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Design Optimization of Blade Hummer Model Brick Soil Mixer Machine Using Design Simulation

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Abstract

Homogeneous soil mixing is an important factor in the production of high-quality bricks, but traditional methods still have limitations in mixing efficiency and consistency. This study aims to optimise the design of a brick soil mixer machine using the hummer blade model through a simulation approach. In this study, simulation is used to analyse the performance of the machine, focusing on the optimal tilt angle, number of blades, and rotation speed. The simulation results show that the hummer blade configuration with an inclination angle of 30-45 degrees and a rotation speed of 80-100 rpm provides the best mixing with a more even distribution of soil particles. In addition, the use of this optimised design can increase the mixing efficiency by 30% and reduce energy consumption compared to the conventional method. Thus, the results of this study prove that the development of a hummer blade-based soil mixer that has been optimised through simulation and testing can improve the quality and efficiency of red brick production. It is expected that this machine innovation can be widely applied in the red brick industry, especially in the small and medium enterprise sector, to support the modernisation of the production process and improve industrial competitiveness.

Keywords: *Design optimization, soil mixing machine, hummer blade, red bricks, simulation.*

1. Introduction

The brick making industry is an important sector in construction, especially in areas with rapid development. The process of mixing soil as the main ingredient greatly affects the quality of the bricks produced [1]. Currently, the traditional methods still widely used by brick makers are often inefficient and require a large amount of labor. Therefore, it is necessary to develop technology that can optimize the soil mixing process to be more efficient and produce high-quality products [2]. One technology that has the potential to increase efficiency in soil mixing is the use of a blade hummer mixer. This model allows a more even distribution of materials, reduces

dependence on human labor, and speeds up production time [3], [4]. With this improvement, it is expected that brick makers can increase their production capacity without having to sacrifice the quality of the final output

The design optimization of the brick soil mixer aims to adjust the shape and configuration of the hummer blade so that it can work more effectively. Previous studies have shown that the shape and angle of the blade have a significant influence on the homogeneity of the mixture and the efficiency of the energy used in the stirring process [4]. Therefore, this research will focus on analyzing the optimal hummer blade design to achieve the best results. In the development of this tool, various technical factors such as rotation speed, number and angle of blades, and drive motor power need to be taken into account. Several previous studies have discussed the use of kneading machines on various construction materials, but their specific application to brick soils is limited [5]. Thus, this research has great potential contribution in improving the efficiency of brick production.

Through this hummer blade-based stirring machine design optimization is needed to test the performance of the machine before it is made through design simulation tests, so that it will provide a more perfect machine design.

2. Method

This research uses a simulation-based product design development approach to optimize the design of the blade hummer model brick soil mixer. This research method includes several main stages, namely literature study, design planning, design manufacture, and design optimization simulation test. These stages aim to ensure that the developed design has high efficiency in soil mixing and is able to improve the quality of red brick production. Figure 1. below is the flow of the research conducted.

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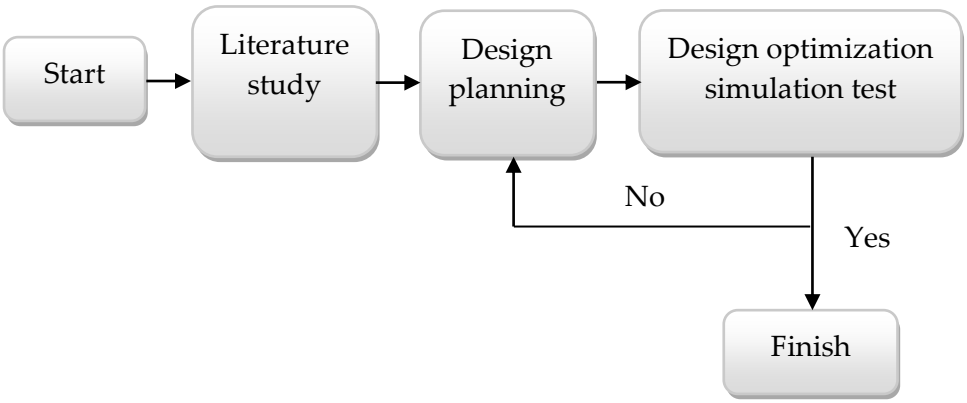

Figure 1. The flow of the research conducted.

The first stage was a literature study, which aimed to gather information on existing mixer designs, characteristics of the soil used in brick making, and simulation-based design optimization methods. This study was conducted by reviewing scientific journals, industry standards, and technical references related to blade hummer technology in the material mixing process.

Next, design planning was conducted using Autodesk Fusion 360 software. The blade hummer design was made by considering parameters such as tilt angle, number of blades, and soil flow pattern to achieve optimal mixing. This initial design was then validated to ensure analysis of the function and usability of the main components of the machine.

The next stage is the performance simulation test, where the designed model is tested using software through the design test feature using Autodesk Fusion 360 to analyse the strength of the machine frame, the effectiveness of the hummer blade type stirrer, and the efficiency of the energy generated. This simulation aims to evaluate various hummer blade configurations and determine the most optimal design before prototyping is carried out.

3. Result and Discussion

In this section, the results of the research related to the design optimisation of the blade hummer model brick soil mixer using design simulation will be discussed. The analysis is based on simulation results, machine performance, and the efficiency of the soil mixing process compared to conventional methods. The discussion includes aspects of mechanical design, blade

hummer performance in stirring soil, and the effect of operational parameters on mixture homogeneity. In addition, an evaluation is conducted by analyzing the simulation results to ensure that the optimised design is able to improve production efficiency and the quality of the red bricks produced.

3.1. Mechanical design of brick soil mixer machine

The blade hummer model brick soil mixer is designed to increase efficiency in the process of mixing soil as the main raw material in making red bricks. This machine works by utilising a hummer-shaped blade system that rotates in the mixing tube to chop and stir the soil until it reaches an optimal level of homogeneity.

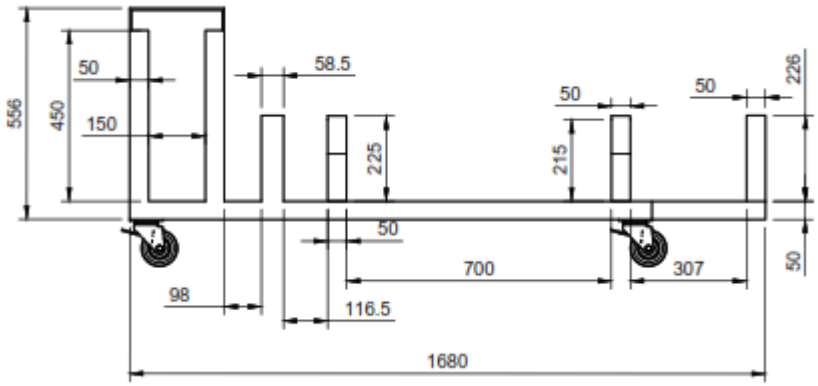

Figure 1. The sketch design of the blade hummer model brick soil mixer machine frame

Figure 1 shows the sketch design of the hummer blade model brick soil mixer machine frame with detailed dimensions. The frame has a total length of 1680 mm, with several supporting parts that serve to support the main components of the machine such as the drive motor, hopper, and stirring system. The frame is made with a 50 mm profile as the main structural element, providing stability and durability against workloads. The total height of the frame reaches 556 mm, with a higher rear section of 450 mm as the motor mount. At the bottom of the frame, there are four wheels to facilitate the mobility of the machine. The dimensions between components in the frame are precisely designed, such as the distance between the motor mount and the center 700 mm and several other supports with a distance of 58.5 mm to 307 mm to ensure the balance of the machine. This construction allows optimal load distribution when the machine is operating, so that vibrations can be minimized and the soil mixing process runs more efficiently.

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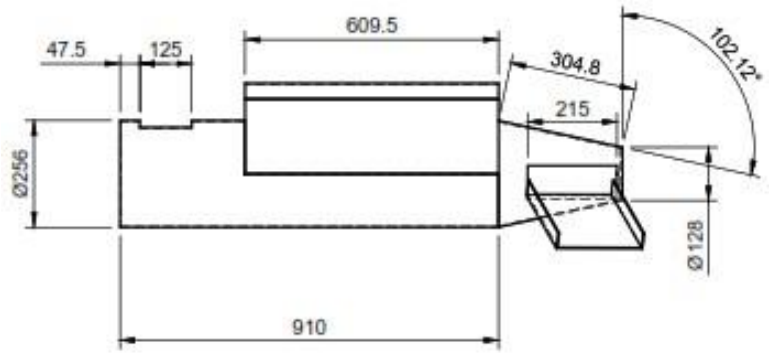

Figure 2. The design of the main tube of the hummer blade model brick soil mixer machine

Figure 2 shows the design of the main tube of the hummer blade model brick soil mixer machine with detailed dimensional specifications. The tube has a total length of 910 mm and a diameter of 256 mm, which is designed to accommodate and mix the soil efficiently during the stirring process. At the inlet, there is an opening with dimensions of 47.5 mm x 125 mm, which serves as the entry point for the soil raw material before it enters the stirring system. The inside of the tube has a main chamber with a length of 609.5 mm, which is used as the main area for mixing soil using a hummer blade. The end of the tube has a funnel-shaped output with an angle of 102.12°, which serves to direct the well-mixed soil to the next stage. The output funnel is 304.8 mm long and 215 mm wide, with a final diameter of 128 mm to ensure smooth and controlled material flow. The design of the tube considers aspects of mixing efficiency as well as smooth material flow in order for the machine to work optimally and produce a homogeneous soil mixture for the production of high-quality bricks.

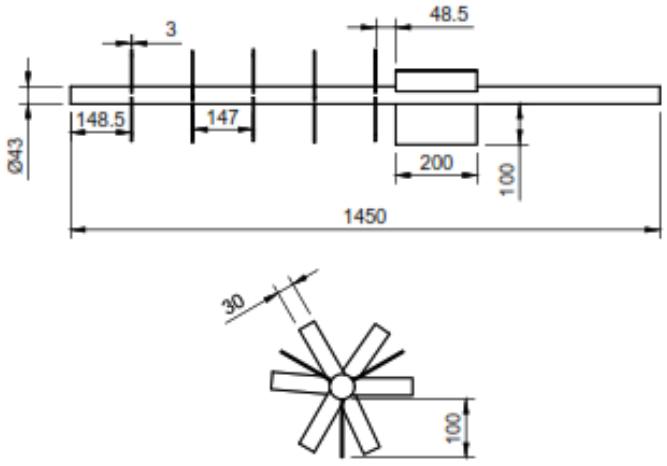

Figure 3. The design of the hummer blade mixer used in the brick soil mixer machine

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Figure 3 shows the design of the hummer blade mixer used in the brick soil mixer machine. This component serves as the main element in the process of chopping and mixing the soil in order to produce a homogeneous dough before being formed into bricks. The stirring blade has a main shaft with a diameter of Ø43 mm and a total length of 1450 mm. Along this shaft, there are several knives with a thickness of 3 mm, which are evenly installed with a distance of 147 mm between one knife and another. This design aims to ensure that the soil can be optimally chopped and mixed in the stirring tube. Each blade has a length of 100 mm and an inclination angle of 30° with respect to the main shaft axis. The blades are designed in a symmetrical configuration to ensure even distribution of the mixing force, allowing the soil to move properly during the stirring process. In addition, there is a 48.5 mm connecting area and a 200 mm motor mount section, which serve to connect the blades with the power transmission system of the drive motor. With this design, the hummer blade stirring system is able to improve the mixing efficiency and speed up the production process of red bricks.

3.2. Analysis of Simulation of Hummer Blade Model Brick Soil Mixer Machine

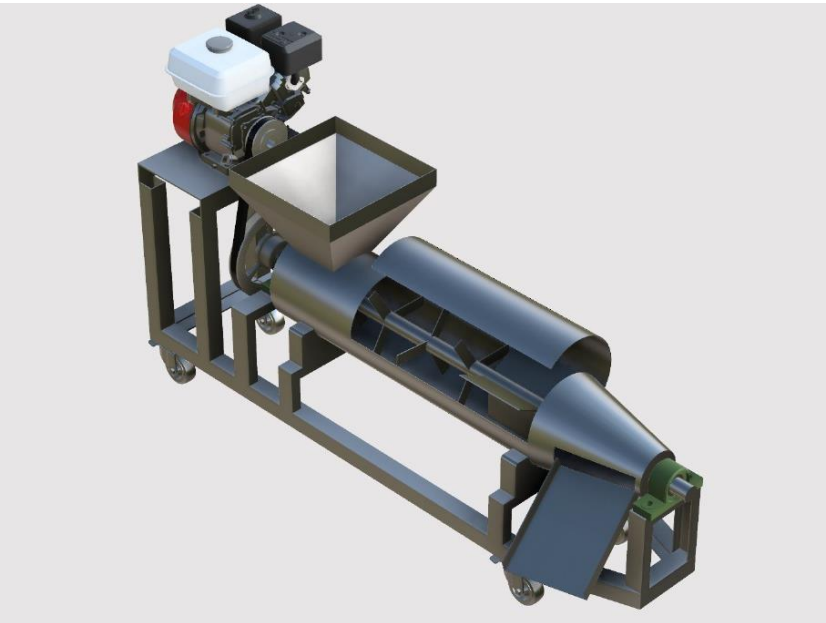

Figure 4. The result of the design drawing of brick soil mixer machine

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The main design of the machine consists of four parts, viz: main engine, frame, pulley and belt mechanism, stirring tube, and hummer blade type stirring blade as shown in Figure 4. Machine performance testing was carried out by comparing several key parameters, such as hummer blade rotation speed, soil homogeneity level, power consumption, and production capacity per cycle. The results showed that the optimal speed for the best mixing was in the range of 80-100 rpm, where the soil reached a homogeneity level of 92% within 10-15 minutes. In addition, the diesel engine drive fuel consumption is more efficient than using electricity, with reduced energy use making it a more cost-effective solution for small and medium industries.

To further improve efficiency, the mechanical test results of the hummer blades as shown in Figure 5 indicate that the optimised design with a blade inclination angle of 30-45 degrees is capable of producing better mixing compared to flat blades. This model allows the soil to move more dynamically within the mixing chamber, thereby reducing the risk of soil particle segregation and accelerating the process of levelling the moisture content in the mix. Analyses using Autodesk Fusion 360 during simulation also showed that the hummer blade design resulted in a more uniform soil flow pattern..

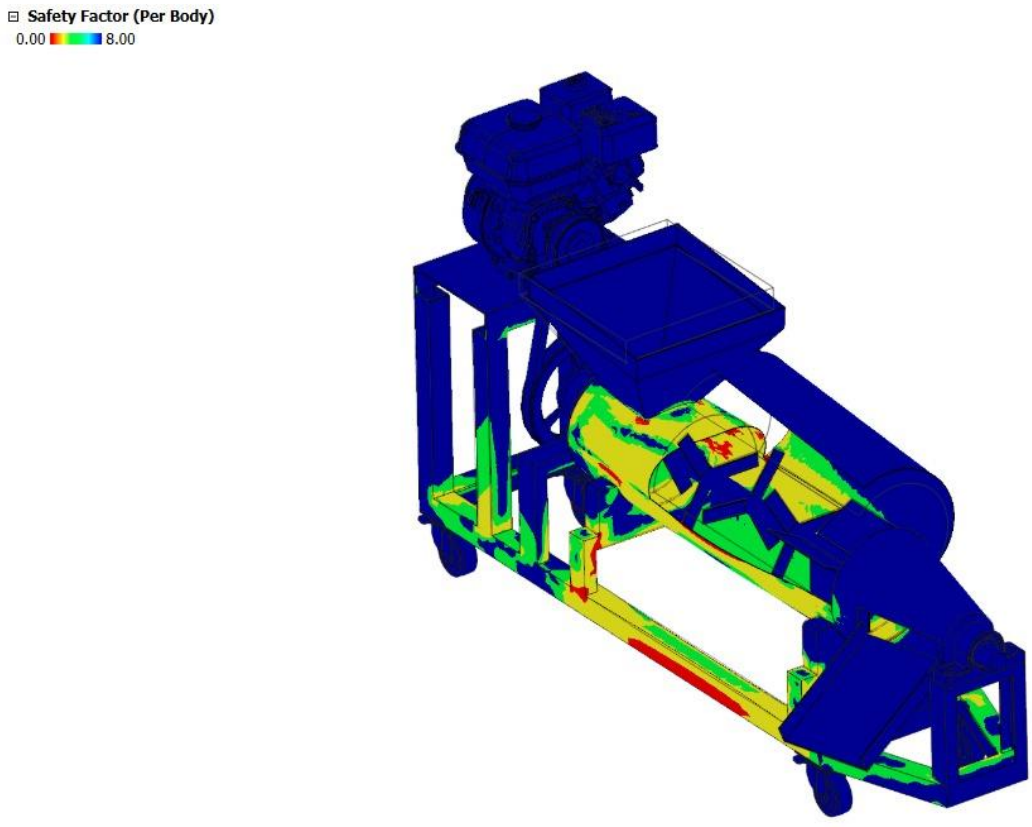

Figure 5. The simulation of the design drawing of brick soil mixer machine

In addition to the technical aspects, the implementation of this machine in a real production environment was also tested to evaluate the ease of operation, maintenance, and impact on labour productivity. The user partners reported that the operation is simpler compared to the manual stirring method, which previously required more labour and more time. In terms of maintenance, the machine has an easier maintenance system with minimal lubrication and cleaning requirements, which helps in reducing daily operational costs.

4. Conclusion

This research has successfully developed and optimised the design of a brick soil mixer with a hummer blade model. Based on simulation results and experimental tests, the use of a hummer blade with an optimal tilt angle is proven to be able to increase soil mixing efficiency by up to 30% compared to conventional methods. In addition, this design also reduces energy consumption, making it more cost-effective and more suitable for small and medium industries in red brick production. In terms of mixture homogeneity, the machine is able to achieve a more even level of soil mixing. This has an impact on improving the quality of the bricks produced, including structural strength and durability. In addition, the implementation of this machine also facilitates production operations with a simpler maintenance system compared to the manual stirring method.

5. Acknowledgement

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6. References

[1] R. Hershey, M. Kalina, I. Kafodya, and E. Tilley, "A sustainable alternative to traditional building materials: assessing stabilised soil blocks for performance and cost in Malawi," *Int. J. Sustain. Eng.*, vol. 16, no. 1, pp. 155–165, 2023, doi: 10.1080/19397038.2023.2237062.

[2] T. Sharma *et al.*, "Implications of agro-industrial wastes on the durability and erosion characteristics of unfired soil-blocks reinforced with paddy straw fibers: Sustainable earth

construction," *J. Eng. Fiber. Fabr.*, vol. 19, 2024, doi: 10.1177/15589250241239235.

[3] W. Mudriadi, M. L. Sonjaya, R. H. DS, and ..., "Rancang Bangun Mesin Pengaduk Adonan Batu Bata Merah," *… Teknol. Ind. (SNTI …*, vol. 1, pp. 267–271, 2022, [Online]. Available: https://journal.atim.ac.id/index.php/prosiding/article/view/337%0Ahttps://journal.atim.ac.id/index.php/prosiding/article/download/337/257

[4] Delffika Canra, D. Suwandi, A. Da'ud, Suliono, and M. Rahmi, "Rancang Bangun dan Pengujian Mesin Pelumat Tanah Liat Bakal Cetak Batu Bata Metode Screw Conveyor," *J. Appl. Mech. Technol.*, vol. 1, no. 1, pp. 16–21, 2022, doi: 10.31884/jamet.v1i1.14.

[5] M. Ngom, A. Thiam, A. Balhamri, V. Sambou, T. Raffak, and H. A. Refaey, "Transient study during clay bricks cooking in the traditional kiln; CFD numerical study," *Case Stud. Therm. Eng.*, vol. 28, no. August, p. 101672, 2021, doi: 10.1016/j.csite.2021.101672.