PalArch's Journal of Archaeology of Egypt / Egyptology

EVALUATION OF DISC BRAKE ON A HONDA VARIO 150 ESP K59 MOTORCYCLE

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Adhita Prasetia, Fitra Rizkiarjo. Evaluation Of Disc Brake On A Honda Vario 150 Esp K59 Motorcycle-- Palarch's Journal Of Archaeology Of Egypt/Egyptology 17(10), 3062-3073. ISSN 1567-214x

Keywords: Motorcycle; Brake; Disc Brake; Effectiveness; Honda Vario 150 Esp K59; Catia

ABSTRACT

The effectiveness of the braking system on a motorcycle is one of the important things that will affect the rider. The brake effectiveness factor and the magnitude of the braking force are important things that must be considered in the construction of the brake system used in motorized vehicles which will affect the stability and safety of the rider. The purpose of this study was to evaluate the brake effectiveness factor and braking force of motorcycle disc brakes, which are usually used on the front wheels of two wheeled motorbikes. The brake construction to be evaluated is the disc brake construction on the Honda Vario 150 eSP K59 motorcycle. Furthermore, the calculation and design drawing of disc brakes using Catia software are carried out. Then to evaluate we perform an analysis of the braking force using disc discs with different diameters. The evaluation results obtained a Brake Effectiveness Factor (FER) of 0.64 and the result of the braking force with a disc of 551.35 N, the most effective use of a disc with a diameter of 220 mm is felt to be better in providing stability and safety for Honda Vario 150 eSP K59 motorcycle riders.

INTRODUCTION

Motorcycles in Indonesia are very popular for being used as two wheeled vehicles which have the advantage of being relatively cheap; affordable by many people and using economical fuel and also very low operating costs. However; there is also a disadvantage to the use of this motorcycle; which is accident prone. To anticipate accidents while driving this motorcycle; one important thing to pay attention to is the braking system by paying attention to the effectiveness of using the brakes.

The driving system on a motorcycle is a very important part of its existence as a complement to safety and security in driving. The main function of the braking system itself is clear; namely to regulate the speed of the motorbike that is running and to keep the motorbike stopped. Generally; there are two types of braking systems on motorbikes that are usually used; namely drum brakes and disc brakes. The two types of brakes certainly have their own advantages and disadvantages. The two types of brakes have the same function and purpose.

The disc brake consists of a steel disc that is held in place by the brake linings on both sides during braking. Disc brakes have a number of advantages; including easy control; stable braking level; which is more gripping and more biting; has good heat radiation so it doesn't heat up quickly because of its position outside; has good heat radiation; so disc brakes are often used in front wheels; as well as a simple construction; easy to maintain and claimed spare parts prices are more affordable. The disadvantages of this disc brake are the short coating life and the large size of the brake cylinders at the wheels.

When the driver is applying the brakes; due to the impact of the inertia force; about 70% of the gravity of the motor will go towards the front wheels. According to calculations; to be able to stop the motorbike more effectively; the front brake must work better and be stronger. That is the main reason that disc brakes are preferred for use on the front wheels.

The problem formulated in this evaluation is to analyze how the brake effectiveness factor and the amount of braking force using disc brakes on the Honda Vario 150 eSP K59 can guarantee stability and safety for the rider. While the scope of this construction evaluation includes the disc brake construction that is on the Honda Vario 150 eSP K59. The purpose of this study was to evaluate the brake effectiveness factor and braking force of motorcycle disc brakes, which are usually used on the front wheels of two-wheeled motorbikes. The brake construction to be evaluated is the disc brake construction on a Honda Vario 150 eSP K59 motorcycle with the evaluated limitation using the analyzed speed of 40 km / hour; brake lining material using semi metallic (half metal) with a layer of friction coefficient of 0.32; neglected hydraulic system; Furthermore, the calculation and design drawing of disc brakes are carried out using Catia software; then to evaluate we perform an analysis of the braking force using disc discs with different diameters.

It is hoped that the evaluation of the effectiveness of the disc brake construction on a Honda Vario 150 eSP K59 motorcycle can be of benefit to the stability and safety of motorcycle drivers; as well as making disc brake design drawings that can be used for quality development of disc brake construction for subsequent products.

LITERATURE REVIEW

A motorcycle is a two wheeled vehicle driven by a machine. The position of the two wheels in a straight line and at high speed the motorbike remains stable due to the gyroscopic force. Whereas at low speeds; the stability or balance of the motorcycle depends on the handlebar settings by the rider. The use of

motorbikes in Indonesia is very popular because of their relatively cheap price; affordable for most people and the use of fuel as well as their quite economical operating costs.

Brake is a device to slow down or stop the wheel movement. Because the wheels are slowed down; the vehicle will automatically slow down. The kinetic energy lost from this moving object is usually converted into heat due to friction. In regenerative brakes; some of this energy can also be recovered and stored in the flywheel; capacitor; or converted to alternating current by an alternator; which is then passed through a rectifier and stored in batteries for other uses.

Disc brake is a braking device used in modern vehicles. This brake works by clamping the disc which is usually attached to the wheels of the vehicle; to clamp the disc; a caliper driven by a piston is used to push the brake pads to the disc. This type of brake is also used on trains; motorcycles; bicycles.

Of course there are some disc brake components that will interfere directly with the parts attached to the wheels so that the wheel rotation can be slowed down and stopped. In disc brakes; there is pressure from the pedal or handle which is then transferred to the brake pads using compressive power which is usually obtained from the hydraulic system used by utilizing the piston and brake fluid itself. When the pressure reaches the brake pads, the brake pads will automatically clamp down on the rotating disc as the wheels turn. With this clamp; of course the rotation will decrease and make the vehicle speed even slower.

Disc brake components and their functions are as follows:

Disc Brake

Disc brakes or discs function as a medium for pressure by brake pads which will later cause a breaking effect. This component is usually made of steel material which is generally able to withstand heat. There are two kinds of disc brakes; namely (a). Solid Disc; the type of disc brake we will generally encounter on four wheeled vehicles or cars. And usually this type of disc is also made of steel material which has better resistance to heat and friction. For the shape itself; this type does not have many holes because it aims to make a stronger grip; (b). Ventilated discs; mostly used for two-wheeled vehicles or motorbikes; are made of steel but generally have a thinner size and have several holes. which is functioned to make the disc cool faster than the heat generated due to friction between the disc and the brake lining.

Brake Pad

The brake pad functions as a clamp or disc brake when the motor is running. The material for brake pad consists of a mixture of organic materials.

Brake Caliper

The function of the Brake Caliper converts the hydraulic pressure obtained from the piston into motion energy in the form of pressure. There are two types of brake calipers; namely (a) Fixed Caliper components which have two pistons which will move in opposite directions when the part is under pressure; and this movement will clamp the brake pads between the two existing pistons; (b) the Floating Caliper has one piston on one side; is a component that is made to float with the aim of being able to move to the right and left.

Piston

Piston with a tubular shape; the position of the piston will be in direct contact with the brake pads because when there is pressure the piston will press the pads evenly.

Piston Seal

Piston Seals are made of rubber; but different from rubber in general; this Piston Seal has a sealing ability to prevent leakage of the brake fluid in the brake caliper.

Nipple Bleed

Nipple Bleed functions to remove air content that is accidentally carried over to the hydraulic system.

Hydraulic Hose (Brake line)

Hydraulic hoses are slightly different from hoses in general; this is because as we all know the hydraulic system itself has such a large compressive power; so the quality of the hose that must be used of course must be a hose that is able to withstand pressure. Therefore, generally the hydraulic hose itself is made of steel material.

Brake Booster

Brake Booster functions to help reduce the compressive power of the brake pedal without reducing braking power; with this brake booster; the compressive power obtained will be doubled so that braking will be far more maximal.

Caliper Bracket

Caliper Bracket functions as a brake caliper holder; so that the main brake caliper will remain in place and will not move at all. The caliper bracket on this motorbike is used for dishes that have a larger diameter.

Disc Brake Oil Reservoir

Disc Brake Oil Reservoir is a tube in which it is used to store or store fluid or spare brake fluid; this component is usually always integrated with the master cylinder.

Figure 1. Production of Honda Vario 150 eSP K59 Motorcycle Disc Brakes

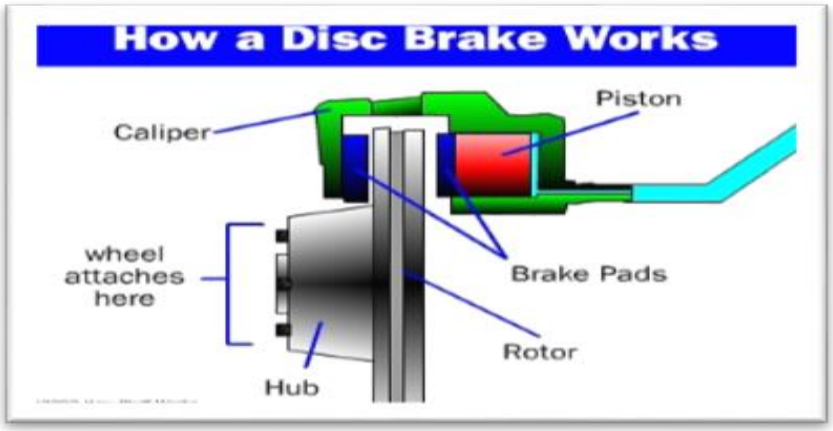

Figure 2. Disc Brake Working System

METHOD

The steps taken in evaluating this effectiveness can be seen in the flowchart as follows:

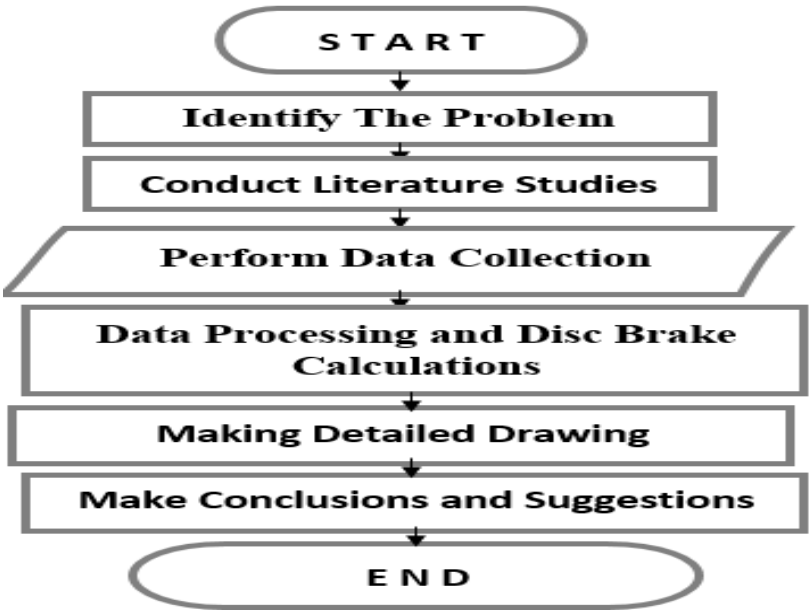

Figure 3. Flowchart

Honda Vario 150 eSP K59 motorcycle data specifications are as follows:

1.	Vehicle length (p)	: 1.921 mm
2.	Vehicle width (l)	: 683 mm
3.	Vehicle height (t)	: 1.096 mm
4.	Wheelbase (Wheelbase) (L)	: 1.280 mm
5.	Total vehicle weight (W)	: 170 kg
6.	Front load (WD)	: 76.5 kg
7.	Rear load (WB)	: 93.5 kg
8.	Disc diameter (d)	: 190 mm
9.	Front caliper piston diameter (d_{WD})	: 34 mm
10.	Master cylinder piston diameter	: 12.7 mm
11.	Front wheel diameter (D) 80 / 90-14	: 499.6 mm
12.	The coating friction coefficient (μ)	: 0.32
13.	Initial speed (Vo)	: 40 km/h
14.	Braking distance (s)	: 20 m
15.	Angle of incline (θ)	: 15°

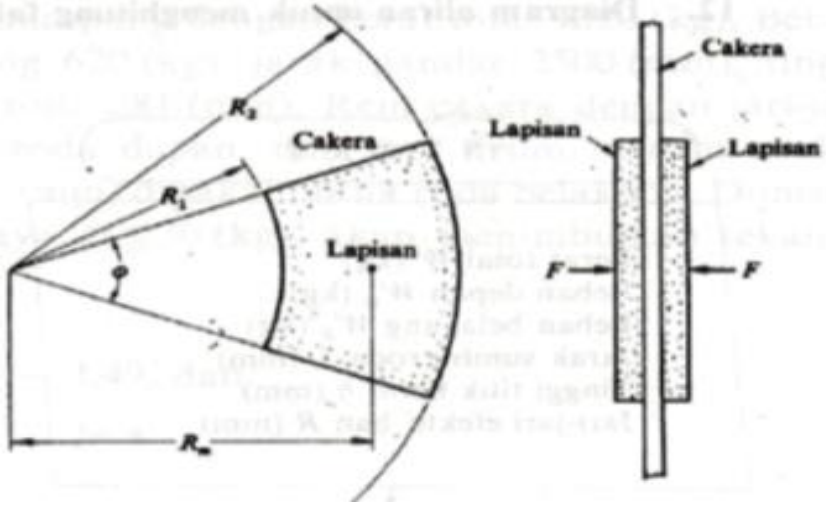

Figure 4. Disc Brake Free-Body Diagram (DBB)

Flowchart for data processing and calculation of disc brake effectiveness:

RESULTS AND DISCUSSION

Data processing and calculation of evaluation of the effectiveness of the Honda Vario 150 eSP K59 Motorcycle disc brake construction, as follows:

Vehicle deceleration calculation

With the initial speed (Vo) of 40 km/h and the braking distance of 20 m; the calculation of the deceleration is as follows:

$V_t^2 = V_0^2 + 2\,a\,s$

$0 = (11.11\ m/s)^2 + (2 \times a \times 20\ m)$

a = - 3.09 $^{m}/s^{2}$

Center of Gravity calculation

To find the value of h, the writer takes θ = 15 °

$$h = r + \left[\frac{(L \times W_d)}{W} - \frac{(L \times W_b)}{W}\right] \cot \theta$$
$$h = 249.8 + \left[\frac{(1280 \times 76.5)}{170} - \frac{(1280 \times 93.5)}{170}\right] \cot 15^{\circ}$$
$$h = 249.8 + [576 - 704] \times 3.7$$
$$h = 223.8 \text{ mm}$$

Wheel Dynamic Load Calculation

$$W_{dD} = W_D + e\left(\frac{h}{L}\right)W$$
$$W_{dD} = 76.5 + 0.32 \times \left(\frac{223.8}{1280}\right) \times 170$$
$$W_{dD} = 76.5 + 9.51$$
$$W_{dD} = 86.01 \text{ kg}$$

(The value of *e* is obtained from the value of the deceleration divided by the acceleration due to gravity).

Calculation of the required brake force of the wheels

$$B_{ID} = e \times W_{dD}$$
$$B_{ID} = 0.32 \times 86.01$$
$$B_{ID} = 27.52\ kg$$

Calculation of the Braking Force on the Disc

$$F_R \times r_r = F_p \times r_p$$
$$27.52 \times 249.8 = F_p \times 95$$
$$F_p = 72.36\ kg$$
$$F_p = 72.36\ kg \times 9.8 = 709.13\ N$$

Information

F_r = Force on wheels = 27.52 kg
r_r = Wheel radius = 249.8 mm
r_p = Disc radius = 95 mm

Calculation of the compressive force on the brake pads

$$F_p = F_k \times \mu$$
$$72.36 = F_k \times 0.32$$
$$F_k = 226.13\ kg$$
$$F_k = 226.13\ kg \times 9.8 = 2216.07\ N$$

Calculation of Hydraulic Cylinder Cross Section Area

$$A_{wD} = \frac{\pi}{4} \times d_{wD}^2$$
$$A_{wD} = \frac{\pi}{4} \times 34^2$$
$$A_{wD} = 907.46\ mm^2$$

Calculation of Oil Pressure on the Brake Line

$$F_k = P_w \times A_{wD}$$
$$226.13 = P_w \times 907.46$$
$$P_w = 0.25\ kg/mm^2$$

Calculation of the Force Needed on the Master Cylinder

$$F_{master} = P_w \times A_{piston\ master\ silinder}$$
$$F_{master} = 0.25 \times \left(\frac{\pi}{4} \times (12.7)^2\right)$$
$$F_{master} = 31.67\ kg$$
$$F_{master} = 31.67\ kg \times 9.8 = 310.37\ N$$

Calculation of Brake Effectiveness Factor (FER)

$$FER_D = 2 \times \mu$$
$$FER_D = 2 \times 0.32$$
$$FER_D = 0.64$$

Braking Force Calculation Using Disc

$$F = FER_D \times P_w \times A_{wD} \times \frac{r_p}{r_r}$$
$$F = 0.64 \times 0.25 \times 907.46 \times \frac{95}{249.8}$$
$$F = 55.22\ kg$$
$$F = 55.22\ kg \times 9.8 = 541.16\ N$$

The result of the Brake Effectiveness Factor (FER_D) is 0.64, while the Braking Force Using a Disc is 541.16 N, using a disc with a diameter of 190 mm.

Table 1. Results of the Calculation of Braking Force Using Discs with Different Diameter of Disc

Parameter	Results Diameter of Size Disc Diameter 190 mm	Results Diameter of Size Disc Diameter 220 mm	Results Diameter of Size Disc Diameter 240 mm
Deceleration	3.09 m/s^2	3.09 m/s^2	3.09 m/s^2

Centre of Gravity	223.8 mm	223.8 mm	223.8 mm
Wheel Dynamic Load	86.01 kg	86.01 kg	86.01 kg
Wheel Brake Force	27.52 kg	27.52 kg	27.52 kg
Brake Force On Disc Brake	709.13 N	612.5 N	561.44 N
Force Press On Brake Pads	2216.07 N	1914.04 N	1754.5 N
Oil Pressure On Brake Line	0.25 kg/mm^2	0.22 kg/mm^2	0.20 kg/mm^2
Force Required On The Master Cylinder	310.37 N	273.13 N	248.33 N
Brake Effectiveness Factor (FER_D)	0.64	0.64	0.64
Disc Braking Force	541.16 N	551.35 N	546.84 N

Detailed design drawings of complete disc brakes for braking construction on a Honda Vario 150 eSP K59 motorcycle are as follows:

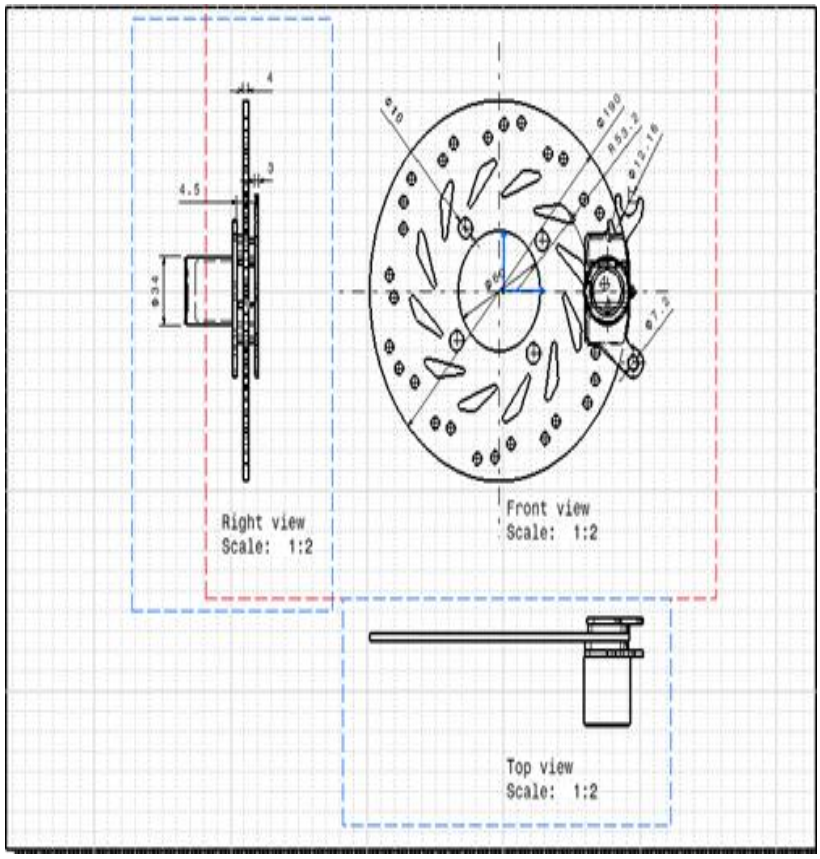

Figure 5. Detailed Design Image Using Catia Disc Brakes for Honda Vario 150 eSP K59 Motorcycles

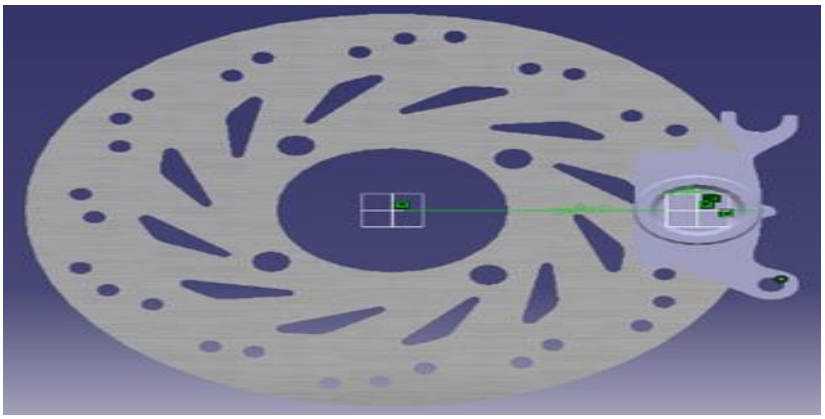

Figure 6. Front View Design Image of 190 mm Diameter Disc Brake Disc for Honda Vario 150 eSP K59 Motorcycle Using Catia

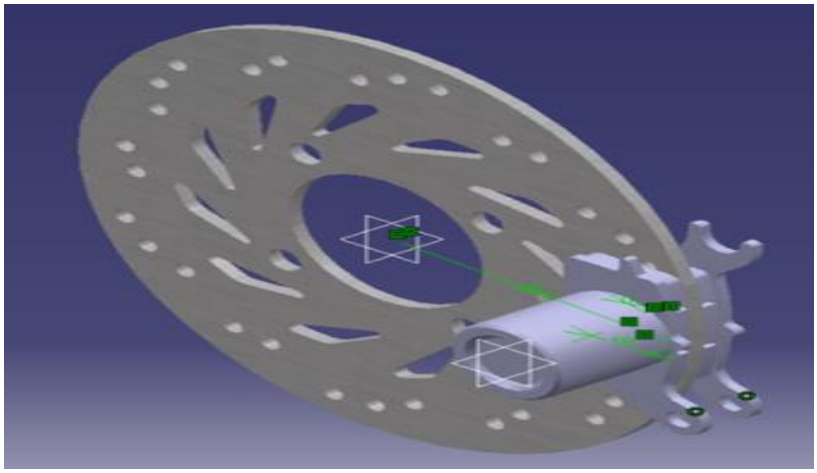

Figure 7. Isometric Look Image Design Results of Disc Brake for Honda Vario 150 eSP K59 Motorcycle Using Catia

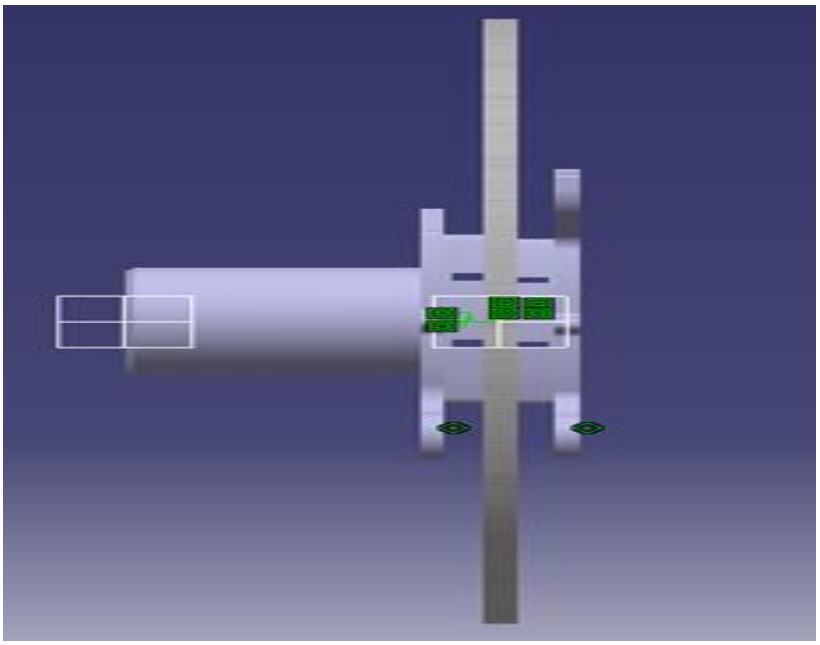

Figure 8. Side View Image Design Results of Disc Brake for Honda Vario 150 eSP K59 Motorcycle Using Catia

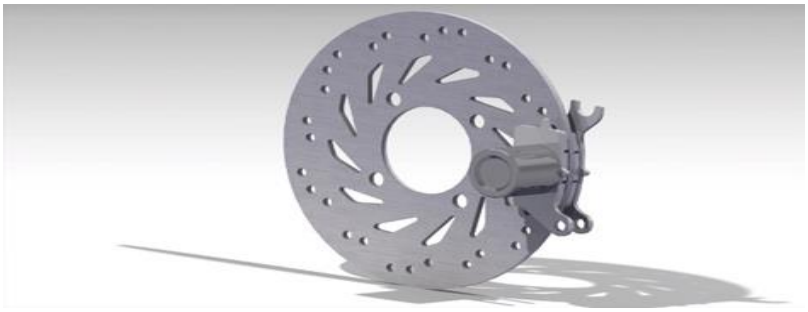

Figure 9. Image Design Results of Disc Brake for Honda Vario 150 eSP K59 Motorcycle Using Catia

CONCLUSION

1. The results of the braking force using disc brakes with discs with a diameter of 190 mm on a Honda Vario 150 eSP K59 motorbike of 541.16 N are less effective results for rider stability and safety; because from the calculation results using a disc with a diameter of 220 mm; the braking force is greater; namely 551.35 N, with a Brake Effectiveness Factor (FER_D) of 0.64. Thus; the use of a disc with a diameter of 220 mm is felt to be more effective for the stability and safety of riders using a Honda Vario 150 eSP K59 motorcycle.
2. Brake force is influenced by hydraulic pressure on the brake line and other brake variables used in the disc brake system on the front wheels.
3. The use of 190 mm diameter disc discs on the Honda Vario 150 eSP K59 motorcycle is based on other factors apart from the calculation of brake effectiveness.

SUGGESTIONS

As an evaluation material for the future. The shortcomings of this research can be an idea for further research, where changes in material types, sizes or dimensions can be changed to better suit your needs.

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