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Stress Analysis of IBS Molding Machine

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***Abstract**: Home is a place for shelter and survival for every living thing. These residential buildings are made using materials, one of which is brick. The technology of making bricks continues to grow over time. At present, bricks have been made using machines that use modern methods with the Interlocking Brick System (IBS) model. This molding machine using pneumatic to press the clay in the mold to becomes an IBS. This study aimed to determine the structural strength of the IBS printing press when given a load when printing is carried out. This research also serves to determine the most vulnerable locations on the machine structure as a concern when the load capacity will be increased. The analysis was carried out using the finite element method by using the finite element software. The simulation results obtained are, this IBS brick molding machine is safely operated for static pressure loads of 100 bar (10MPa).*

***Keywords**: IBS brick, stress analysis, molding machine.*

I. INTRODUCTION

The shelter is a place to shelter for every living thing. Not apart humans also need a place to live as a means of survival.

Various forms of dwellings were built to protect people from heat, rain, disasters, wild animal disorders and so forth. Today, residential buildings cannot be separated from the materials used to build dwellings, one of which is brick.

The simplest technology in making bricks is clay that is molded using manual molding which is then dried and ended by burning dried bricks.

This brick making technology continues to develop over time. At present, bricks have been made using modern methods with the Interlocking Brick System (IBS) model. The IBS system uses a mixture of red earth, sand, cement, and water which is then pressed into a certain form.

A lot of research has been done on this brick making machine. In 2011, Pius Bamidele Mogaji and friends conducted research on the design of a brick molding machine using hydraulic power [1]. In 2013, S.K. Kolawole and friends conducted research by designing and making a brick-making machine made of clay [2]. This machine is then evaluated for its reliability, where production time is one indicator of the efficiency of the machine. In 2014, R.K. Watie and friends conducted a brick test by utilizing dust material from the combustion of a power plant [3]. This test includes a compressive test, a test of water absorption and the density of the bricks. In 2014, Cristina Gentilini and friends conducted a study by testing the compressive stress and shear stress on a brick connection that has been arranged as many as three levels [4]. This test is carried out under humid and dry joint conditions. In 2015, R.K Watile and colleagues conducted a study by experimenting with bricks with several material compositions: fly ash - dust stone - sand (sand) – GFRP [5]. In 2015, Abhinandan R. Gupta and friends conducted a study by designing a form of brick construction [6]. The design of the brick shape is then realized into a prototype that is then tested on the strength of the brick. 2015, S.O. Yakubu and his friends conducted research on the design and manufacture of multipurpose brick molding machines [7]. This research was tested to produce a brick product that can be used. In 2016, Shivasheesh Kaushik and his colleagues conducted research by designing and making a machine to produce Fly Ash Brick [8]. In 2016, Sundar Ganesh C.S and his colleagues conducted a study by designing an automatic machine to cut clay in the final process to a certain smaller size [9]. In 2017, I.P. Malavika and his friends conducted a study by testing on the bricks resulting from the mixing of precarious waste material - sand - cement with the composition of the precarious waste: sand: cement = 1: 2: 4 [10]. In 2017, Shubham Mehta and friends conduct research by making a hopper, mixer, vibration table design to test the bricks produced [11]. In 2017, Amin Al-Fakih and friends conducted a study by testing a compressive test of the interlocking brick system [12]. In 2018, P. Manoj Kumar and friends conducted a study by making an automatic brick making a machine that was driven by using a screw conveyor [13].

The research mentioned above only pays attention to the products produced by machines in the form of bricks, without regard to the structural strength of the machines that produce these bricks. Therefore, the author intends to carry out a study analyzing the strength of the IBS brick molding machine.

II. BASIC CONCEPT

Interlocking bricks (IBS) are an alternative to conventional bricks. This interlocking brick is made without using combustion and using raw materials: red earth, sand, cement, water mixed with a ratio of 3: 2: 1 [14].

Interlocking bricks are printed using a brick molding machine that uses pneumatic as a prepress. While printing is done using a mold. The design and machine can be seen in Figure 1 and Figure 2.

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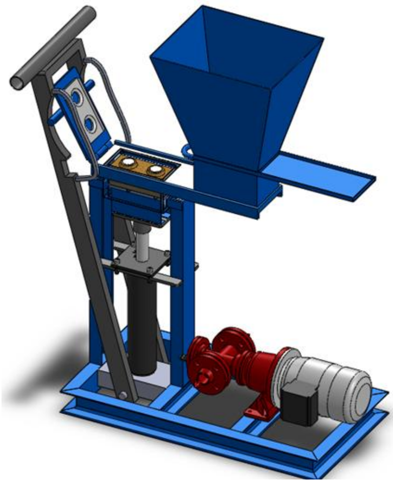

Fig. 1 Mold Machine Design [14]

Fig. 2 Mold Machine [14]

III. METHODE

The method used in this study uses the analysis method. In this research, the analysis carried out using the finite element method. The simulation of the finite element method is carried out using finite element software. Not all machine components are analyzed, and only a few are analyzed. This is done because not all components receive a repetitive burden.

The component of the tool that receives repetitive loads is the mold part which can be seen in Figure 3.

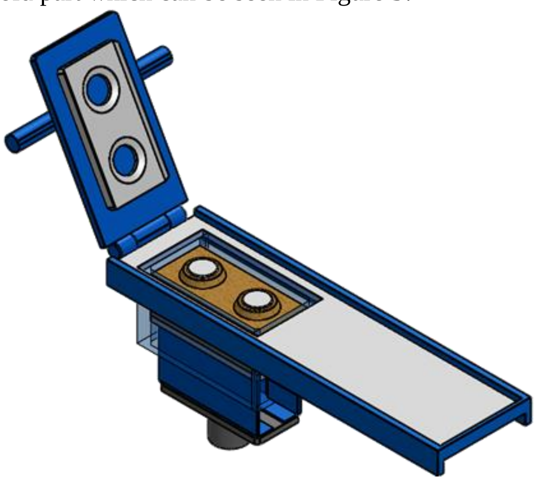

Fig. 3 Analyzed Molding section

The loading position follows the position on the design ie on the pneumatic arm which is assembled with a press block component. Thus, the press block component can represent the loading location.

The loading was simulated at 100 bars (10 MPa) through the holder on the mold. The model for loading support can be seen in Figure 4.

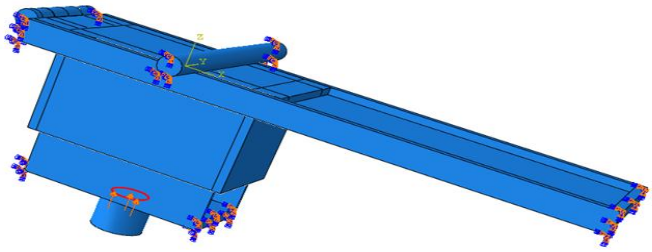

Fig. 4 Loading Support

The load on the tool is carried pneumatically to the mold component. The location of the imposition on the tool can be seen in Figure 5.

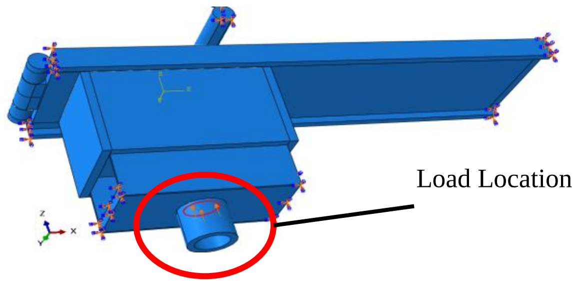

Fig. 5 Loading Location

IV. RESULT AND DISCUSSION

The loading analysis of the molding machine is simulated using Finite Element software application. The magnitude of stress that occurs in the molding machine varies between 3.095 kPa (Mold Component) – 86.76 MPa (Top Cover). Overall, the stress that occurs in the molding machine can be seen in Figure 6

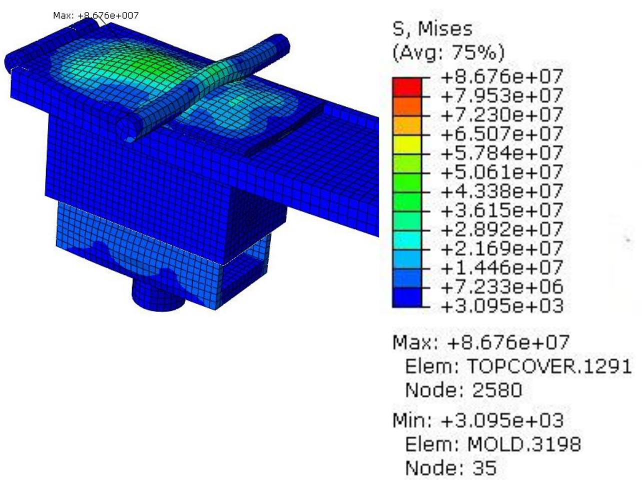

Fig. 6 stress distribution on the molding section

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This molding machine simulated using AISI 1010 material and 10 MPa of the load.

In the mold component, the stress that occurs is in the range of 3.095 kPa – 27.81 MPa as shown in Figure 7.

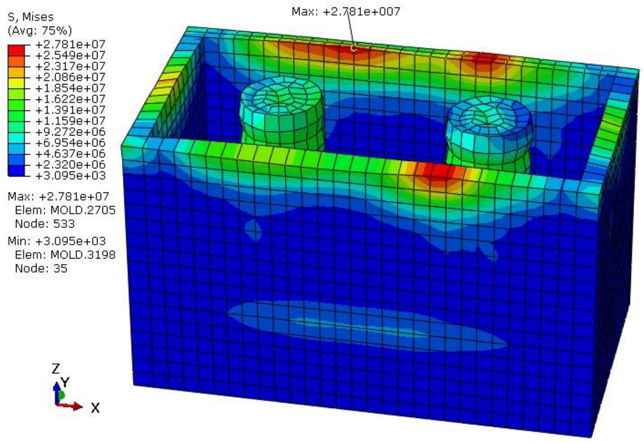

Fig. 7 stress distribution on mold

In the press block component, the stress that occurs is in the range of 299.2 kPa – 29.5 MPa as shown in Figure 8.

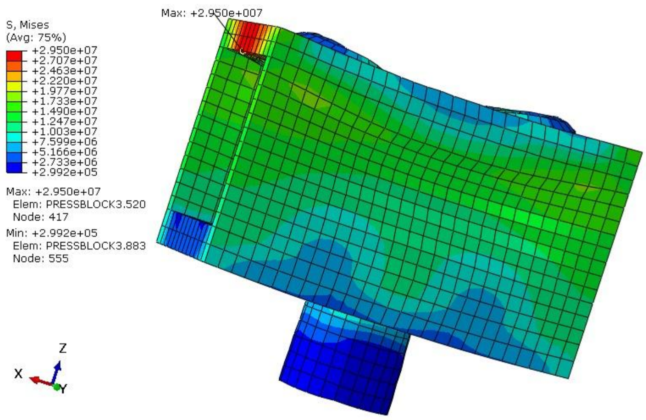

Fig. 8 stress distribution on press block

Component table, the stress that occurs is in the range of 4.817 kPa – 7.6 MPa as shown in Figure 9.

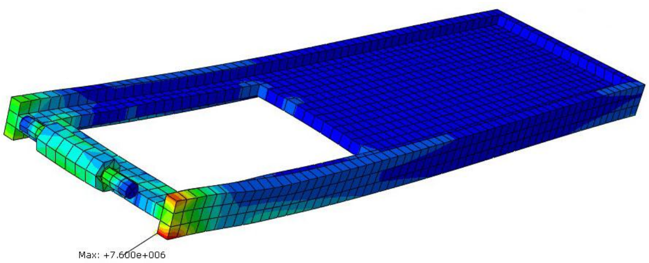

Fig. 9 stress distribution on the table

At the top cover, the stress that occurs is in the range 157.5 kPa – 86.76 MPa.

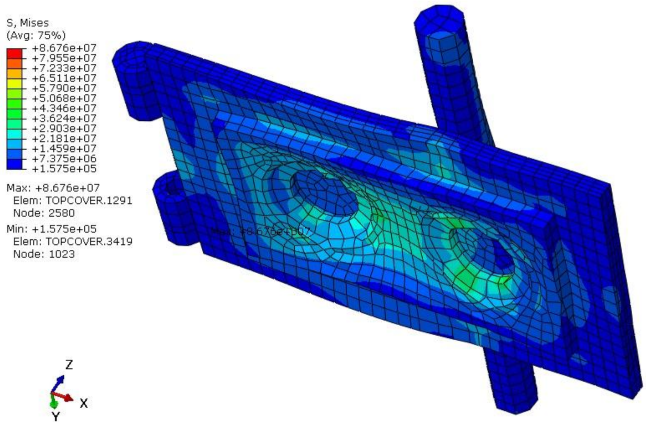

Fig. 10 stress distribution on the top cover

The top cover is the component with the greatest stress. For this reason, the analysis is carried out on the component that gets the maximum stress.

The maximum stress that occurs on the top cover occurs in the 1291st element or in the 1023rd nodal as shown in Figure 11.

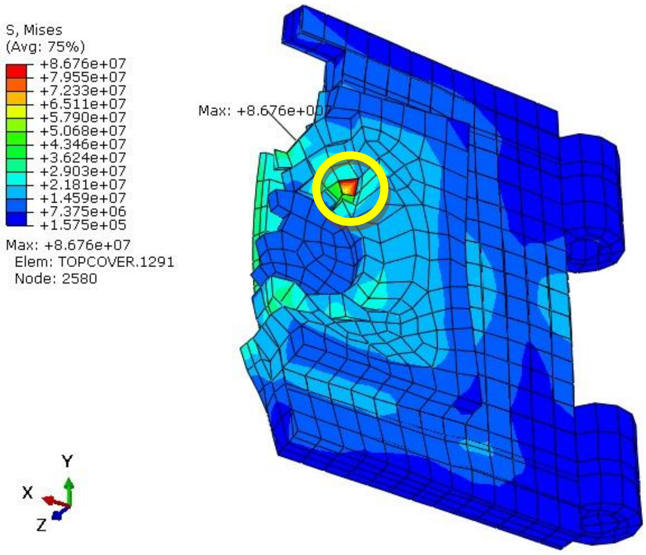

Fig. 11 highest stress location in 1291st element or in 1023rd element of the top cover

Overall stress results in the components of the IBS molding machine can be shown in table 1.

Table 1. Minimum & Maximum Stress that occurs in components of IBS mold machine

Components	Min Stress (kPa)	Max Stress (MPa)
Mold	3.095	27.81
Press Block	299.2	29.5
Table	4.817	7.6
Top Cover	157.5	86.76

The analysis is carried out on several elements around the hole where the maximum stress occurs as shown in Figure 12.

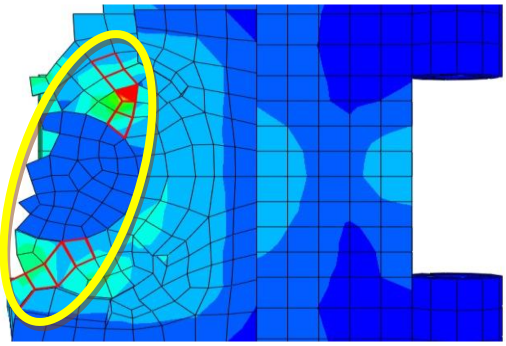

Fig. 12 analyzed area around the hole of the top cover

The amount of stress around the mold hole varies according to the distance to the center of the circle of the hole as shown in Figure 13.

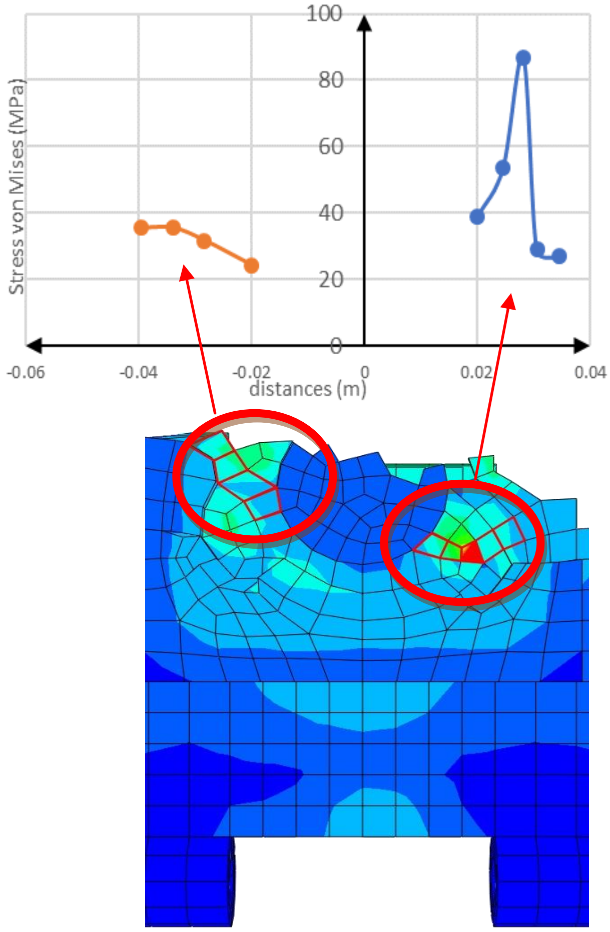

Fig. 13 stress – distance curve on the top cover

The highest stress that occurs on the molding machine is 86.76 MPa on the top cover. The yield strength of AISI material is 305 MPa [15]. If the occurring stress is compared to the yield strength of the material, the highest stress is still below the yield strength. This means that the molding machine can be safely used for 100 bars of pneumatic pressure.

V. CONCLUSION

The simulation results of the molding machine of IBS on the finite element application tell us that all components of the IBS molding machine can operate safely until 100 bars of static pressure load (10 MPa).

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