Analysis of static characteristics of a motorcycle swing arm of a twin-shock suspension type using the finite element method

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Abstract. Motorbikes need a swing arm or swing arm to connect the rear wheel to the frame. Static loading is important in planning the main motorbike so that it can run safely. Swing Arm is the main structural part of a motorcycle chassis that serves to hold the rear wheels for driving and as a shock breaker support. The swing-arm is free to follow the road contours and vehicle loads as long as the motorbike moves. This study aims to determine the condition of the motorcycle swing arm static type twin-shock suspension. This type is chosen because it is most widely used by consumers. This research was carried out by making 3D models of swing arms made from carbon steel models. Analysis of static loading on the swing arm structure was simulated using software based on the finite element method so that the value of von stresses and displacement was obtained. The results of the analysis concluded that the swing arm has good characteristics because the maximum von mises voltage of 43.55 MPa is smaller than the total thickness of 350.0 MPa, and the maximum deformation is 0.003923 mm.

1. Introduction
The swing-arm functions as a retaining wheel and as a support for a shock breaker. In addition, the swing-arm also serves to reduce motor shocks as it passes through the hole. The type of swing arm on a motorcycle has two types including mono-shock and twins-hock types, While the twin-shock type is a suspension system that uses two shock breakers that are installed on both swing arm rods with a distance from the wheel as a pedestal axis [1].

The shape and location of the pedestal on each type of swing arm affects the vibration produced due to the uneven contour of the road surface and affects also the comfort and safety of the rider. The shape and conditions of different road surfaces make the vehicle's speed and comfort and safety for the driver a little disturbed. If the road conditions are uneven or damaged it will affect the excessive vibration on the swing-arm. Excessive vibration will result in the structure of the swing arm will experience pressure on the scattered plane and will experience changes in the structure displacement [1].

To determine the ability of the swing arm in accepting vehicle loads and passenger loads can be seen by looking at the results of the stress and changes in the maximum structure of the Finite Element method simulation results. In addition, other useful methods are provided [2,3]. Finite Element Method is a numerical method that is used to solve technical problems and mathematical problems of a phenomena phenomenon with the accuracy that can be received by the engineer. Types of technical and mathematical problems that can be solved by finite element methods
are divided into two groups, namely group analysis, and group structure non-structural problems. analysis of the strength of the swing arm structure can be done with this method, so that the specifications obtained according to needs [4].

The objectives of this study are as follows: Knowing the pressure acting on the swing arm structure, and knowing the deflection value of the standard and modified swing arm structure,

2. Methods
This research was carried out in a computer laboratory and design department of Mechanical Engineering at Musamus University. the method used is an experimental method (si, using a computer). The flow of research can be seen in the following figure.

| Information                | Data                          |
|----------------------------|-------------------------------|
| Material                   | Carbon steel SA-691           |
| Modulus                    | 2.0e+005 MPa                  |
| Rasio Paisson              | 0.29                          |
| Density                    | 7.87e-6 Kg/mm³                |
| Tensile Yield Strength     | 350.0 MPa                     |
| Tensile Ultimate Strength  | 420.0 MPa                     |

The force given is in the direction of vector Y according to the direction of loading. Input force of 2869 N.

| Load Type | Force  |
|-----------|--------|
| Magnitude | 2869 N |
| Vector X  | 0 N    |
| Vector Y  | 2869 N |
| Vector Z  | 0 N    |

3. Result and discussion
The material is said to start melting when Von Mises's stress reaches its critical value known as Yield Strength. Maximum Principal Stress which shows specifically the tensest part, red is the tensest part. Minimum Principal Stress that shows specifically the most relaxed part, yellow is the most relaxed part, Safety Factor that shows the safe part when given the style, the safest part is the Dark Blue, Safety factor (Fd or Sf must be worth above 1).

The load used is the maximum passenger load that is located on the swing-arm. Constraint uses the type of pin. As for the results of the force analysis in the constraint, the area is 2869 N. From the static analysis, the results of Von mises or Equivalent, Maximum and Minimum Principal stresses are obtained.
Figure 1. Von Mises Stress (Max: 43.55 MPa)

Figure 2. 1st Principal stress (Max: 35.8 MPa)

Figure 3. 3rd Principal stress (Max: -29.73 MPa)
Figure 4. Displacement (Max 0.003923 mm)

Figure 5. Safety Factor (Min 8.04 ul)
The stress convergence rate is the rate at which the stress direction causes a slip or deformation that has not been in the same direction when applied to a certain time duration the direction of the stress force will slowly be in the direction of the deformation or slip plane. The faster the direction, the greater the convergence rate.

4. Conclusion
From this study, it is concluded :
1. Maximum stress on the swing arm with the loading of 2869 N is 43.55 Mpa
2. Maximum deformation on the swing arm by loading 2869 N at 0.003923 mm
3. Minimum Safety factor 8.04, so that the swing arm is safe or able to accept force loads of 2869 N

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