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Effect of Ballast Mass Variation on A 2-Stage Type Sand Sieving Machine

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***Abstract*—The sand sieving machine is designed with the aim of separating the grain size from the sand that will be used in the manufacture of building material mix. The sieve is used in 2 sizes by arranging in layers. This study aims to analyze the effect of the variation of the ballast mass on the resulting vibration. The masses of the ballast tested were 480 grams, 740 grams, and 980 grams.The focus of the study is on the effect of the use of ballast with these three variations on acceleration and displacement to find the vibration frequency value. The second focus is on the influence of engine rotation which is set with the same RPM but when a ballast is installed, it will experience a change in the weight of each ballast. Data collection was carried out by preparing a double-decker sand sifting machine and testing its movement first before adding a ballast. The data recorded was in the form of the initial rotation of the motorcycle, then a 480-gram ballast was installed, the rotation of the motorcycle after adding the ballast was recorded from the tachometer and acceleracy and the displacement was recorded from the vibration tester meter. The data obtained were analyzed to determine the correlation between the mass of the ballast and vibration, as well as to evaluate how the change in the rotational speed of the machine affects the performance of the sand sieving machine with different ballast masses. The results show that the mass of the ballast has a significant impact on the vibration characteristics of the machine. The larger mass of the ballast tends to produce vibrations of higher intensity, which can affect the efficiency of the sand filtration process. In addition, variations in engine rotation also affect engine performance, with different ballast weights showing different responses to changes in rotation speed. These findings provide important insights for optimizing the design and operation of sand sieving machines, in order to improve efficiency and effectiveness in the separation of granular materials.**

Keywords— ***san sieving machine; ballast; experiment; vibration***.

I. INTRODUCTION

Sand is a material that is really needed in the process making buildings and houses. Sand is used as one of the main materials in building construction. Sand particles usually has a size between 0.0625 mm to 5 mm. an efficient sand sieving machine is needed. By using the vibration method on the sand sieving machine, it is hoped that it can increase work efficiency and speed up the process sand sifting.

Several studies on the development of sand sieving equipment prototypes have been conducted. Among them is a sand sieving machine that uses an electric drive motor. The belt pulley transmission system is used to reduce the motor's rotation, and then the eccentric drive shaft is used to rotate the crank and move the pusher rod, allowing the sieve to move translationally.

Another study uses a drive system from a 350W Brushlesss Direct Current electric motor as the drive motor. Brushless Direct Current Motor is used because it has the advantage of large starting torque, higher speed because it does not use brushes. As a source of electricity, new renewable energy is used, Solar Panels with a capacity of 400Wp which are more environmentally friendly and efficient. This machine works when the solar panel supplies the power source to the drive motor and then it is transmitted by the chain and gear to the sieve tube for the sieving process. This machine is faster in the sand sifting process than manual sifting and the type of motor used is more efficient. [2]

Apart from the alternative design and energy source of the belt pulley transmission system and solar panels, the sieving capacity has been studied from the density of the sand which produces the efficiency of the equipment from sifting dry, semi-wet and wet sand [5]

This study was conducted by comparing the effects using the variation of the ballast mass: efficiency and capacity requirements of the machine sand sieves and the magnitude of vibration that occurs in the sand sieving machine.

II. METHOD

The method used in this study is an experimental method.

1. Create a machine design using Autocad.

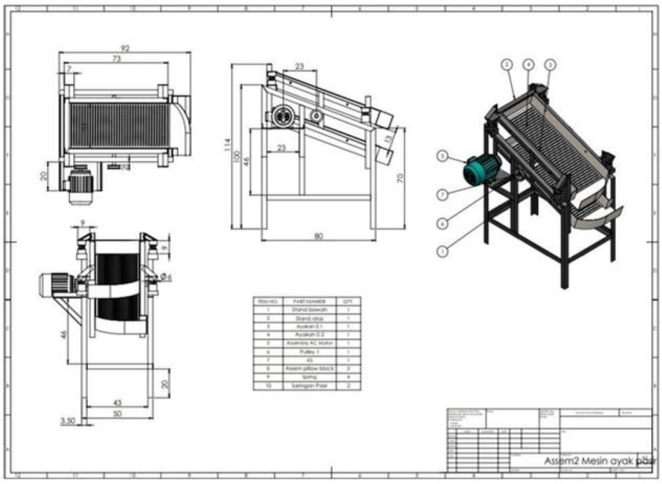


Figure 1. Desain of Sieving Machine 2-stage

2. Selection of materials
3. The manufacture of components are carried out. In this part, ballast massa is also made with weights of 480 grams, 740 grams and 980 grams.
4. The next stage is the assembly of the machine.
5. The machine is simulated with a variation of ballasts.
6. The data taken are the sieving time, and the magnitude of the vibration frequency of the machine from the use of each ballast mass.

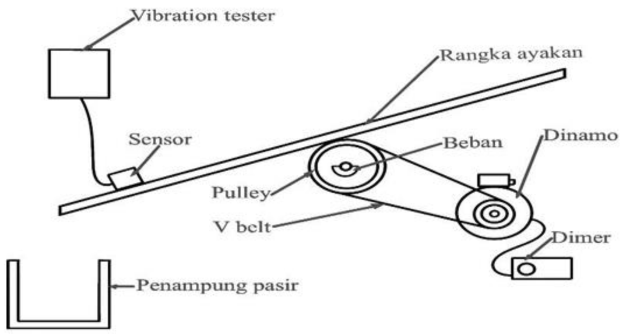


Figure 2. stage sand sieving machine working cycle

To analyze the vibration that occurs in each change of ballast mass, it must first be understood the D'alembert Principle. An alternative approach to getting an equation is the use of the D'Alembert Principle which states that A system can be created in a state of dynamic equilibrium by adding a fictitious force to the external forces that It is usually known as the inertial force.

Motion equations;
$m\ddot{x} + kx = 0$

Example:

$x = A\,\sin\omega t + B\cos\omega t$ (displacement)

$\dot{x} = A\omega\cos\omega t - B\omega\sin\omega t$ (velocity)

$\ddot{x} = -A\omega^2\sin\omega t - B\cos\omega^2 t$ (acceleracy)

$$\frac{\ddot{x}}{x} = \frac{-A\omega^{\wedge}2\ \sin\ \llbracket \omega t - B\cos\omega^{\wedge}2\,t \rrbracket}{A\,\sin\omega t + B\cos\ \llbracket \omega t \rrbracket}$$

$$\frac{\ddot{x}}{x} = -\omega^2$$

$$\omega = \sqrt{\frac{\ddot{x}}{x}}$$

ω = natural frequency (rad/s)

$f = \omega\ x\ 2\pi$ (natural frequency in Hertz)

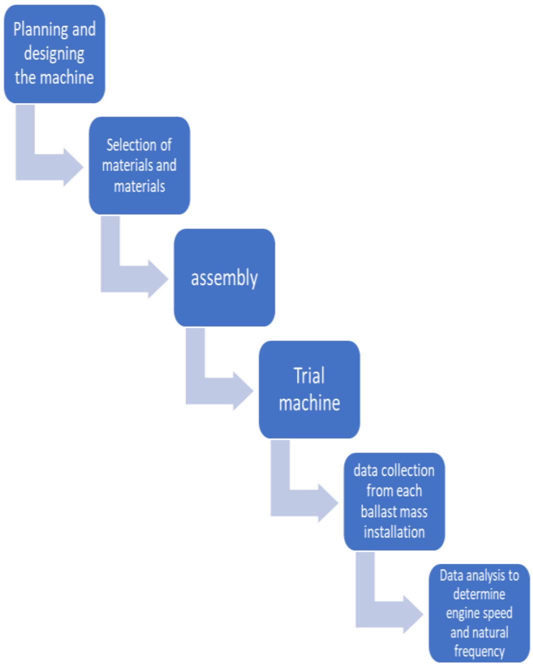


Figure 3. Research Steps

III. RESULTS AND DISCUSSION

Engine Rotation

Engine rotation.Engine rotation is measured using a tachometer. By changing the mass of the ballast, it can be seen that the difference in the engine rotation response produced.

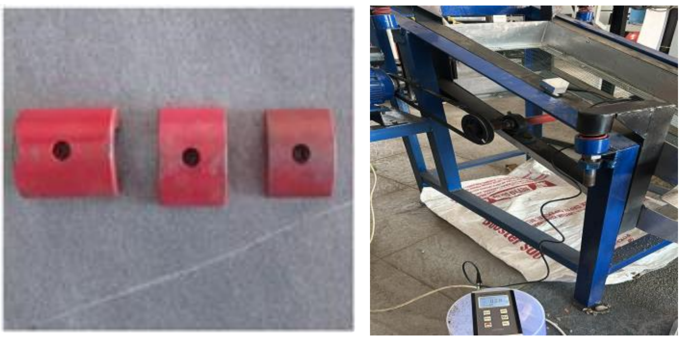


Figure 4. Mass ballast and sand sieving machine

The amount of rotation produced at each variation of the ballast mass is carried out in a duration of 15 minutes

TABLE I TABLE OF THE RESPONSE OF THE ROTATION THE ENGINE TO THE CHANGE IN BALLAST MASS

Based on the above data, it can be concluded that the

Timer (s)	Rotation on Ballast 480 gram (Rpm)	Rotation on Ballast 740 gram (Rpm)	Rotation on Ballast 980 gram (Rpm)
0-15	1772	1516	1095
16-30	1100	1105	1098
31-45	1096	1087	1100
46-60	1032	1084	1772

engine rotation with the weight of 980 grams causes the engine to spin slower (rpm low). As a result, the sand sifting process takes more time long to finish.

Effect of engine rotation change from the use of various ballast mass weights of 480 grams, 740 grams, and 980 grams on sand sieving machine tools on its time can be concluded that the greater the mass weight of the ballast, the slower the rotation of the machine, which resulting in a longer sifting time. Mass weight options the ballast must consider the need for time efficiency and capacity sand sieving machine.

Productivity

In testing the productivity of the sand sieving machine, the following formula is used:

$$productivity : \frac{M}{t}$$

Information: Productivity = sieving productivity (gr/s) M = mass of sifted sand (gr) T = time taken to sift (s)

TABLE II.

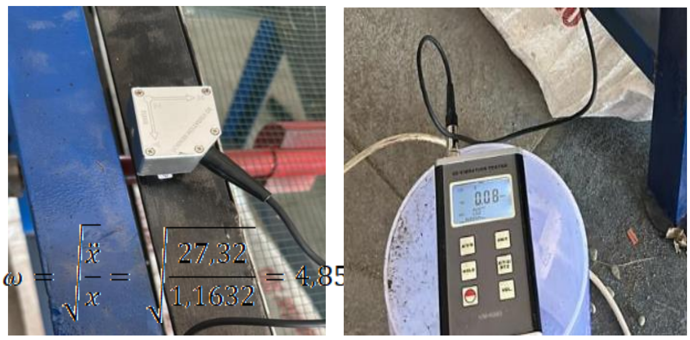
Ballast mass (gr)	Sand mass (gr)	Time (s)	Productivity (gr/s)
480	5000	28,87	173,19
740	5000	32,18	155,37
980	5000	40,76	122,66

It can be seen that productivity decreases along with increase in the mass of the ballast. A ballast with a mass of 480 grams has productivity highest (173.19 grams/second), while the ballast with a mass of 980 grams has the lowest productivity (122.66 grams/second). This is due to the fact that increase in the time it takes to produce the same output when use a heavier ballast. The use of ballasts with a mass that lighter will be more efficient in terms of the time it takes to produce sand sieve. Therefore, to achieve productivity that higher, ballasts with lighter masses can be used to keep efficient.

Vibration in sand sieving machine

Vibration data consisting of acceleration, displacement and velocity, were carried out five times and averaged at each ballast mass.

Example: mass of ballast 480 gram



$$\omega = \sqrt{\frac{\ddot{x}}{x}} = \sqrt{\frac{27,32}{1,1632}} = 4,85$$

$$fn = \frac{\omega}{2\pi} = \frac{4{,}85}{6{,}28} = 0{,}772\ Hz$$

Experiments were carried out five times and the natural frequency of each weighting mass was calculated. The whole can be presented in the table

Ballast mass (gr)	Acc (m/s^2)	Disp (mm)	$\omega(\frac{rad}{s})$	Fn (Hz)
480	27,32	1,1632	4,894	0,772
740	58,74	2,3362	5,014	0,798
980	55,66	1,5978	5,896	0,939

Vibration analysis through the acceleration and displacement data approach obtained from the vibration tester meter.

Ballast mass 980 grams has very strong vibrations due to the heavier weight mass. Vibration This more powerful one may be required for applications that require high vibration intensity, but it may affect the stability of the engine if not designed to handle large loads.

IV. CONCLUSIONS

Effect of engine rotation change from the use of various ballast mass weights of 480 grams, 740 grams, and 980 grams on sand sieving machine tools on its time can be concluded that the greater the mass weight of the ballast, the slower the rotation of the machine, which resulting in a longer sifting time. Mass weight options the ballast must consider the need for time efficiency and capacity sand sieving machine.

A ballast with a mass of 480 grams has productivity highest (173.19 grams/second), while the ballast with a mass of 980 grams has the lowest productivity (122.66 grams/second). The use of ballasts with a mass that lighter will be more efficient in terms of the time it takes to produce sand sieve

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The recommended optimal combination is the use of mass weight 480 grams. This approach ensures high productivity and time efficiency, while still maintaining the vibration strength of the enough for the sand sifting process.

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