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Motorcycle wheel rim press tool design

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Abstract
In motor vehicles, especially motorcycles, sometimes there are a lot of problems with the wheel rim in the event of an accident, or hit by a pothole that causes the wheel rim to be dented. In this case, we design a motorcycle wheel rim press tool as shown in Figure 2.1. The things that must be considered for a tool design in material selection are hardness, strength, fragility. The types of materials used are carbon steel, alloy steel, hollow steel, U iron, axle iron, angle iron, plate iron. In general, there are several grades of iron, including JIS G3101 SS400, ASTMA 36; BS 4360; DIN 17 100JIS G 3101; JIS 3106; SNI 07 2054, which has a different maximum tensile strength or stress by using formulas, for example the calculation of shafts, levers, weld strength and selection of hydraulic jacks. Supporting instruments in the process of working on the wheel rim press tool are machine tools and other measuring tools. To obtain truly satisfactory results from a tool, we are required to observe and look for alternatives and as carefully as possible in order to achieve a result that meets the standard. The tool must have high efficiency, easy to operate, and uphold work safety. Based on the results of the design and testing of the design of this motorcycle wheel rim press tool, it is more efficient, fast, and precise when compared to the tools owned by David Jaya Motor's workshop. The time required is faster according to the test results, which is between 25 minutes to 40 minutes with different wheel rim damage cases, while manually at the David Jaya Motor workshop, from observing field test results it takes a minimum of 90 minutes.

Keywords: Design, motorcycle, wheel rim, press tool

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1. Introduction

1.1. Research Background

Design is the engineering of a construction or structure that embodies the concept into goods or tools. The design activity of a construction must consider several criteria, namely easy, simple, easily available components on the market, economical, aesthetic and effective [1], in the advancement of science and technology, especially in the automotive sector, the world of higher education is increasingly demanded to further increase creativity, innovation. quality, superior and professional students. Due to the challenges of working in the automotive industry, which requires qualified human resources with technical skills specialization, productive practitioners. To answer these challenges, it is required to improve the quality of students both in theory and practice. In the automotive world which is widely used as transportation, one of them is motorbikes. In terms of the shape of the motorcycle, it consists of several parts besides the engine as the main power that can move the wheel rim through the transmission system.

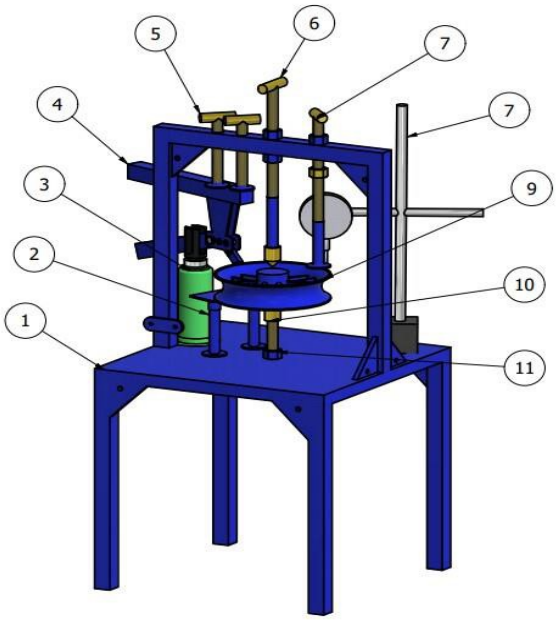
In motorized vehicles, especially motorcycles, sometimes there are lots of problems with the wheel rim if they have an accident, or get hit by a pothole that causes the wheel rim to be dented. The situation gets worse when using CW (casting wheel rim) type wheel rim with tubeless tires where the air inside the tires will come out through the dented or damaged wheel rim. Meanwhile, if you use tube tires with less severe damage, the vehicle can still be used but will usually feel wobbly or uncomfortable [2]. Several motorcycle repairs shops in East Denpasar City use a simple wheel rim press, and one of the workshops as a reference in the design of this wheel rim press is the David Jaya Motor workshop, which is located at Jalan Gatot Subroto Timur No. 173, East Denpasar.

2. Method dan Materials

2.1. Research Description

This research is divided into three parts, namely the design, analysis and design of a motorcycle wheel rim press tool. The form of the planned design is as shown in Figure 1. While Figure 2 is a reference for the shape and model of the wheel rim adjustment in this study. The picture is a wheel rim adjustment tool that is in the David Jaya Motor workshop located at Jalan Gatot Subroto Timur No. 173, East Denpasar, where the shape of the tool is very simple with the process of repairing motorcycle wheel rim here is still done manually, namely by being hit with a hammer and covered with wood and then heated using a blender fire (LPG and O_2) to change the shape of the dented wheel rim.

This method requires a lot of energy to hit the dented part of the wheel rim, but this method is less effective.



Descriptions:

1. Frame
2. Wheel rim mount
3. Hydraulic jack
4. Lever handle
5. Lever grip retainer
6. Handle upper wheel rim
7. Wheel rim holder
8. Dial gauge
9. Motorcycle wheel rim
10. Handle bottom wheel rim
11. Lock nut

Figure 1. Picture of the planned design [3]

Figure 2. Manual wheel rim adjustment

2.2 Materials

Machine building designs are generally made of metal or metal alloys such as steel, aluminium, cast iron, zinc, titanium or bronze. The properties of these materials are strength, elasticity and ductility to metals. Other material properties are usually determined from a tensile test in which a sample of material, usually circular or flat rods, is clamped between clamps and pulled gently until they break. The magnitude of the force on the bar and the change in length (strain) are monitored and recorded continuously throughout the test. Since the stress in the rod is equal to the force acting on the rod divided by the area, the stress is proportional to the force acting on the rod.[4]

In selecting materials, the things that must be considered for a tool design are:

1. **Hardness**, is the resistance of a material to indentation by a penetrator, which is an indication of its hardness. Several types of tools, procedures, and penetrators for measuring hardness are the Brinell hardness tester and the Rockwell hardness tester most commonly used for machine elements.
2. **Strength**, the ability of the material to withstand stress without damage. Or the ability of a material to accept a load, the greater the load that can be received by the material, the object can be said to have high strength.
3. **Brittleness**, refers to the nature of metal that is easy to crack or break when subjected to a blow to it.

Materials used to support other components in the design of a tool include carbon steel (Carbon steel), alloy steel (Alloy Steel), hollow steel, U iron, axle iron, angle iron, plate iron and in general there are several classes of iron, including JIS G3101 SS400, ASTMA 36; BS 4360 ; DIN 17 100JIS G 3101 ; JIS 3106 ;SNI 07 2054, which has different maximum tensile strength or stress, for example the standard St.42 strength = 41.41 N/mm^2 St.42 Hardening strength=21.86 N/mm^2 and St.42 Annealing strength= 16.89 N/mm^2 [5].

2.3. Types of Wheel Rims

The types of wheel rim that we usually encounter on the market are as follows [6]:

1. Spoke wheel rim. The spoke wheel rims on the motorbike are made of iron metal but the outside is re-coated with chrome so it is not easy to rust.

Figure 3. Spoke wheel rim

2. Cast Wheel rim (CW). This one wheel rim is more familiar with racing wheel rims. Cast Wheel rim (CW wheel rims) are also known to be practical, suitable for tubeless tires.

Figure 4. Cast wheel rim

3. Aluminum wheel rim, judging from the name of course, it can be ascertained that these wheel rims are made of aluminum, the weight is lighter than the two types of wheel rims above.

Figure 5. Aluminium wheel rim

2.4. Calculation

The thing that needs to be considered in a design is quality. To support the results of this design, the strength of each component is needed. Before carrying out the manufacture or production of the designed tool, the following calculations must be carried out: [4,5].

2.4.1. Lever Calculation

In the process of making this motorcycle wheel rim press tool, one of the most important things to calculate is [5].

$$WxLb = FxLk \quad (1)$$

Description:
W = Load (N)
F=Effort (N)
Lb = Load arm (m)
Lk = Effort arm (m)

2.4.2. Shaft

In this case the shaft is designed based solely on strength. If the shaft to be designed does not receive loads other than torsion, bending, tension, or pressure, for example if a belt, chain, or gear is attached to the shaft, then the possibility of additional loading needs to be taken into account in the factor of safety [4,5], calculation used in the design of the shaft is as follows.

Calculating plan power

$$Pd = P \text{ (kW)} \quad (2)$$

Description:
Pd = Plan power (Kw)
fc = Correction factor
P=Nominal power (Watt)

Calculating the torsional moment or torque on the shaft

$$T = 9.74\ x\ 10^5 Pd/n1 \quad (3)$$

Description:
T = Torsion moment (N x m)
Pd = Plan power (Kw)
n_1=Number of revolutions on the shaft (rpm)

Calculating the allowable shear stress

$$ra = rb/(Sf_1 x\ Sf_2) \quad (4)$$

Description:
rb= Tensile strength of shaft material (kg/$mm2$)
Sf_1 = 5.6 for ST type steel and 6.0 for S-C type steel
Sf_2=Influence factor (1,3 – 3,0)

Calculating shaft diameter

$$d_s = [\frac{5,1}{\tau a}\ \text{Kt . Cb .T}]^{1/3} \quad (5)$$

Description :
d_s = Shaft diameter (mm)
K_t= Torsional moment correction factor (1,0 – 1,5)
C_b = Correction factor due to bending load (1,2- 2,3)
τ_a = Allowable shear stress (kg/$mm2$)

Weld strength calculation

In another sense, welding is the joining of two similar or dissimilar metals by heating (melting) the metal below or above its melting point, with or without pressure and with or without filler metal [7].

Weld strength formula:

$$r = \frac{F}{0,7.A} X\sqrt{1 + [\frac{6.H}{L}]^2} \quad (6)$$

Description:
F = Effort (N)
r = Total tension (N/$mm2$)
H = Plate height (mm)
A = Cross-sectional area (A = 2.a.L)
a =Welding clamp
L = Welding length

2.4.3. Selection of hydraulic jack

This tool is made by applying Pascal's law. namely the laws of physics that relate to liquids and the forces acting on them. Pascal's law reads, "Pressure is applied to a liquid in a container will be transmitted in all directions and the same magnitude." This law is then applied to the workings of a hydraulic jack. This tool uses the force of water or fluid pressure to be able to lift heavy vehicle loads up to a matter of tons [8]

Pascal's law formulas:

$$P_1 = P_2$$
$$\frac{F1}{A1} = \frac{F2}{A2} \quad (7)$$

Descriptions:
F_1= Force 1 (N)
F_2 = Force 2 (N)
A_1= Cross-sectional area 1 ($M2$)
A_2= Cross-sectional area 2 ($M2$)

Figure 6. Hydraulic bottle jack

2.4.4. Heater

A pressing tool requires a heating device to help flex the dented part of the wheel rim. Gas torch as a heater for press wheel rim because this gas torch is very easy to use and very easy to get on the market, storage is also very easy. Gas torch is a handheld burner model that is used when doing

outdoor activities, such as lighters commonly used when camping, cooking, and welding, gas torches can reach temperatures of 1300 °C to 2000 °C [8].

Figure 7. Gas torch

3. Result and Discussion

3.1. Product

In realizing the design of this wheel rim press tool, supporting instruments are needed in the working process with the following equipment:

1. Machine Tools
   - Welding machine, used to join metal in the manufacture of frames.
   - Lathe, used to make shafts.
   - Sitting grinders, used for cutting materials such as metal for frames and shafts.
   - Hand grinders are used for cutting materials and smoothing welded parts.
   - Drilling machine, used to make holes in the frame as a housing for bearing locking bolts, electric motors on the frame.
2. Several types of measuring instruments such as callipers to measure the diameter of the shaft, steel ruler, which is used to measure length, right angles are used to determine the perpendicular of the object being measured as in the frame.
3. Compressor, used to spray compressed air in the painting process so that the painting can be evenly and efficiently.

3.2. Instruments

In this analysis, instruments or tools are needed that support the process of collecting analytical data with the preparation of materials to obtain analytical data on test results, namely:

- Dial gauge
  Dial gauge is used to measure the flatness of the wheel rim
- Steel ruler
  A steel ruler is used to measure the length and width, the overall height of the tool.
- Vernier callipers
  The calliper is used to measure the outer diameter and depth of the material.
- Measuring tools
  The measuring tool is used to measure the total dimensions of the motorcycle wheel rim press tool.
- Elbow
  The elbows are used to measure the angle and as a tool for assembling a motorcycle wheel rim press tool.

3.3. Wheel Rim Press Tool Design

The manufacture of this tool has taken into account several construction criteria, namely easy to manufacture, economical, aesthetic and efficient, so that the resulting motorcycle wheel rim press tool is as follows:

Figure 8. Motorcycle wheel rim press tool

Specification:

1. This tool can be used to adjust ring wheel rim 12 inches, 14 inches, 17 inches, 18 inches,
2. Jack strength 6 tons
3. Tool height 150 cm
4. Tool width 75 cm

This motorcycle wheel rim press tool uses a hydraulic bottle jack as a tool to press with the help of a lever. How to use this wheel rim press tool, first we put the wheel rim on the cone at the bottom then we lower the top cone to clamp the wheel rim, then we adjust the dial gauge, rotate the wheel rim until we find the bent part, if we already know the bent part we mark and put it right at the end of the lever, then we attach the support to the top of the wheel rim, then we attach the wheel rim mat to adjust to the height of the wheel rim, so that later when pressing the wheel rim it doesn't shake and must be precise. If the wheel rim is installed, we heat the part of the wheel rim that will be pressed using fire from the gas can just enough, after it is heated, we pump the jack slowly until it lifts the lever and the end of the lever presses the bent part of the wheel rim, until it finds flatness, if we remove the mat, we also remove the wheel rim and supports, then fit the dial gauge on the bent wheel rim, then turn them around until there are no more bends. In the process of making this motorcycle wheel rim press tool, it consists of several parts, namely:

3.3.1. Frame
This frame is made with hollow iron measuring 7 cm x 5 cm x 2 mm, for the legs it has a length of 75 cm while for the table it uses hollow iron with a size of 4 cm x 4 cm x mm with a length of 75 cm and the plate used has a thickness 6 mm, this frame is square

3.3.2. Wheel rim mount
This wheel rim holder is made with iron threads with a size of 1 inch with a height of 15 cm, and the plate is 35 cm x 15 cm, this wheel rim holder is made so that it can go up and down following the height of the wheel rim to be pressed.

3.3.3. Hydraulic jack
This hydraulic jack is able to withstand a load of 6 tons, this jack has a major role in the design of this tool, because this jack pushes the lever so that the tip of the lever presses the bent lip of the wheel rim.

3.3.4. Lever handle
The handle of this lever is made with iron 'U' which is added to the iron strip plate to make it square, with a thickness of 3 mm, because this section must use thick iron.

3.3.5. Lever grip retainer
This part is made to hold the lever handle when pressing so it doesn't shake, this tool has a length of 20 cm with a diameter of 1 inch.

3.3.6. Handle the upper wheel rim
The handle of this wheel rim is made of axle iron which is made of thread (thread) so that it can go up and down following the height of the wheel rim, this tool has a length of 45 cm and this tool is attached to a cone so that it can be stuck in the hole of the wheel rim.

3.3.7. Wheel rim holder
This wheel rim holder is also made of axle iron with a thread (thread) and has a length of 40 cm, this tool has the function of holding the pressed wheel rim part so that it does not move.

3.3.8. Dial gauge and wheel rim
This dial gauge has a function as a measuring tool for the bend of the wheel rim, this tool can be moved according to the part of the wheel rim that is bent. Wheel rims that can be repaired with this tool are 12-inch, 14-inch, 17-inch, 18-inch alloy wheel rims. The handle of this wheel rim is made of axle iron which is made of thread (thread) so that it can go up and down following the height of the wheel rim, this tool has a length of 30 cm and this tool is attached to a cone so that it can be stuck in the hole of the wheel rim. The nut used is made of steel, with an inner diameter of 1 inch, this nut has a function as a shaft lock while holding the wheel rim

3.4. Using the Tool
How to use the design of this motorcycle wheel rim press tool is as follow:

1. Install the wheel rim that will be pressed on the bottom cone then tighten the middle lever until the cone presses the wheel rim.
2. Then turn the wheel rim until you find the part of the wheel rim that is wobbly, if it is found, give a mark.
3. Place the pressed part of the wheel rim on the end of the pressing lever.
4. Install the support at the bottom and adjust the height.
5. Install the wheel rim holder on the side of the wheel rim
6. Heat the wheel rim to be pressed (bent).
7. When it is hot, pump the hydraulic jack lever to the end of the pressing lever and press the bent part of the wheel rim until it finds flatness.

3.5. Tool Testing
After the tool components have been assembled, then the tool testing is carried out to determine the capabilities of the designed tool. The test was carried out 3 times with different positions or parts of the wheel rims in each test. The following are the results of the tests that have been carried out. The test results on the motorcycle wheel rim press tool can be seen in the image below:

Figure 9. The First Trial Process

The first test was carried out specifically on the lip of the wheel rim which was bent inward. After being measured using a dial gauge, the bend of the wheel rims reaches 1.6 mm. Figure 9 shows some of the processes of repairing wheel rims with the designed tools. First we look for the rim that is bent using a dial gauge, if we find it, we install it on the tool and we adjust the position of the wheel rim then we heat it and pump it slowly until we find flatness and finally we check again with the dial gauge, until the dial gauge doesn't move. Cases like this using a tool that was made took 35 minutes.

The second test was carried out with the case of the bent wheel rim radius. After being measured using a dial gauge, the bend of the radius of the wheel rim reaches 0.8 mm. As Figure 10 shows some of the wheel rim repair processes with the designed tool, first we look for the bent wheel rim section using a dial gauge, if we find it we install it on the tool and we adjust the position of the wheel rim then we heat it up and pump it slowly until we find flatness, and lastly we check again with the dial gauge, until the dial gauge does not move. Cases like this using a tool that was made took 40 minutes.

Figure 10. The second trial process

The third test was carried out with the case of the lip of the wheel rim bent outward. After being measured using a dial gauge, the bend of the wheel rim reached 0.7 mm. Figure 11 shows some of the wheel repair processes with the designed tools. First we find the part of the wheel rim that is bent using a dial gauge, if we find it we install it on the tool and we adjust the position of the wheel then we heat it up and pump it slowly until we find flatness, and finally we check again with the dial gauge, until the dial gauge doesn't move. Cases like this using a tool that was made took 25 minutes.

Figure 11. The Third Trial Process

4. Conclusion

To obtain truly satisfactory results from a tool, we are required to observe and look for alternatives and as carefully as possible in order to achieve a result that meets the standard. The criteria for a good machine are to have high efficiency, easy to operate, and uphold work safety. From the results of the design and design testing, this motorcycle wheel rim press tool is more efficient, fast, precise and the time it takes is faster according to the test results, which is between 25 minutes to 40 minutes with different wheel damage cases compared to the other motorcycle wheel rim press tool in the David Jaya Motor workshop which is used manually and takes a minimum of 90 minutes.

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