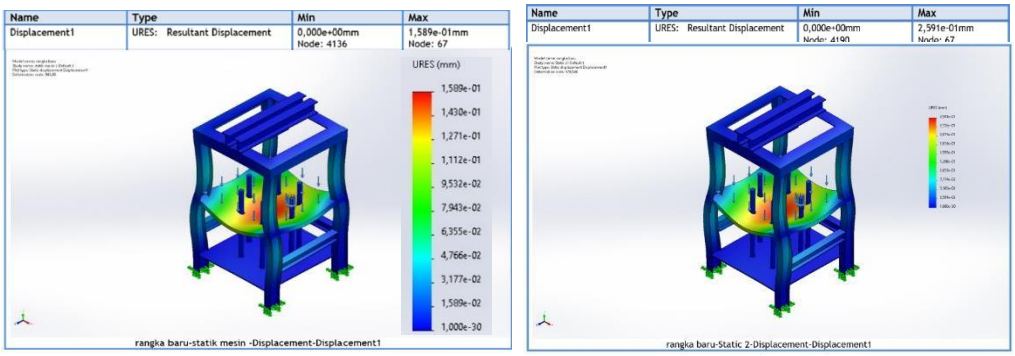

**(a)** **(b)**

**Fig 3.** Stress Value Analysis



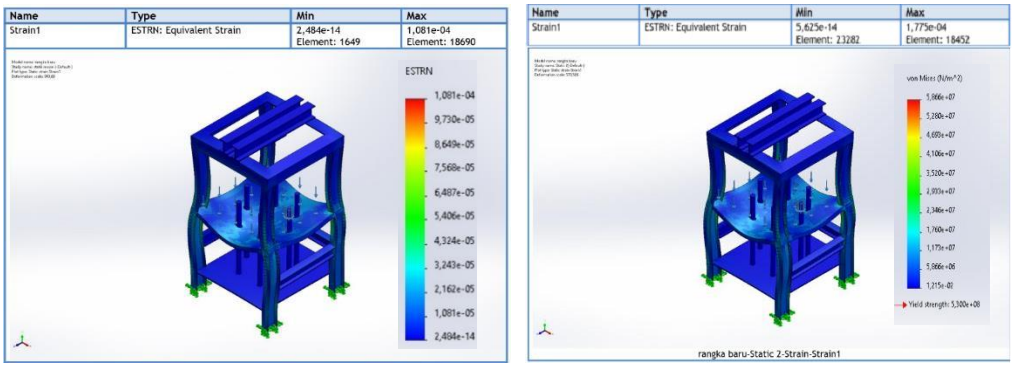

**(a)** **(b)**

**Fig 4.** Analysis of Factor Of Safety




**(a)** **(b)**

**Fig 5.** Displacement Analysis




**(a)** **(b)**

**Fig 6**. Strain Analysis

The picture above shows the results of the value of each compression and each analysis, part of picture (a) shows a compressive strength of 15000 N/m$^2$, and figure (b) shows a compressive strength of 40000 N/m$^2$, where each part produces the value of Stress, Factor of Safety, Displacement, and Strain.

The results of the analysis of the compressive strength of 15000 N/m2 in part (a) obtained a stress value of 5.585 x $10^{-3}$ N/m$^2$ up to 3.621 x $10^7$ N/m$^2$ with a safety factor value of 1.46 x $10^1$ to 9.489 x $10^{10}$ which caused the occurrence of displacement of 0.1589 mm. With a strain of 0.0001081 mm, with the results obtained, the machine design is still safe to use in the analysis simulation test in the printing process, where the stress value is still below the yield strength of the material of 2.5 x $10^8$ N/m$^2$ and the displacement value is still below the value Poisson's ratio threshold is 2.6 mm. The compressive strength value obtained is 40000 N/m$^2$ in Fig (b) is also still safe to use in the printing process where the stress analysis results are 1,215 x $10^{-2}$ N/m$^2$ up to 5,866 x $10^7$ N/m$^2$, the Safety Factor is 9,035 up to 4,361 x $10^{10}$, which causes a displacement of 0.2591 mm.

## 4. Conclusion

This study is about designing and analyzing paving block molding machines using ASTM A 36 material on the mold base and AISI 1045 Steel, Cold Draw on the frame. The analysis process uses two types of pressure, 15000 N/m$^2$, and 40000 N/m$^2$, while the results obtained from simulation, namely the value of stress, Factor Of Safety, Displacement, and Strain, where the results obtained are then compared with the strength of the use of the material. The value obtained from static analysis using SolidWorks software shows that the static test value of the paving block printing machine is still safe to use, where the maximum compressive strength value is still below the material yield strength value, and the shape changes that occur are still below the Poisson's Ratio value.

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