

## **PUBLICATION ARTICLE**

**ANALYSIS AND MANUFACTURING COMPOSITE FOR BRAKE SHOES OF  
MOTORCYCLE HONDA SUPRA X 125 USING FLY ASH COAL AND  
MAGNESIUM OXIDE WITH EPOXY MATRIX**



Submitted as a Partial fulfillment of The Requirements for Getting Bachelor Degree  
of Engineering in Mechanical Engineering Department

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## APPROVAL

The research paper entitled "ANALYSIS AND MANUFACTURING COMPOSITE FOR BRAKE SHOES OF MOTORCYCLE HONDA SUPRA X 125 CC USING FLY ASH COAL, AND MAGNESIUM OXIDE WITH EPOXY MATRIX", has been agreed by supervisor and authorized by the Director of International Program as partial fulfillment of the requirements for getting the Bachelor Degree of Engineering in Automotive Department of Muhammadiyah University of Surakarta.

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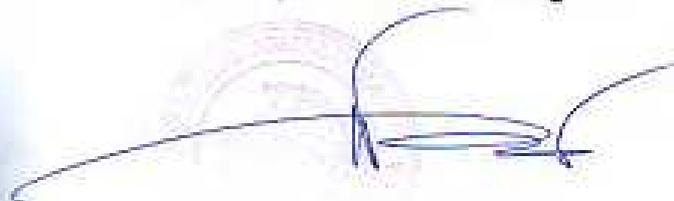
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# ANALYSIS AND MANUFACTURING COMPOSITE FOR BRAKE SHOES OF MOTORCYCLE HONDA SUPRA X 125 CC USING FLY ASH COAL, AND MAGNESIUM OXIDE WITH EPOXY MATRIX

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## ABSTRACT

*Brake is one component of a motor vehicle that serves to slow or stop, this is very important in supporting aspects of driving safety. The study aims to investigate the influence of use fly ash coal and Magnesium oxide (MgO) with epoxy matrix as a material brake shoes.*

*The research was conducted in two phases, namely the field of testing and measuring brake wear in the lab. Metrology using a profile projector, in addition to the Brinell hardness testing is also performed to determine the hardness of each specimens of brake shoes before and after testing higher speeds with the same braking load time, braking distance and the wear rate also increased.*

*From brinell hardness test results generated that hardness resulting from brake shoes variation has a value of 6.4 BHN and brake shoes variation 2 has a value of 14.8 BHN more great than brake shoes Honda Genuine Parts has a value of 12.3, while for Variation 3 has a value of 10.2 BHN and Variation 4 has value 8.9 BHN is smaller than Honda Genuine Parts brake shoes.*

**Keywords:** *Fly ash coal, magnesium oxide (MgO), brake non-asbestos.*

## BACKGROUND

Composite materials is one of the alternatives that can be used for the manufacture of brake shoes. In the development of technology, composite experiencing very rapid progress is due to the renewable nature of privilege and power to weight ratio of high stiffness and corrosion resistance.

Fly ash is one of the residue from the combustion of fuels, especially coal. Fly ash is not used and if stacked in one place can only bring adverse effects to the environment. This fly ash, in addition to meeting the criteria as a material that has properties pozzolan (compounds containing silica and alumina), fly ash also possess good physical properties, such as having low porosity and fine particles. Shape of fly ash particles are spherical with a smooth surface, where it is very good for manufacturing process. Therefore, the author tries to raise the issue of fly ash to the brake shoes material.

Brake that is used most of the current is made from a mixture of asbestos and onther elements. The use of asbestos brake shoes made from a very environmentally unfriendly, because it has a negative impact on health which can cause asbestos / fibrosis (thickening and scars on the lungs), lung cancer and respiratory tract cancers.(Anoname. 1981). For that it is needed once a brake shoes material to create a friendly environment and good for health also rider safety.

## PROBLEM STATEMENT

Problem statement that can be drawn from the problem above is how the effect of variations in the composition brake shoes made from Fly ash coal, Magnesium Oxide (MgO), and epoxy resin against weariness, hardness, and braking distance.

## OBJECTIVES

The objectives of the research are as follow :

1. Knowing the ability of brake shoes made from fly ash coal and MgO ( Magnesium Oxide) among 4 variations agains of Hardness Brinell Number and weariness.
2. Comparasion analysis in the manufacture of brake shoes between 4 variation to get the best composition.
3. Knowing braking ability of brake shoes made from 4 variations for brake shoes motorcycle Honda Supra X125 .

## PARTICULATE COMPOSITES

Particulate composites using a composite powder particles as reinforcements and evenly distributed in its metric.

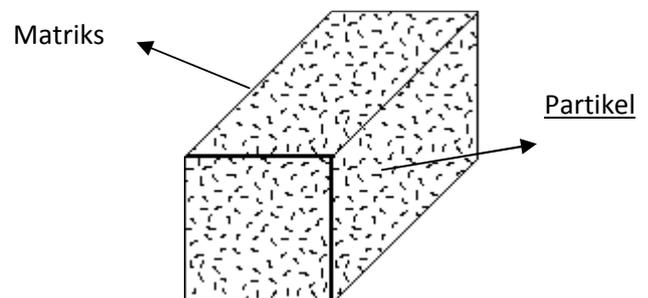


Figure 1. Particulate Composite

## MgO (MAGNESIUM OXIDE)

MgO selected as filler material that also serves as a reinforcing material for good characteristics. MgO is structured materials are very light metal with a specific gravity ( 1,74 gr/cm<sup>3</sup>), melting point ( 650 OC), boiling point (1097 OC), ristal modulus (110 Mpa ), yield strength (255 MPa), hardness (12 VHN).

Although a small percentage of MgO powder plays an important role in improving the ability of wettability with

solid surface condition also have the ability to fill any difference in height of the rough surface and lower the interfacial tension.



**Figure 2. Magnesium Oxide**

(source : <http://usermeds.com>)

## FLY ASH COAL

Fly ash is the fine particles that are precipitated from the burning pile of coal powder. Waste on tinter can in large enough quantities. The amount is quite large, so it requires a management that does not cause environmental problems such as air pollution, water and ecosystem degradation.



**Figure 3. Fly Ash Coal**

(source : <http://www.aerc.org/>)

## EPOXY RESIN

Epoxy Resin is a matrix material that is often used for the manufacture of composites.

This material is a thermoset polymer type of plastic that can not be recycled that does not melt when heated, consists of two epoxy resins namely epoxy material itself and hardener or hardener (curing agent). Epoxy resin systems can be found in the form of one or two components, one component systems include solvent-free liquid resin, liquid resin paste, powder, pellet, and pasta. Two-component system consisting of resin and curing agent are mixed at time of use.



**Figure 4. Epoxy resin and Hardener**

(source : <http://www.aerc.org/>)

## CANVASS MATERIAL

Requirements for the brake shoes materials, either to the drum or disc is very difficult. Besides, in order to provide high coefficient friction, is also expected not affected by temperature, pressure, friction velocity, water, oil, and mechanically should be able in the rivet or glue on his shoes, no noise due to braking, in expensive and have long service life. Canvass the general basic material are asbestos, equipped with inorganic materials such as metal oxide, sulphat, and silicates. Everything is attached along with a variety of resins, rubber, and others. However, current widely used synthetic materials where all ingredients are put together, including asbestos fibers, zinc and brass wire by adding a resin binder.



Figure 5. Brake shoes

## COMPACTION PROCESS

Compacting the material in powder compaction process dies (mold) with a compressive force of the compacting machine and the amount of compressive force in accordance with the research conducted, compaction has the objective to get a green body of the specimen test objects resulting from the homogeneous mixture.

Compression process is a process engine that delivers style uniaxial stress. (German, 1984).

## SINTERING PROCESS

Sintering is a heating process that aims at a certain temperature to form bonds between the particles of grain boundary constituent powder particles, mix the grain boundaries are the result of heating below the melting temperature (Melting point) particles making involving Atomic Transfer in solid condition and being held in a certain time or in the absence of pressure. (Suchanen, Yoshimura, 1998). Sintering process requires heating furnace temperature and heating rate can be set when the heating material, the temperature of the natural environment consider this use because it has an influence on the processes that occur on heating, Kalpakjian., (2003).

## HARDNESS

This study use a Brinell hardness test (ASTM E-10). Brinell hardness can be searched by the formula :

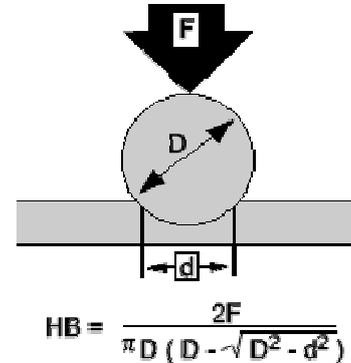


Figure 2. Brinell Hardness Test

(source : <http://www.inston.us/>)

Where :

HB: Brinell Hardness Number

D : Diameter of ball indenter (mm)

d : Diameter of Indentation (mm)

F : Force (kgf)

## WEARNESS

Wear and tear is a partial loss of material in the solid surface due to friction, to determine the value besarna wear rate can be calculated using the following formula Ogashi wear :

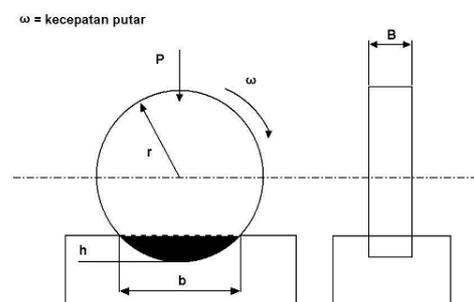


Figure 3. Oghosi wear testing method

(source : [www.scribd.com/doc/217044/uji\\_keausan](http://www.scribd.com/doc/217044/uji_keausan) at 10.27 )

$$W_s = \frac{B \times B_o^3}{8 \times r \times P_o \times L_o} \frac{\text{mm}^2}{\text{Kg}}$$

Where :

- Ws : the specific wear rates  
(mm<sup>2</sup>/ Kg)
- B : width of plate wearred  
(mm)
- Bo : width of the wear in the  
test specimen (mm)
- r : radius of the disc wearred  
(mm)
- Po : compressive force on the  
wear process takes place  
(Kg)
- Lo : wearred mileage on the  
process (m)

new tires on a dry road. The last parameter that we will consider is your initial velocity. Obviously, the higher your speed the longer it will take you to stop, given a constant deceleration. The braking distance and the brake reaction time are both essential parts of the stopping sight distance calculations.

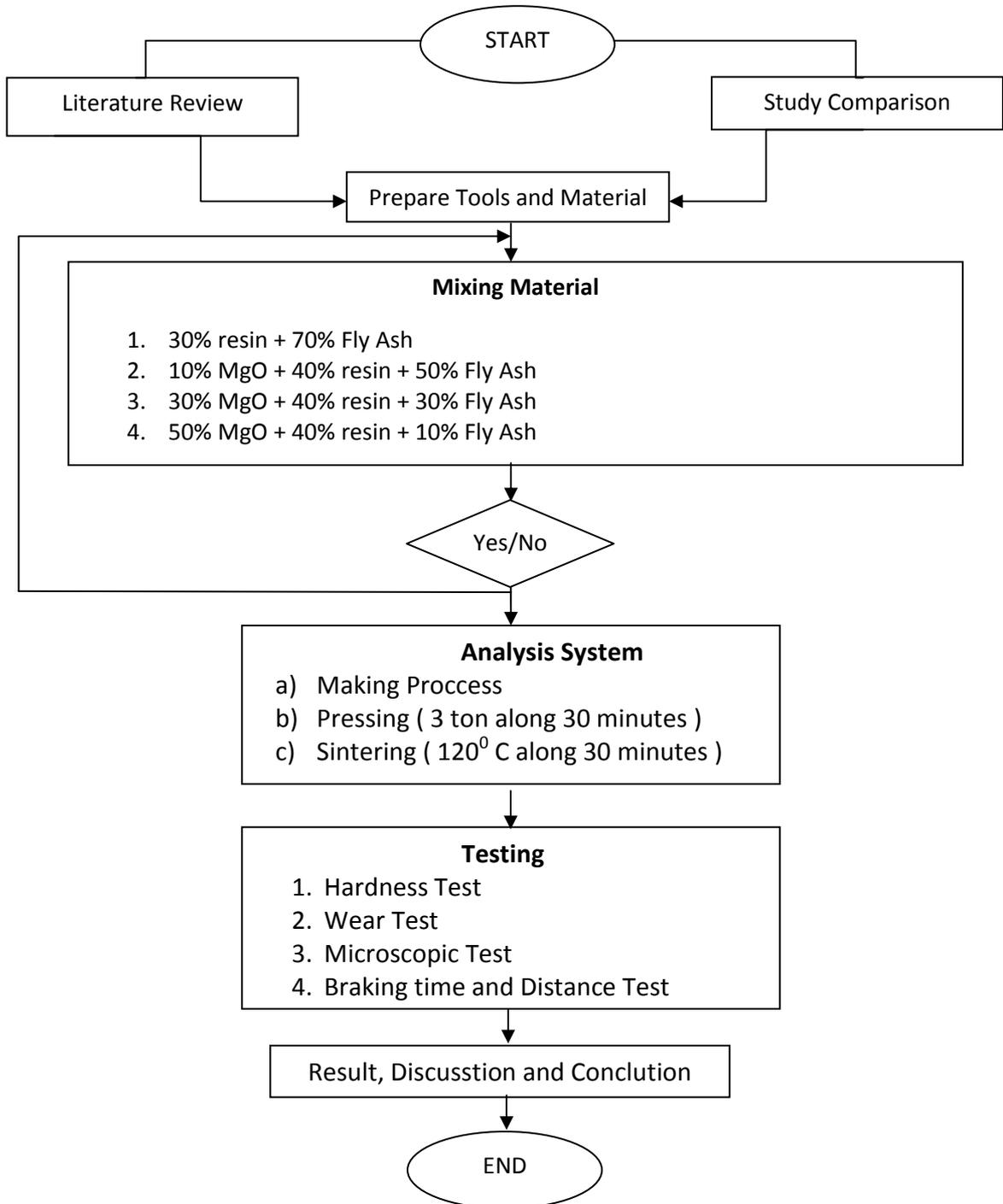
## MACRO STUCTURE TEST

Macrostructure examination is a method of examination of large regions of the specimen surface or fractured section with the naked eye or under low magnification.

## BRAKING DISTANCE AND TIME TEST

The braking distance is the distance that a vehicle travels while slowing to a complete stop. The braking distance is a function of several variables. The frictional resistance between the roadway and your tires can influence your braking distance. If you have old tires on a wet road, chances are you'll require more distance to stop than if you have

# FLOW CHART OF RESEARCH



## RESULT AND ANALYSIS

### RESULT

Table 1. Wear Test Result

Specimen	Final Load	Abrasion Time	Abrasion Distance	Abrasion Speed	Abrasion groove width	Bo <sup>3</sup>	Specific Abrasion
	Po (Kg)	T (sec)	Lo(m)	V (m/sec)	Bo (mm)		WS (mm <sup>2</sup> /kg)
Honda Genuine Parts	6.36	120	100	0.25	2.3	12.167	0.000239
Variation 1	6.36	120	100	0.25	3.1	29.791	0.000586
Variation 2	6.36	120	100	0.25	1.9	6.859	0.000135
Variation 3	6.36	120	100	0.25	2.4	13.824	0.000272
Variation 4	6.36	120	100	0.25	2.7	19.683	0.000387

Table 2. Braking Time and Distance Test Result

Specimen	Load	Speed	Time of braking	Distace of braking
	Kg	Km/Hours	Sec	meter
Honda Genuine Parts	6.00	40	3,30	14,2
		50	4,18	20,9
		60	5,10	25,1
Variation 1	6.00	40	4,58	21,2
		50	5,17	25,7
		60	6,31	29,0
Variation 2	6.00	40	2,80	13,0
		50	3,58	18,9
		60	4,47	22,1
Variation 3	6.00	40	3,52	16,0
		50	4,30	20,0
		60	5,24	25,5
Variation 4	6.00	40	3,50	17,0
		50	4,39	21,7
		60	5,28	26,8

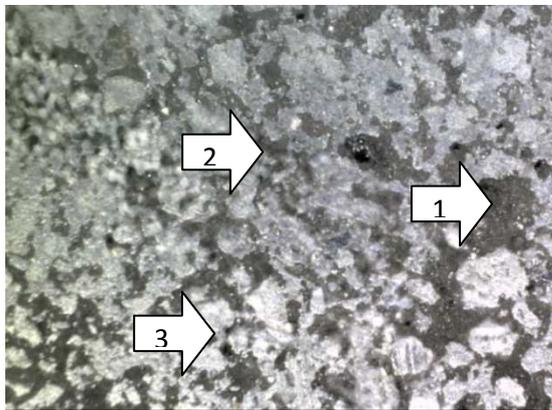
Table 3. Macro Photograph Result



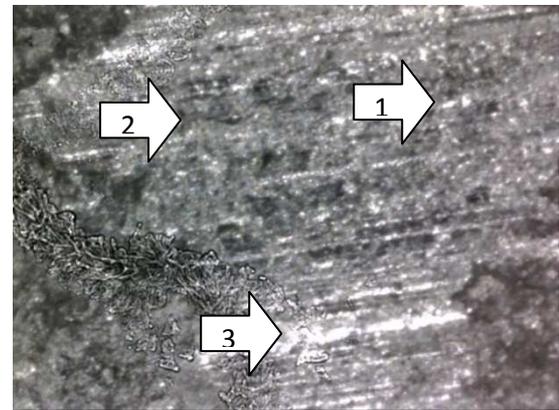
Honda Genuine Parts



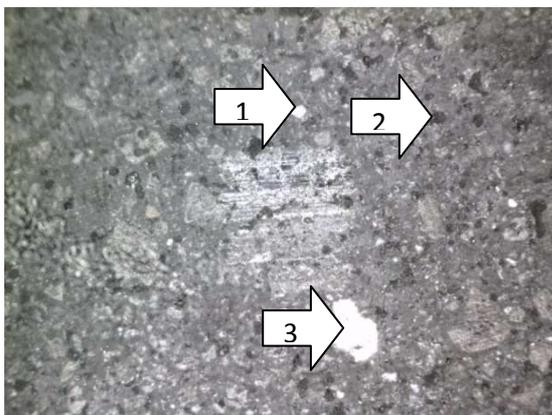
Variation 1  
(30% Epoxy resin + 70% Fly Ash)  
(1. Epoxy resin 2. Fly ash)



Variation 2  
(10% MgO (Magnesium Oxide) + 40%  
Epoxy resin + 50% Fly As)  
(1. Magnesium Oxide 2. Fly ash 3. Epoxy Resin)



Variation 3  
(30% MgO (Magnesium Oxide) + 40%  
Epoxy resin + 30% Fly Ash )  
(1. Magnesium Oxide 2. Fly ash 3. Epoxy  
Resin)



Variation 4  
(50% MgO (Magnesium Oxide) + 40%  
Epoxy resin + 10% Fly Ash )  
(1. Magnesium Oxide 2. Fly ash 3. Epoxy Resin)

Coal Fly Ash on the Macro Photograph Result was mixed evenly with epoxy resin and equitable distribution on each specimen canvass. Magnesium Oxide (MgO) which has been mixed with epoxy resin to cover the empty cavities in the specimen so that the brake pads increasingly crowded during the sintering process.

Table 3. Brinell Hardness Test

No	Specimen	d (mm)	Brinell Hardness Number (BHN)
1.	Honda Genuine Parts	1.20	13.0
		1.20	13.0
		1.30	10.9
Average		1.23	12.3
2.	Variation A	1.60	6.9
		1.64	6.5
		1.72	5.8
Average		1.65	6.4
3.	Variation B	1.12	15.0
		1.12	15.0
		1.15	14.2
Average		1.13	14.8
4.	Variation C	1.32	10.6
		1.35	10.1
		1.35	10.1
Average		1.34	10.2
5.	Variation D	1.48	8.2
		1.40	9.3
		1.40	9.3
Average		1.43	8.9

From brinell hardness test result generated that hardness resulting from brake shoes Variation 1 with composition 30% resin + 70% Fly Ash has value of 6.4 BHN. For brake shoes Variation 2 with composition 10% MgO (Magnesium Oxide) + 40% Epoxy resin + 50% Fly Ash has value of 14.8 BHN great than brake shoes Honda Genuine Parts (original) has value of 12.3 BHN, while for Variation 3 with composition 30% MgO (Magnesium Oxide) + 40% Epoxy resin + 30% Fly Ash has a value of 10.2 BHN and Variation 4 with composition 30% MgO (Magnesium Oxide) + 40% Epoxy resin + 30% Fly Ash has a value of 8.9 BHN is smaller than Honda Genuine Parts brake shoes.

The prices difference is influenced by the percentage of violent fly ash, it greater price of its hardness. It can be seen from the composition fly ash on brake shoes variation 1 by 70% so the price of the lowest hardness of any other brake shoes variation. Besides the magnesium oxide (MgO) mixture can also cause differences in the price violence, which at the macro photograph looks brake shoes variation 2 is more hard than any other variation, so that the brake shoes variation 2 has the highest rates of hardness compared with other brake shoes variation.

### BRINELL HARDNESS TEST

In the Brinell hardness testing of each specimen hardness test performed with a three point load 153.2 N (15.62 kg), 2.5 mm ball indicator.

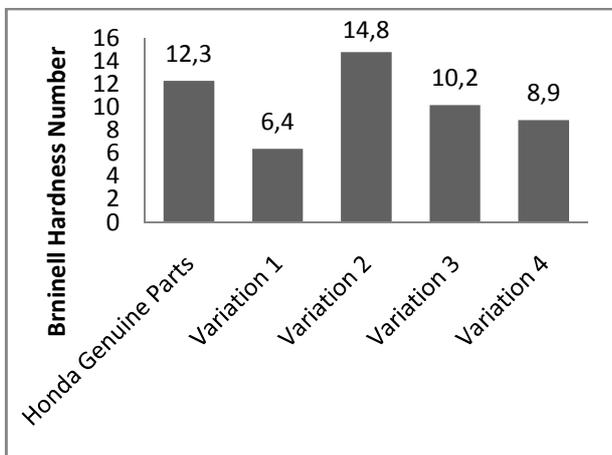


Figure 1. Result calculation of Brinell Hardness Test

## OGHOSI WEAR TEST

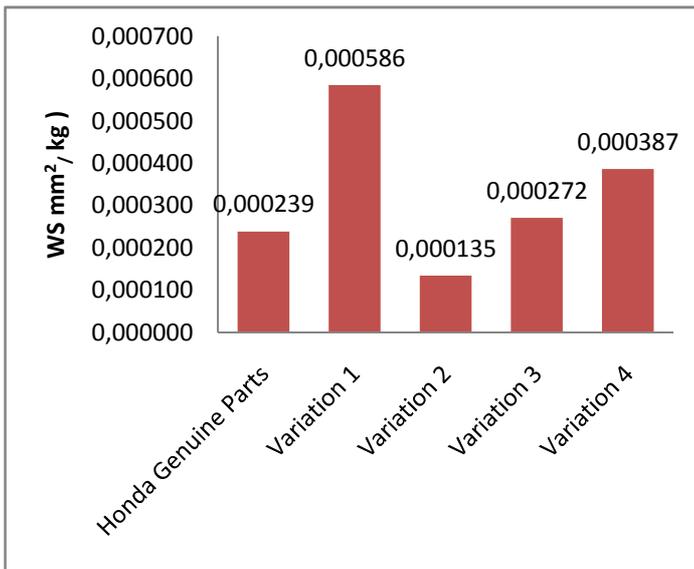


Figure 2. Result calculation of Oghosi wear test

Looked from the graphs results of calculations on Oghosi wear testing, Brake shoes Variation 1 with composition 30% Epoxy resin and 70% Fly Ash has a value of 0.000586 mm<sup>2</sup>/kg, for brake shoes Variation 2 with composition 10% MgO (Magnesium Oxide), 40% Epoxy resin, and 50% Fly Ash has a value of 0.000135 mm<sup>2</sup>/kg, for brake shoes Variation 3 with composition 30% MgO (Magnesium Oxide), 40% Epoxy resin, and 30% Fly Ash has a value of 0.000272 mm<sup>2</sup>/kg, and for brake shoes Variation 4 with composition 50% MgO (Magnesium Oxide), 40% Epoxy resin and 10% Fly Ash has a value of 0.000387 mm<sup>2</sup>/kg, while for brake Honda Genuine Parts has a value of 0.000239 mm<sup>2</sup>/kg. This shows that the brake shoes Variation 2 was better and more durable than the brake shoes Variation 3, Variation 4, and Variation 1. However Variation 2 brake shoes has a better value from Honda Genuine Parts.

## BRAKING DISTANCE AND TIME TEST

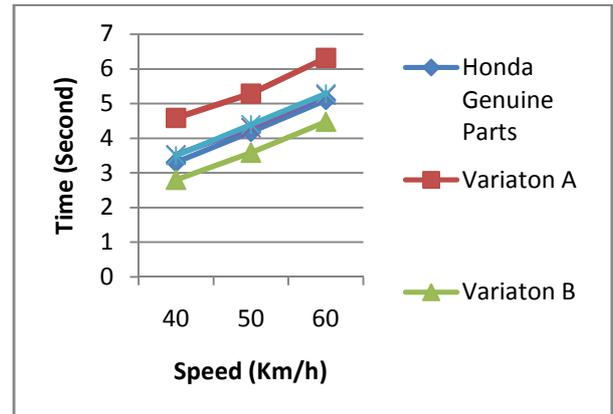


Figure 3. Graph showing the relationship between speed and braking time.

From the test results, the fifth variation of braking shoes resulting in different braking time. Braking time of Honda Genuine Parts has a value 3.30 seconds, Variation 1 has a value 4.58 seconds, Variation 2 has a value 2.80 seconds, Variation 3 has a value 3.52 seconds, and Variation 4 has a value 3.50 seconds, on testing speed of 40 Km/h with a load 6 Kg. This shows that the brake shoes variation 2 was better and more less time braking than the brake variation 1, variation 3, and variation 4. but compared with Honda Genuine Parts with brake shoes Variation 2 has a value braking time was better than the fourth variation.

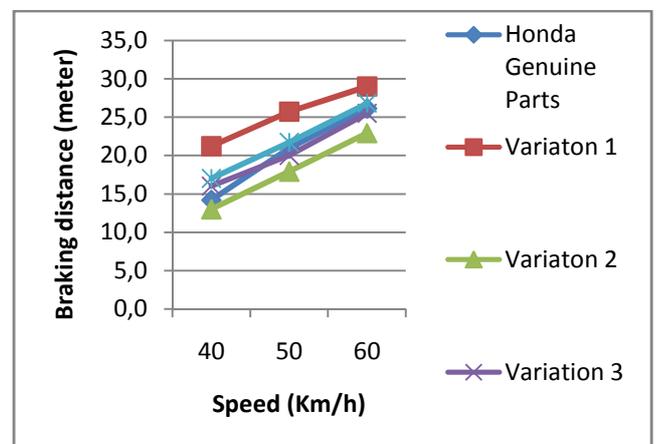


Figure 4. Braking distance test calculation result.

Looked from the graph result of calculation braking distance and time test, brake shoes variation 1 has a distance value of 21.2 meter with braking time of 4.58 second, for brake shoes variation 2 has a distance value of 13.0 meter with braking time of 2.8 second, for brake shoes variation 3 has a distance value of 16.0 meter with braking time of 3.52 second, for brake shoes variation 4 has a distance value of 17.0 meter with braking time of 3.5 second, and braking shoes Honda Genuine Parts has a distance value of 14.2 meter with braking time of 3.3 second. At speed 40 km/h with braking load 6 kg.

This proves that brake shoes Variation 2 was better than Variation 1, Variation 3 and Variation 4, but Variation 2 is better than Honda Genuine Parts brake shoes. So Variation 2 has the shortest braking distance and fastest time.

## **CONCLUSION**

1. From brinell hardness test results generated that hardness resulting from brake shoes variation 1 has a value of 6.4 BHN and brake shoes variation 2 has a value of 14.8 BHN more great than brake shoes Honda Genuine Parts has a value of 12.3, while for Variation 3 has a value of 10.2 BHN and Variation 4 has value 8.9 BHN is smaller than Honda Genuine Parts brake shoes.
2. Results from Brinell hardness test, wear test, braking time and distance test. that Variation 2 has a value more better than Variation 1, Variation 3, Variation 4, and Honda Genuine Parts. Thus, the composition of brake shoes Variation 2 can be applied to the brake shoes.
3. For the results of testing braking distance and time, at speed 40 km/h with braking load 6 kg. This proves that brake shoes Variation 2 was better than Variation 1, Variation 3 and Variation 4, but Variation 2 is better than Honda Genuine Parts brake shoes. So Variation 2 has the shortest braking distance and fastest time.

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