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DESIGN OF REAR WHEEL DISC BRAKES YAMAHA R25 250 CC MOTORCYCLE 2015

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Abstract
Motorcycle is one of the two-wheeled vehicles that are often used and we encounter in everyday life. Motorcycles consist of various components and parts that have their respective functions. The engine elements of a motorcycle are designed in such a way as to suit the desired function.
Brake is a component or device used to slow down or stop the vehicle through friction. The design of brake components is carried out in order to obtain a design result that is in accordance with the function of the brake component which will later become a recommendation. Several factors in brake design are braking force, torque, braking power, wear volume, life time and materials.
From the calculation results obtained the value of braking force (Pv) of 87.5 kg, torque (MR) of 3128 kg.cm, volume of wear 6.75 cm³, service life of 140 hours and with Asbestos Passed Hidraulically and AISI 1045 materials.

Keywords: *Breaking force, Torque, Braking power, Wear volume, Materials*

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Introduction

The brake is a component or device that functions to stop the vehicle or slow down the rotation of the vehicle's wheels by means of friction. Brakes are a vital component in a vehicle that must be designed according to the capacity, capability or specifications of the motor and also the brakes are very important to be considered by a designer in terms of safety when the vehicle speed wants to be slowed or stopped.

Brakes are components that are used to slow down or stop the rate of movement of the engine by converting motion into heat and regulating the speed at which the load decreases. (Sonawan, 2015:142).

Broadly speaking, the working mechanism of the brakes is to stop the rotation of the vehicle's wheels through friction by converting motion energy into heat energy. In this study, the brake mechanism used is a disc brake.

In the braking mechanism, the disc brake parts can be seen in Figure 1

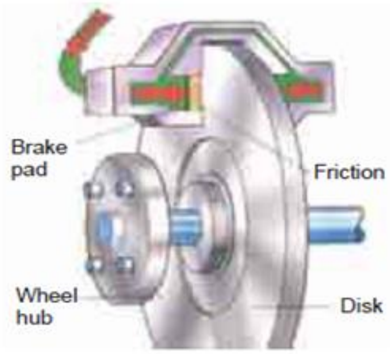

Figure 1. Disc brake parts

Disc brakes have advantages compared to other brakes that are commonly used on other motorcycles, so it is expected to function optimally on this sport model vehicle which has a higher speed than the duck and automatic motorcycles.

In addition to the type of brake, the material on the brake is also very important and has an effect on the type of motorcycle. the type of material is adjusted to the capacity of the motorcycle, the higher the speed of the motorcycle, the higher the ability of the brake material to withstand heat and friction.

In addition, the material used for brake linings must have the following characteristics:

1. Must have a high coefficient of friction with minimum fading. In other words, the coefficient of friction must remain constant across the surface with changes in temperature.
2. It should have low wear rate.
3. It must have high heat resistance.
4. Must have high heat dissipation capacity.
5. Must have a low coefficient of thermal expansion.
6. It must have adequate mechanical strength.
7. It should not be affected by moisture and oil.

The materials that are commonly or often used to coat a brake and their properties are shown in Figure 2

Table 29/2. Typical data for friction pairings (see also Figs. 29/8 to 29/12)
For Group I, $q_v = 0.125$ to 0.2 for dry running, ≈ 0.05 for oil lubricated (running against smooth surface); for Group III $q_v \approx 0.025$

Group	Friction pairing	Coefficient of friction μ dry	Coefficient of friction μ wet	ϑ_{zul} continous °C	ϑ_{zul} short °C	p kgf/cm²	Costs[1]
I	*Grey iron, cast steel or steel with:*						
	Phenolic plastic	0,25	0,1 ···0,15	100	150	0,5··· 7	//
	Cotton fabric with plastic	0,4 ···0,65	0,1 ···0,2	100	150	0,5···12	///
	Asbestos fabric with plastic	0,3 ···0,5	0,1 ···0,2	200	300	0,5···20	///
	Asbestos pressed hydraulically with plastic	0,2 ···0,35	0,1 ···0,15	250	500	0,5···80	///
	Metal fibre pressed with Buna	0,40···0,65	0,1 ···0,2	250	300	0,5···80	///
	Graphitic carbon/steel	0,25	0,05···0,1	300	550	0,5···20	////
II	*Grey iron, cast steel or steel with:*						
	Poplar wood	0,2 ···0,35	0,1 ···0,15	100	160	0,5···5	/
	Leather	0,3 ···0,6	0,12···0,15	100		0,5···3	/
	Cork	0,3 ···0,5	0,15···0,25	100		0,5···1	/
	Felt	0,22	0,18	140		0,3···7	/
	Vulkan fibre, paper	0,22	0,18	140		0,5···3	/
III[2]	Hard steel/hard steel or Sintered metal wet with oil film	$\mu_0 = 0{,}12 \cdots 0{,}17$	$\mu_G = 0{,}06 \cdots 0{,}11$	100		5···30	///
	Hard steel/hard steel or sintered metal with oil flow	$\mu_0 = 0{,}08 \cdots 0{,}12$	$\mu_G = 0{,}03 \cdots 0{,}06$	100		5···40	///
IV	Grey iron/steel	0,15···0,2	0,03···0,06	260		8···14	/
	Grey iron/grey iron	0,15···0,25	0,02···0,1	300		10···18	/
V[3,4]	Steel shots/grey iron or steel, graphited	0,4 ···0,5		350			//
	Steel balls/grey iron or steel, graphited	0,2 ···0,3		300			////

Figure 2. Brake friction material property table

To design and determine a brake component, a calculation process flow is carried out in order to obtain values and data that become the material for selecting the required brake components. The brake calculation flow used is as follows:

a. Braking time (tr)

$$tr = \frac{Vg}{bv} \qquad (1)$$

Note:

tr : Braking time(s)

Vg : Vehicle speed $(\frac{m}{s})$

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bv : Deceleration $(\frac{m}{s})$

b. Braking distance (Sr)

$$Sr = Vg\,.\frac{tr}{2} \qquad (2)$$

Note:
Sr : Braking distance (m)
Vg : Vehicle speed $(\frac{m}{s})$
tr : Braking time(s)

c. Braking force (Pv)

$$Pv = Gg\,.\frac{bv}{g} \qquad (3)$$

Note:
Pv : Braking force (kg)
Gg : Total vehicle weight (kg)
g : Acceleration of gravity $(\frac{m}{s^2})$
bv : Vehicle deceleration $(\frac{m}{s^2})$

d. Braking torque (MR)

$$MR = 1.1\ Pv\frac{D}{2} \qquad (4)$$

Note:
MR : Braking torque/friction (kg.cm)
Pv : Braking Force (kg)
D : Tire Diameter (cm)

e. Calculation of brake lining (pad) life
The service life of the brake pads depends on the volume of friction material wear (Vv), the average friction force (Nr) and the wear constant (qv). To determine the service life of the brake pads, the equation used is:

$$Am = \frac{1{,}1.Gg.Vg^2}{g.2} \qquad (5)$$

Note:
Am : Kinetic Energy (kg.m)
Gg : Total vehicle weight (kg)
Vg : the average speed of the vehicle $(\frac{m}{s})$
g : Acceleration of gravity $(\frac{m}{s^2})$

$$Nr = \frac{Am.z}{27.10^4} \qquad (6)$$

Note:

Nr : Average friction (HP)
Am : Kinetic Energy (kg.m)
Z : braking operation

$$Vv = F \, . \, Sv \qquad (7)$$

Note:
Vv : Volume of friction material wear (cm^2)
F : projected area (cm^2)
Sv : Wear limit (cm)

Where :

$$F = 0.9.d.b.8 \qquad (8)$$

Note:
d : average disc friction diameter (cm)
b : area of layer (cm)

$$Lb = \frac{Vv}{qv.Nr} \qquad (9)$$

Note:
LB : Age of friction plate/brake canvas (hours)
qv : Specific wear (cm)
Nr : Average friction (HP)

In this study, a brake component will be calculated regarding the efficiency or effectiveness of brake performance on a Yamaha R25 250 cc motorcycle for a brake design to match the desired capabilities, capacity and specifications of the Yamaha R25 250 cc motorcycle.

Research Method

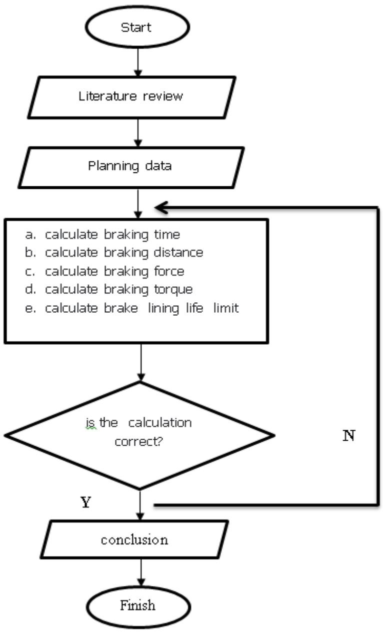

Figure 3. calculation flow chart

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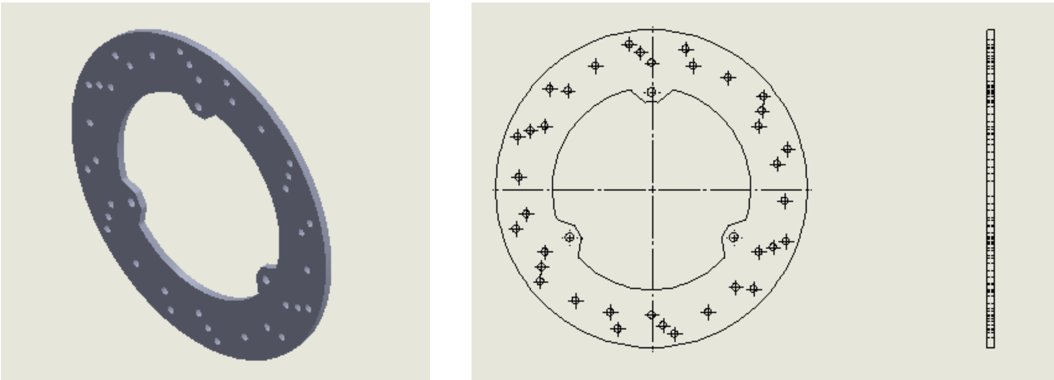
In this study, the flow of the calculation process to get the value that will be used as a reference for selecting brake components can be seen in Figure 3

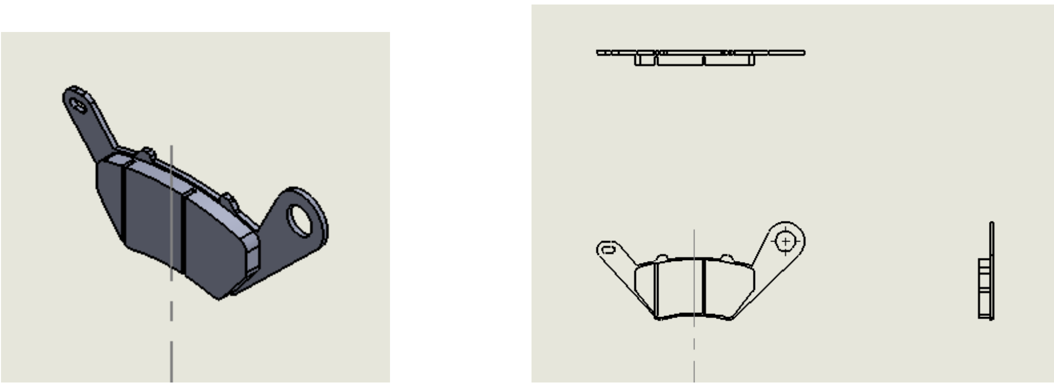
2d and 3d drawings of brake components
Below are 2D and 3D images of Disk Brake components on disc brakes:



(a) (b)

Figure 4. (a) Disk brake 3D (b) Disk brake 2D

Below are 2D and 3D images of the brake pad components on the disc brake engine elements:



(a) (b)

Figure 5. (a) Brake pad 3D (b) Brake pad 2D

Planning Data

Vehicle weight when traveling (Gg)	: empty motorbike weight + passenger weight
	: 166 kg + (2 x 60 kg) = 286 kg
Wheel brake	: (Gw : Gg/2) : 143 kg
Vehicle speed(Vg)	: 80 km/h = 22.2 m/s
Deceleration (bv)	: 3 m/s
Tire diameter: 65 cm	
Braking operation (z)	: 100 times/hour
Wear limit (sv)	: 0.3 cm
Specific wear (qv)	: 0.125 cm
Leg strength (H)	: 5 kg
Load factor (kg)	: 4.5

R out	: 110 mm = 11 cm = 0.11 m
R in	: 80 mm = 8 cm = 0.8 m
θ	: 52º
thickness	: 6 mm = 0.6 cm = 0.06 m
canvas and disc material	: asbestos passed hydraulically and AISI 1045
μ asbestos	: 0.2
σ	: 220 MPa = 2200 kg/cm²

Results and Discussion

From the calculation of the disc brakes on the Yamaha R25 250 cc above, the following results are obtained:

Assuming the use of the vehicle and also the vehicle brake specifications as follows:

Average speed	= 80 km/h
Vehicle braking operation	= 100 times/hour
Deceleration (bv)	= 3 m/s²
Canvas Material	= Asbestos Pressed Hydraulically
Coefficient of friction	= 0.2 – 3.5
Wear limit	= 0.3 cm
Specific wear	= 0.125 cm

The following results were obtained:

Braking time (tr)	= 7.4 s
Braking distance (Sr)	= 82.4 m
Braking force (Pv)	= 87.5 kg
Friction (F friction)	= 11375 kg
Braking torque (MR)	= 3128 kg.cm
with the average friction diameter	= 17 cm
total pressure on each canvas	= 920 kg , on each canvas
kinetic energy	= 7.902 kg.m
Friction	= 2.92 HP
Wear volume	= 6.75 cm³ , and
The life of the brake pads	= 140 hours, in continuous use
Material used	= Asbestod passed Hidraulically and AISI 1045

Conclusion

From the results of calculations regarding the life of the brakes on the Yamaha R25 250 cc motorbike, steps were carried out to find the results of these calculations, the first stage was calculating the braking force (Pv) which obtained a result of 87.5 kg, then braking torque (MR) with first measure the standard vehicle wheels (the size used in the calculation is 65 cm) with the result of calculating the torque of 3128 kg.cm. To do a brake design, there are many things that need to be considered regarding planning data that will later be used in calculations, for example the average speed of the vehicle is 80 km/h then the assumption of brake use is 100 times/hour and also the type of material to be used. For example, hydraulically pressed asbestos with a dry friction coefficient (0.2 – 3.5) then the wear limit (Sv) is 0.3 cm and the specific wear (qv) is 0.125 cm. So from the results obtained from the brake life on the Yamaha R25 250 cc motorbike of 140 hours which is with the total wear volume (Vv) of 6.75 cm³.

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The selection of materials that are suitable for use in these brake components cannot be separated from the needs of using brakes, such as materials that are heat resistant and good friction resistant. the materials that are suitable for use in these brake components are hydraulically pressed Asbestos and AISI 1045 Steel.

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