

# International Conference on Engineering and Technology Development



# 3<sup>rd</sup> ICETD 2014

**28, 29 October 2014, Bandar Lampung, Indonesia**

Hosted By :  
Faculty of Engineering and Faculty of Computer Science  
Bandar Lampung University, Indonesia



In cooperation  
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INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA  
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# 3<sup>rd</sup> ICETD 2014

THE THIRD INTERNATIONAL CONFERENCE  
ON ENGINEERING AND TECHNOLOGY DEVELOPMENT

28 -29 October 2014  
Bandar Lampung University (UBL)  
Lampung, Indonesia

## PROCEEDINGS

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## **PREFACE**

The Activities of the International Conference is in line and very appropriate with the vision and mission of Bandar Lampung University (UBL) to promote training and education as well as research in these areas.

On behalf of the Second International Conference on Engineering and Technology Development ( 3<sup>rd</sup> ICETD 2014) organizing committee, we are very pleased with the very good response especially from the keynote speaker and from the participants. It is noteworthy to point out that about 80 technical papers were received for this conference.

The participants of the conference come from many well known universities, among others : University Kebangsaan Malaysia – Malaysia, IEEE – Indonesia, Institut Teknologi sepuluh November – Indonesia, Surya Institute – Indonesia, International Islamic University – Malaysia, STMIK Mitra Lampung – lampung, Bandung Institut of Technology – Bandung, Lecture of The Malahayati University, B2TP – BPPT Researcher – lampung, University of Kitakyushu – Japan, Gadjah Mada University – Indonesia, Universitas Malahayati – Lampung, Lampung University – lampung,

I would like to express my deepest gratitude to the International Advisory Board members, sponsor and also to all keynote speakers and all participants. I am also grateful to all organizing committee and all of the reviewers who contribute to the high standard of the conference. Also I would like to express my deepest gratitude to the Rector of Bandar Lampung University (UBL) who give us endless support to these activities, so that the conference can be administrated on time

Bandar Lampung, 22 October 2014

Mustofa Usman, Ph.D  
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## Table Of Content

No	Title	Author	Page
1	The Influence Of Implementing Information Technology On Knowledge Management Toward Performance Evaluation Using Balanced Scorecard	Sarjito Surya	1-3
2	Implementation Of Customer Relationship Management (Crm) To Automate Logging Track Record Students And Alumni	Robby Yuli Endra <sup>#1</sup> Fenti Aryani <sup>*2</sup> Septiany Dian Puspita <sup>#3</sup> Ade Kurniawan <sup>*4</sup>	4-10
3	Prototype Model Classification System Level Internal Audit Findings Based On Case-Based Reasoning In Education Quality Management	Marzuki <sup>#1</sup> Maria Shusanti Febrianti <sup>*2</sup>	11-13
4	Implementation Case Based Reasoning In Determining The Rational Prescription Of Tb Drugs	Ahmad Cucus	14-19
5	Implementation Of Workflow Management System On E-Learning Platform For The Effectiveness Of Distance Learning	Yuthsi Aprilinda <sup>#1</sup> Agus Sukoco <sup>*2</sup> Ahmad Cucus <sup>#3</sup>	20-25
6	Thermal Bioclimate For Tourism: Case Study Of Kuta, Bali Province, Indonesia	Nyoman Sugiarta <sup>#1</sup> Andreas Matzarakis <sup>#2</sup>	26-32
7	Minimum System Design Of Android Based Pstn Phone	Deo Kiatama <sup>#1</sup> Fransiscus Ati Halim <sup>*2</sup> Arnold Aribowo <sup>#3</sup>	33-38
8	The Design Of Pressing Equipment For Banana Fruit	M.C. Tri Atmodjo	39-44
9	Modelling Supply Chain Management In B2b E-Commerce Systems	Idris Asmuni	45-51
10	Extreme Programming Study Method Case Study On Designing Of Accounting Term Dictionary	Usman Ependi <sup>#1</sup> Qoriani Widayati <sup>*2</sup>	52-55
11	Review On Economic Valuation Of Solid Waste Management In Bandar Lampung, Lampung	ling Lukman <sup>#1</sup> , Diah Ayu Wulandari Sulistyaningrum <sup>*2</sup> , Taqwan Thamrin <sup>#3</sup>	56-57



No	Title	Author	Page
12	Prototype Topology Sdn For Simple Network Campus	Arnesyulivandika	58-61
13	Tsunami Force On A Building With Sea Wall	Any Nurhasanah <sup>#1</sup> Nizam <sup>*2</sup> Radianta Triatmadja <sup>#3</sup>	62-64
14	Analysis The Quality Of Website Service Information System Academic Integrated ( Siater ) Bandar Lampung University Using Pieces Methods	Yusinta Ria Disanda	65-71
15	Organize Bad Manual Financial Database Of Educational Organization By Bank To Decrease Financial Criminalize	Ruri Koesliandana <sup>#1</sup> Eka Imama Novita Sari <sup>*2</sup> Arnes Yuli Vandika <sup>#3</sup>	72-74
16	Design Of Lampung Bay Waterfront Using Poetic Architecture Approach	Shofia Islamia Ishar, S.T.,M.T. Muhammad Syahrani, S.T.	75-83
17	Analysis Limiting Internet Sites With The Method Using Squid Proxy Server At Smkn 1 South Rawajitu	Reni Tri Astuti	83-88
18	Effect Of Grading On Differences Using Mixed Concrete Aggregate Rough And Fine Aggregate Concrete Compressive Strength Of Natural	Yulfriwini	89-97
19	Analysis Quality Dino Tour Travel Management Website Using Webqual 4.0	Rola Hengki	98-105
20	Holonic Manufacturing System: Current Development And Future Applications	Moses Laksono Singgih	106-113
21	An Analysis Perspective Implemented Text Mining Analytics Information Extraction For Impact Of Indonesian Social Media	Agus Suryana.Mti <sup>#1</sup> Sri Ipnuwati.M.Kom <sup>*2</sup>	114-123
22	Study Of Gold Mine Tailings Utilization As Fine Aggregate Material For Producing Shotcrete Based On Concept Of Green Technology	Lilies Widojoko <sup>1)</sup> Harianto Hardjasaputra <sup>2)</sup> Susilowati <sup>3)</sup>	124-133

No	Title	Author	Page
23	Decision Support System For Determined Recommendations Lecturer Teaching Handbook Using Fuzzy	Usman Rizal <sup>#1</sup> Fenti Aryani <sup>*2</sup>	134-140
24	The Expert System Software Application On Lecture Scheduling Based On Rule Based Reasoning	Taqwan Thamrin <sup>#1</sup> Ahmad Cucus <sup>*2</sup> Adi Wijaya <sup>#3</sup>	141-144
25	Portal Website Analysis Using Iso / Iec 9126-4 Metric Effectiveness (Case Study Indonesia Wi-Fi Portal Website)	Refky Jumrotuhuda	145-149
26	Student Satisfaction Analysis Of Siater Using End User Computing Satisfaction (Eucs)	Erlangga, Jefri Krisna Putra	150-155
27	Urban Tourism Development Through Low Impact Development (Lid) Towards Green-Tourism	*Iir. Wiwik Setyaningsih, Mt *2tri Yuni Iswati, St., Mt, *2sri Yuliani, St., M.App.Sc.	156-161
28	Hawkers Empowerment Strategy To Promote Sustainable Economy In Surakarta	Murtantjanirahayu Rufiaandisetyanaputri	162-172
29	New Urbanism: A Comparative Analysis Between Traditional Village And Housing Estate	Bhakti Alamsyah	173-179
30	Traditional Market Revitalization As An Urban Catalyst In The City Of Surakarta	Istijabatul Aliyah #1, Bambang Setioko #2, Wisnu Pradoto #3	180-188
31	The Robinson Mall Impact On Fv And Ds In Zapa Street, Bandar Lampung City	Ida Bagus Ilham Malik Ilyas Sadad	189-195
32	Decision Support System For Mall Nutrition Using Simple Additive Weighting (Saw) Method	Reni Nursyanti Mujiasih	196-200
33	Effect Of Cement Composition In Lampung On Concrete Strength	Heri Riyanto	201 – 204

No	Title	Author	Page
34	E-Archive digital storage media	Arnes yuli vandika, ade kurniawan, ari kurniawan	205 -207
35	Virtualization Technology for Optimizing Server Resource Usage	Edwar Ali, Didik Sudyana	208 – 212
36	Decision Support System (DSS) For The Determination Of Percentage Of Scholarship Quantity Based Fuzzy Tahani	Robby Yuli Endra #1, Agus Sukoco #2	213 -223
37	Evaluation of Pedestrian Way's Comfort Case Study: Jl. Z. A. Pagar Alam, Bandar Lampung	Haris Murwadi 1*, Fritz Akhmad Nuzir 2	224 - 228
38	Modification Effect Of Volume Cylinder Four Stroke Engine To Effective Power	Ir. Najamudin, MT	229-239
39	Impact Of Motor Vehicle Emissions On Air Quality In Urban And Sub Urban Area ( Case Study: Bandarlampung City)	Ir. A. Ikhsan Karim, MT., Ir. Sugito, MT	240-249

# **MODIFICATION EFFECT OF VOLUME CYLINDER FOUR STROKE ENGINE TO EFFECTIVE POWER**

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**Abstract:** To improve the ability, power changes (performance) of a motor used for racing most mechanics do modifications to the cylinder volume. When the motor cylinder enlarged, the enlarged combustion volume, so that automatically will increase the compression ratio and compression pressure effect on the combustion pressure rise as well, in order to obtain great power. Bore up is a way to increase the volume of the contents of the cylinder, using a piston that has a larger diameter than the standard. So that the cylinder and piston are enlarged, the fuel and air for combustion in the engine can be more obtainable with high compression ratio that produces greater energy (torque) and a higher engine speed (rpm). In the discussion of this study the author discusses the influence of bore up the engine on the motorcycle supra x-cylinder 125 cc of cylinder diameter 52.4 mm to 54 mm, the things that need to be reviewed in this discussion include: Changes in power (performance), changes in torque before and after the engine in the bore up.

**Keywords :** Bore up, power, torque, an increase in the volume of the cylinder.

## **INTRODUCTION**

Along with the rapid competition in the automotive and more people are thinking of adding to the engine it has, among others, by improving the performance and power bore up the motor by means of the moment of choice for modifying the motor, this way is considered more efficient and improve the ability praktis. Untuk a motor that is used for most racing mechanic make modifications to the cylinder volume. When the motor cylinder enlarged, the enlarged combustion volume, so that automatically will increase the compression ratio and compression pressure effect on the combustion pressure rise as well, in order to obtain great power. Bore up is a way to increase the volume of the contents of the cylinder, using a piston that has a larger diameter than the standard. So that the enlarged cylinder piston that will be used in order to fit in the cylinder, then the fuel and air for combustion in the engine can be obtained with much higher compression ratio that produces greater energy (torque) and engine rotation (rpm) higher.

The things to consider in doing bore up bore up is prior to the beginning of the machine see first volume, initial power, power end, effective pressure, thick liner and piston diameter would be used.

In the discussion of this study describes the influence of the author only bore up the engine on the motorcycle supra x-cylinder 125 cc of size 52.4 mm to 54 mm 4 stroke engine, the things that need to be limited in this discussion include:

1. Changes in power (performance) before and after the engine in the bore up.
2. Change the engine torque before and after in the bore up.

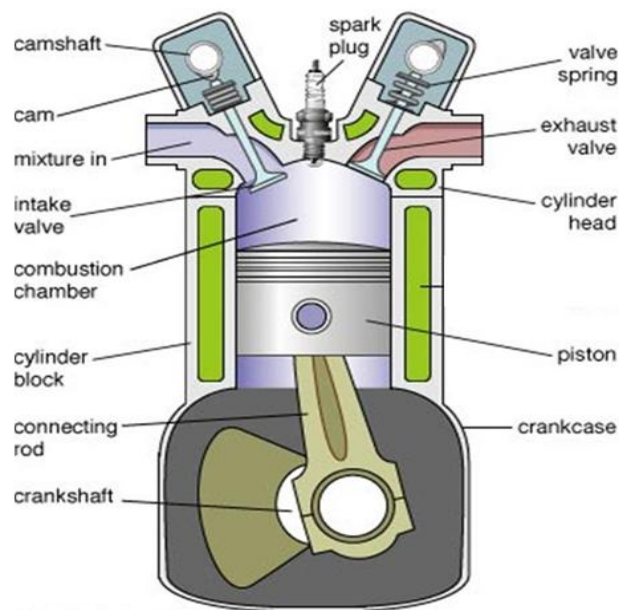
The purpose of this paper is to find out how much difference the effective power, torque, and how much fuel consumption generated by the engine on the motorcycle that bore up the experience.

### BASIC THEORY

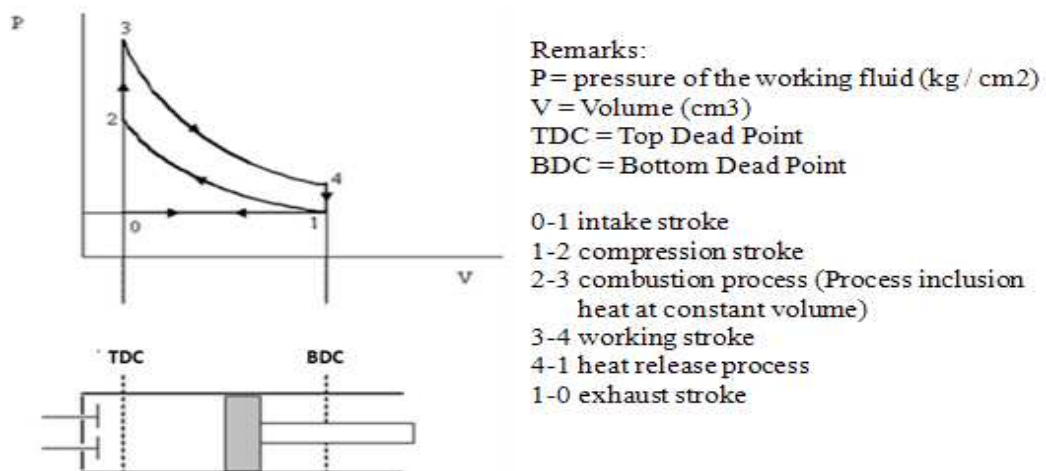
As is the combustion engine is an engine in which the mechanical energy obtained by burning fuel in the engine itself. Therefore, combustion engine sometimes classified in heat engines (Internal Combustion Engine).

One of the prime movers that are widely used heat engine, which is a machine that uses thermal energy to mechanical work, or change the thermal energy into mechanical energy. Energy itself can be obtained by the combustion process.

### Parts of Internal Combustion Engine



**Figure 1. Parts of The Internal Combustion Engine**



**Figure 2. Otto Cycle (Four Stroke Internal Combustion Engine )**

### The plunger (piston)

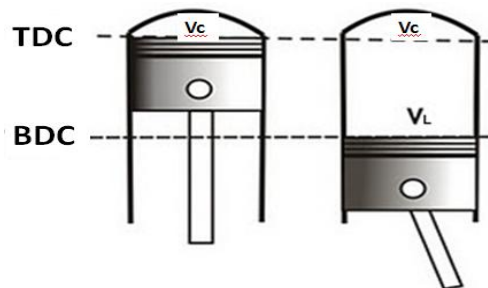
Piston which functions as a tool to suck the fuel, compress the fuel (compression), to accommodate the high-pressure power with higher temperatures. When the piston is replaced with a larger size, automatically measure the cylinder bore must be enlarged also in accordance with the relevant piston diameter and cylinder bore enlarging the term referred to the crankcase. See: RS. Northop. Motorcycle Repair Technique (1987, p: 36).



**Figure 4. Cylinder and plunger (piston)**

### Volume of Cylinder

The total volume ( $V_t$ ) obtained from the total volume of the piston stroke ( $V_L$ ) and clearance volume ( $V_c$ ). The volume of the piston stroke ( $V_L$ ) obtained from stroke piston is at TDC and BDC. Where large volumes of steps depending on the cylinder diameter ( $D$ ) and the piston stroke length ( $L$ ) usually has a unit cubic centimeters (cc).



**Figure 5. The volume of a cylinder**

$$V_t = V_L + V_c$$

$$V_L = \text{Area circle} \times \text{length stroke}$$

$$V_L = \frac{\pi \times D^2 \times L}{4}$$

where:

$$V_L = \text{Stroke volume (cm}^3\text{)}$$

$$D = \text{Cylinder diameter (cm)}$$

$$L = \text{Stroke length (cm)}$$

### Clearance volume

Clearance volume ( $V_c$ ) obtained from stroke piston is at TDC and the combustion chamber.

$$V_c = V_t - V_L$$

Thus, the amount and size of cylinder combustion engine by volume depending on the number of cylinders used and the size of the cylinder.

### The compression ratio

The compression ratio is the number of comparisons between the total volume and the volume of clearance.

$$\epsilon r = \frac{V_L + V_c}{V_c}$$

where:

$r$  = The compression ratio

$V_L$  = Stroke volume (cm<sup>3</sup>)

$V_c$  = Clearance volume (cm<sup>3</sup>)

### Effective power in the Internal Combustion Engine

Motor power is the amount of motor work for a certain time to address all engine load, engine four stroke effective power (4 stroke) uses one cylinder is:

$$Ne = \frac{P_e \times V_L \times n \times z \times a}{100 \times 60 \times 75}$$

Where :

$Ne$  = Effective Power ( PS)

$P_e$  = Mean pressure effective (kg/cm<sup>2</sup>)

$D$  = Cylinder diameter (cm)

$n$  = Engine Speed (rpm)

$V_L$  = Stroke volume (cm<sup>3</sup>)

### Torque moment

Torque is a measure of the ability of a machine to do the work, the amount of torque is the amount of a derivative that is used to calculate the energy produced from the object rotates on its axis, torque values can be calculated :

$$T = \frac{V_L \times z \times a \times P_e}{2 \times \pi \times 100}$$

Lihat : Wiranto Arismunandar. *Internal Combustion Engine*. (2002, p: 33)

Where :

$T$  = Torque moment (kg.m)

$P_e$  = Mean effective pressure (kg / cm<sup>2</sup>)

$V_L$  = Stroke volume (cm<sup>3</sup>)

$Z$  = Number of cylinders

$a$  = The number of cycles per revolution

## METHODS

### Implementation Research

The study was performed using motorbike engines Supra X-125 cc and a standard that has been in the bore up (modified). This test focused on the comparison of the performance of the machines, which are obtained from the comparison between the standard engine with a cylinder diameter of 52.4 mm and engine that already bore up (modified) with a 54 mm diameter cylinder.

This research is data taken power (power), the torque produced by the engine are not experienced and bore up the change and and a machine that already bore up (modified) with a 54 mm diameter cylinder at engine speed 1500, 2500, 4000, 5500 and 7000 rpm.

### **Tools and Materials**

Tools and materials used in this experiment as follows:

1. One unit of Honda Supra X-125 cc in 2006.
2. The standard engine block units and one unit engine block that already bore up (modified) Honda Supra X-125cc.
3. Dynojet, a tool used to calculate engine torque and maximum power is obtained at engine speed (rpm) specific.
4. The fuel, in this case, is premium gasoline.
5. Stop watch, to measure time in the experiment.
6. Tachometer, to measure the rotation speed of the engine
7. Feeler gauge, used to measure the valve gap and spark plug gap.
8. Compression tester, used to measure the compression pressure in the cylinder.



**Figure 6. The cylinders and pistons are used in testing**

### **Research Procedure**

#### **Preparation experiments**

- a. Prepare and check the support equipment used in the study.
- b. Prepare and check the vehicle motorbike Supra X-125d.
- c. Prepare a standard engine block unit and one unit block has bore up (modified) motorbike supra x 125d that will be used in this study.
- d. Measuring the compression of the engine and the engine is standard bore up.

#### **Implementation of the experiment**

##### **1. Experiment to standard machine conditions :**

- a. Measure the compression pressure on a standard machine conditions using Compression Tester, by installing a compression tester in the spark plug hole, then the machine at the kick starter a few times.
- b. Open a faucet in the fuel line so that the carburetor filled.
- c. Pressing the channel ignition switch to "on".
- d. Turning the engine by means of a kick starter machine.
- e. After the engine, adjust the throttle rev the engine to set up a stationary condition and then left to stand for 3-5 minutes to warm up.
- f. After warming the engine for about 3-5 minutes, adjust / rotate the throttle so the initial rotation of 1500 rpm the engine and left for some time so that the rotation is stable.



- g. Once the machine has been incited, new vehicles increased to Dynojet or dynotest.
- h. At the same time, the data are read. Reading the magnitude of the torque, power or power at engine speed 2500 rpm.
- i. Repeating steps i to round (n) = 4000 rpm.
- j. The next step is the same as i. Every up 1 stroke, setting the addition of 1500 rpm engine rev up at 7000 rpm rotation and is also accompanied by the reading of the data.
- k. When finished, operate the throttle control to the idle position, then turn off the engine.

## **2. Experiment for the condition of the engine that has been modified (bore up) :**

- a. Install the cylinder block dibore up on the vehicle.
- b. After silnder block installed, then do the same test as the standard engine testing above.
- c. When finished, operate the throttle control to the idle position round, then turn off the engine.

### **Analysis**

This research uses the method of observing the direct observation of experimental results then make conclusions and research results.

### **Analysis Calculation Before The Bore Up**

#### **1. Determine the Stroke Volume (VL)**

Piston diameter (D) = 52.4 mm = 5.24 cm

Stroke Length (L) = 57.9 mm = 5.79 cm

$$VL = \frac{\pi \times D^2 \times L}{4}$$

$$VL = \frac{3,14 \times (5,24 \text{ cm})^2 \times 5,79 \text{ cm}}{4}$$

$$VL = 124,8 \text{ cm}^3$$

#### **2. Determining the Clearence Volume (Vc)**

Compression ratio = 9.3: 1

Stroke Volume = 124.8 cm<sup>3</sup>

$$\text{Jadi, } r = \frac{Vl + Vc}{Vc}$$

$$9,3 = \frac{124,8 \text{ cm}^3 + Vc}{Vc}$$

$$9,3 Vc = 124,8 \text{ cm}^3 + Vc$$

$$9,3 Vc - Vc = 124,8 \text{ cm}^3$$

$$8,3 Vc = 124,8 \text{ cm}^3$$

$$Vc = 15,03 \text{ cm}^3$$

**Analysis Calculation Bore Up After The (modified)  
Determining Stroke Volume (VL)**

$$VL = \frac{\pi \times D^2 \times L}{4}$$

Given: Piston Diameter (D) = 54 mm = 5,4 cm  
Length stroke (L) = 57,9 mm = 5,79 cm

$$VL = \frac{3,14 \times (5,4 \text{ cm})^2 \times 5,79 \text{ cm}}{4}$$

$$VL = 132,54 \text{ cm}^3$$

**Compression ratio after modified (r)**

$$r = \frac{Vl + Vc}{Vc}$$

Where :

$$\text{Clearence Volume} = 15,04 \text{ cm}^3$$

$$\text{Stroke Volume} = 132,54 \text{ cm}^3$$

Then,  $r = \frac{Vl + Vc}{Vc}$

$$r = \frac{132,54 \text{ cm}^3 + 15,04 \text{ cm}^3}{15,04 \text{ cm}^3}$$

$$r = 9,8$$

**RESULTS AND DISCUSSION**

**Research Results**

Specifications Motor Honda Supra X-125d

Engine type: 4 stroke

Diameter x Stroke: 52.4 mm x 57.9 mm

Volume stroke : 124.8 cc

The compression ratio: 9.3: 1

Diameter x Stroke: 54 mm x 57.9 mm (modified)

Volume Stroke: 132.54 cc (modified)

The compression ratio: 9.8: 1

**The results of the data collection engine condition at Bore Up (modified)**

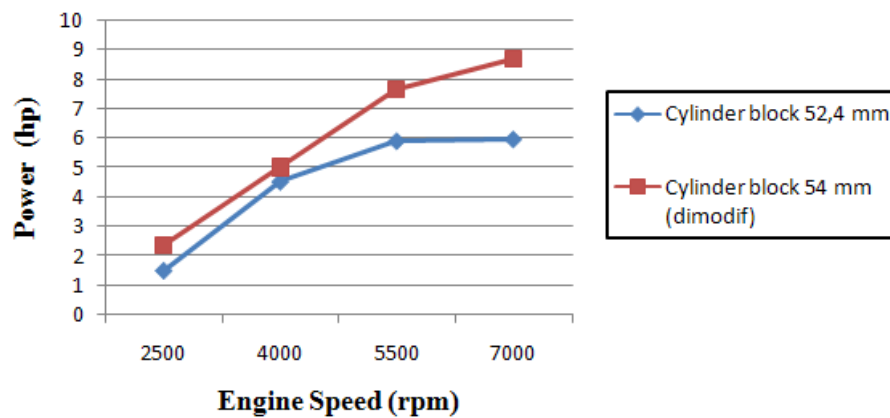
Collecting data in a test using a 54 mm cylinder block as follows:

From the test results with the use of a 54 mm diameter cylinder block, from stage 1 to stage 4, power and maximum torque changes or significant increases of approximately 2 hp from the use of 52.4-mm diameter cylinder block.

**Table 1. Average power and torque on cylinder 52.4 mm and cylinder 54 mm**

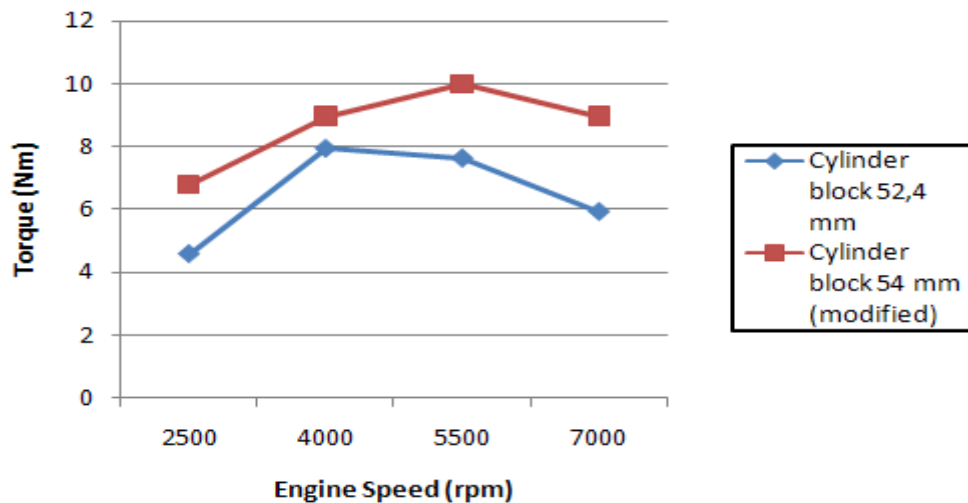
Type Cylinder	Speed rotation (Rpm)	Power (Hp)					Torque (Nm)				
		1	2	3	4	Average	1	2	3	4	Average
Cylinder block standar 52,4 mm	2500	2.00	2.10	1.01	0.87	<b>1.50</b>	5.23	5.75	4.02	3.38	<b>4.60</b>
	4000	4.38	4.49	4.70	4.52	<b>4.52</b>	7.75	8.00	8.20	7.93	<b>7.97</b>
	5500	5.93	5.87	6.02	6.15	<b>5.90</b>	7.50	7.53	7.83	7.76	<b>7.66</b>
	7000	5.92	5.92	6.00	6.00	<b>5.96</b>	5.86	5.90	6.01	6.02	<b>5.95</b>
Cylinder blok 54 mm (modification)	2500	2.49	2.25	2.61	2.25	<b>2.40</b>	7.20	6.00	7.11	6.94	<b>6.81</b>
	4000	5.00	4.90	5.25	5.00	<b>5.04</b>	9.02	8.62	9.21	9.00	<b>8.96</b>
	5500	7.75	7.50	7.75	7.75	<b>7.69</b>	10.01	9.90	10.01	9.97	<b>9.97</b>
	7000	8.81	8.32	8.84	8.83	<b>8.70</b>	9.00	8.83	9.00	8.99	<b>8.96</b>

**Graphics Power (hp) vs Engine Speed (rpm)**



From the chart above, it is seen that the power cylinder combustion engine that uses a block of diameter 54 mm higher, because it is basically an enlarged cylindrical major effect of increasing the power generated.

**Graphics torque (Nm) vs engine rotation (rpm)**



From the graph above, the value generated torque of the motor under test increases with increasing engine rev up to 4000 rpm and then decreased, both for the use of state of the cylinder block 54 mm increased to 5500 rpm and then decreased.

## **CONCLUSIONS AND RECOMMENDATIONS**

### **Conclusion**

Based on the results of research and analysis of data and discussion of the theory of the field is done, it can be concluded as follows:

1. In testing the power and torque of the engine to the standard conditions of cylinders 52.4 mm, 6.15 hp gain maximum power and maximum torque of 8.20 Nm using test equipment Dynojet.
2. Then in a test using a 54 mm cylinder power gain (power) 8.84 maximum hp and maximum torque of 10.01 Nm.
3. Specifications Engine before modified (bore up) :
 

Stroke Volume (VL)	= 124.8 cm <sup>3</sup>
Clearance volume (V <sub>c</sub> )	= 15, 03 cm <sup>3</sup>
Compression ratio (r)	= 9.3: 1
Maximum Effective Power	= 6.15 Hp
Torque (T)	= 8.20 Nm
4. Specifications Engine after modified (bore up) :
 

Stroke Volume (VL)	= 132.54 cm <sup>3</sup>
Clearance volume (V <sub>c</sub> )	= 15, 03 cm <sup>3</sup>
Compression ratio (r)	= 9.8: 1
Maximum Effective Power	= 8.84 Hp
Torque (T)	= 10.01 Nm
5. Judging from the analysis calculation upgrade the engine by means of a bore up stroke affect the volume, cylinder volume, power and greater torque than a standard machine conditions.

### **Suggestion**

1. For motorcycle users who want to increase the power and speed of the bike can bore up the engine.
2. For the motorist who has experienced bore up the engine, you should change it ignition system and the fuel system in order to get a big power anyway.
3. It is recommended if you want to bore up, need to pay attention to the thickness of the cylinder wall, if it is too thin and followed the suggested enlarging the cylinder to replace the cylinder block as desired.

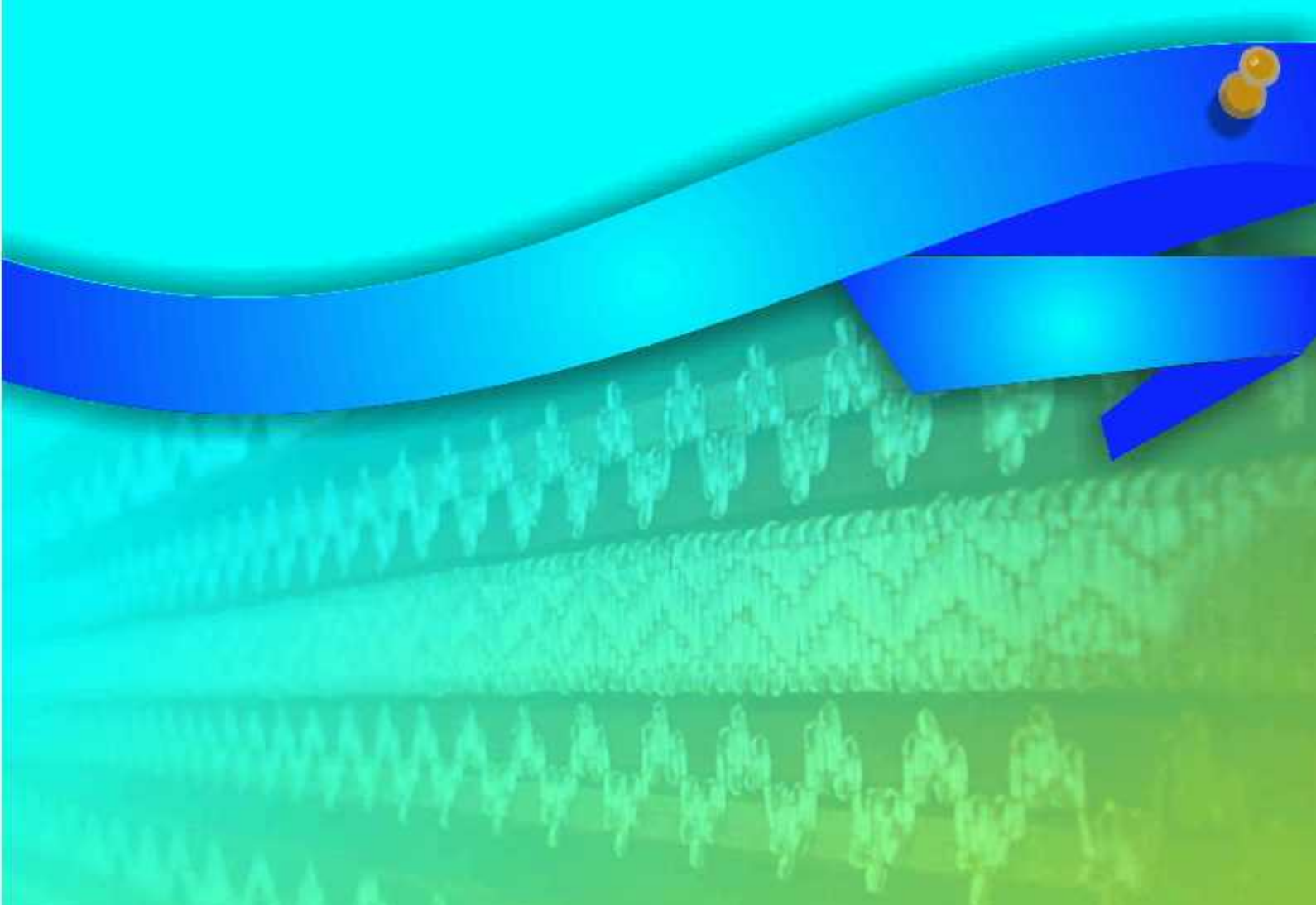
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