PROCEEDINGS

4th International Conference on Technical and Vocational Education and Training (TVET)

Theme:
Technical and Vocational Education and Training for Sustainable Societies

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FOREWORD

Welcome for all respected scholars, researchers, post graduate studentsand especially Keynote Speakers to the 4 ICTVET. The theme of the conference focus on Technical and Vocational Education and Training for sustainable societies and consist of six subthemes. i.e Development of learning model on TVET, Workplace Learning and entrepreneurship, Innovationon applied engineering and information technology, Management and Leadership on TVET, Vocational and Technical Teaachers education, and Assessment and Evaluation on TVET.

Sustainable society shoul be followed by the improvement of various factors that have impacts to the quality of vocational and technical education and training, particularly to overcome the competitiveness of the world business. As we have already known the rapid change of technology as well as the change of demography, having a great effects to the life of peoples in this world, The competitiveness need a collaborativeness to survive the life of millions peoples who lost their jobs. Young peoples as aproductive generation have to be creative and innovative to face the competitiveness. So this prociding contents consist of various findings of research in the field of vocational and technical education as well as applied technology and mainly based on the subthemes of the conference.

Finally, we would like to thank a million for all participants of this conference and all parties who support the success of this conference. Hopefully the seminars and scientific work of this seminar can be a reference material for basic education and elementary school teacher education in Indonesia.

Padang, July 2, 2018

Tim Editor

CONTENT PROSIDING ICTVET 2017 REPOSITORY UNP

DESIGN OF ELECTROMAGNETIC REGENERATIVE SHOCK ABSORBER AS A TOOL OF HARVESTING VIBRATION ENERGY ON VEHICLE

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ABSTRACT: This article discusses vibration energy on the vehicles shock absorber which was converted to electrical energy by using magnet and coil. Principally, vibration energy on the shock absorber will be wasted into friction and heat form. But, we are able to obtain the vibration energy and utilize it as a new energy source for the vehicle by adding the mechanism of harvesting energy electromagnetic type. Linear movement of the shock absorber is captured by electromagnetic generator mechanisms which are consist of a coil and a permanent magnet. The produced output of the electromagnetic generator can be used as new energy source for the vehicle. The mechanism of harvesting energy used electromagnetic generator was chosen through literature study that has been done by the researcher. Which was electromagnetic generator has the smallest of loss of energy value of all type of harvesting energy. The testing data which used galvanometer, it was obtained that the resurrection energy was 2.5 mV on 1.5 Hz excitation frequency, 4.24 mV on 2.0 Hz excitation frequency and 5.6 mV on 2.5 Hz excitation frequency.

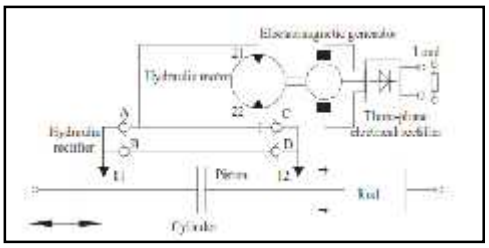
Keyword: shock absorber, harvesting energy, electromagnetic generator,

1. INTRODUCTION

Based on the data which was obtained on Center for Energy, Transportation and the Environment (CETE), it is known that vehicles will work effectively using 16% of fuel energy from the result of combustion used. The rest 62% will be engine losses in heat and vibration form, 11% engine idling, 6% transmission losses, and 2% from the adding of accessory such as Air Conditioner (AC), wiper, etc. Shock absorber is a component which is used as the pedestal of vehicle's body and to isolate the vehicle from the vibration cause of the road's contour. The changes of mechanism energy happened on the conventional shock absorber (up and down energy of vehicle's body) into heat energy which was happened because the movement of fluid on the shock absorber. Meanwhile, the design changes happened on the electromagnetic regenerative shock absorber which was the up and down energy on the shock absorber captured and changed it into excitation energy to actuate the electromagnetic mechanism which is set on the Shock absorber. So, the loss energy on the shock absorber can be reused. This regenerative shock absorber is expected to be able to keep down the looses energy value on the heat and vibration sector which is 62% until the efficiency value of vehicle increase.

2. LITERATURE REVIEW

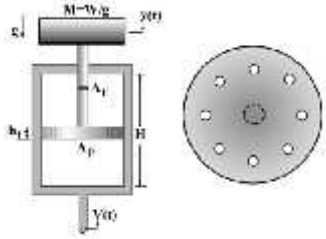
There are several studies relate to a Regenerative shock absorber which was used as the background of this article. One of them is Li Chuan, et al [1] with regenerative shock absorber by using hydraulic rectifier as rectification flow and then go through the hydraulic motor.



Picture 1. Regenerative shock absorber with a hydraulic motor

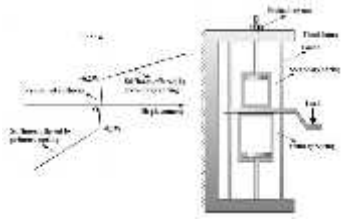
Compression and rebound movement of the shock absorber is rectified through a rectifier and then goes to the hydraulic motor. The function of the hydraulic motor is to spin the generator. The source of motor movement on the generator is obtained from the pressure fluid which has come from the rectifier. The generator spin produces electrical energy which is used as a new energy source.

Next, a shock absorber liquid damper type [2] from Indian Institute of Technology.



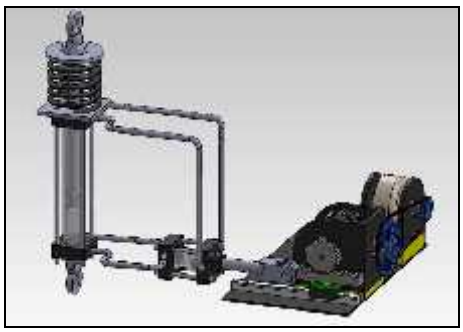
Picture 2. Liquid damper shock absorber

From the test, it was obtained that the damping energy is a nonlinear curve. This is the damping energy's value of the test:



Picture 3. Force dumper curve of liquid dumper shock absorber

Last, HEMSA (Hydraulic Electro Mechanic Shock absorber) from Institut Teknologi Sepuluh Nopember [3]. The following picture is the design of HEMSA from Institut Teknologi Sepuluh Nopember



Picture 4. Hydraulic Electro Mechanic Shock absorber (HEMSA) from ITS

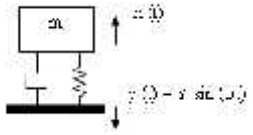
From the test with the load 85 Ω, 125 Ω, 250 Ω, it was obtained the resurrection energy on 1.7 Hz excitation frequency in sequence based on the load, are 0,52 watt, 0,39 watt, 0,32 watt. With the cylinder variation 40:40, double port pipe and 85 Ω, 125 Ω, 250 Ω load, it was obtained velocity sprung mass value in sequence based on the load, are 2.270 m/s^2, 2.084 m/s2, 1.744 m/s^2.

Based on those literature sources, the writer was interested to make a regenerative shock absorber with the electromagnetic mechanism. Besides the simple construction design, this electromagnetic system also has a small loss of energy.

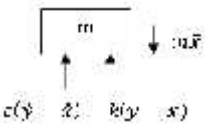
3. BASIC THEORY

3.1 Harmonic Vibration

Usually, vibration not only occurs on the spring system nor the prop, the base of the system will also experience the vibration in harmonic vibration form.



Picture 5. Excitation on the base



Picture 1. Free Body Diagram excitation on the base

From the free body diagram on picture 5 and excitation on the base on picture 6, the equation of movement that was obtained is:

$$m\ddot{x} + c(\dot{x} - \dot{y}) + k(x - y) = 0$$

The Steady-state response of the mass is $x_p(t)$ which is can be formed into this following equation:

$$x_p(t) = \frac{kY\sin(\omega t - \theta_2)}{[(k - m\omega^2)^2 + (c\omega)^2]^{1/2}} + \frac{\omega cY\sin(\omega t - \theta_1)}{[(k - m\omega^2)^2 + (c\omega)^2]^{1/2}}$$

So, the system equation above can be written as:

$$x_p(t) = X\sin(\omega t - \theta_1 - \alpha)$$

$$= \left[\frac{k^2 + (c\omega)^2}{(k - m\omega^2)^2 + (c\omega)^2}\right]^{1/2} \sin(\omega t - \theta_1 - \alpha)$$

Where the value of $\theta_1 = tan^{-1}\left(\frac{C\omega}{k - m\omega^2}\right)$

That equation can be simplified into:

$$x_p(t) = X\sin(\omega t - \theta)$$

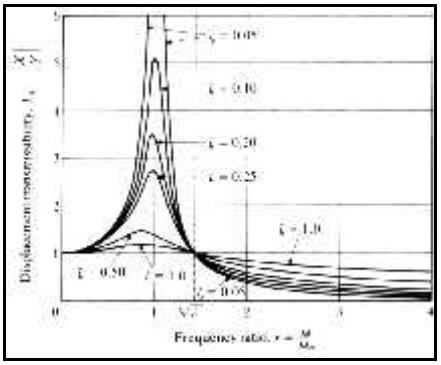
Where $\frac{X}{Y}$ is displacement transmissibility:

$$\frac{X}{Y} = \left[\frac{k^2 + (c\omega)^2}{(k - m\omega^2)^2 + (c\omega)^2}\right]^{1/2} = \left[\frac{1 + (2\zeta r)^2}{(1 - r^2)^2 + (2\zeta r)^2}\right]^{1/2}$$

And,

$$\theta = tan^{-1}\left[\frac{mc\omega^2}{(k - m\omega^2)^2 + (c\omega)^2}\right] = tan^{-1}\left[\frac{2\zeta r^3}{1 + (4\zeta^2 - 1)r^2}\right]$$

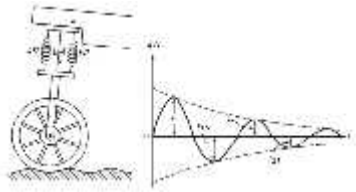
The relevance of damping ratio, frequency ratio, and displacement transmissibility is shown in the following graphic:



Picture 2. Displacement transmissibility vs frequency ratio

3.2 LOGARITHMIC DECREMENT

Logarithmic decrement is a display of amplitude reduction on free damp vibration. The value of damping constantan on the system will be known if the logarithmic decrement (δ) is also known.



Picture 8. System 1 DOF on vehicle's shock absorber with its damper and system experiment analysis

From the picture above, t is known as time on the first and second peak, $x_1$danx$_2$ show the peak movement, and form the ratio:

$$\frac{x_1}{x_2} = e^{2\pi\zeta/\sqrt{1-\zeta^2}}$$

If both parts of logarithm were naturalized, it will be:

$$\delta = \ln\frac{x_1}{x_2} = \frac{2\pi\zeta}{\sqrt{1-\zeta^2}}$$

The equation above can be written as:

$$\zeta = \frac{\delta}{\sqrt{(2\pi)^2+\delta^2}}$$

From displacement graphic, the function of time will be obtained from x_1 and x_2, and then the value will be included in decrement equation, so the equation will be:

$$\zeta = \frac{\delta}{\sqrt{4(\pi)^2+\delta^2}}$$

Where:ζ = damping ratio

δ = logarithmic decrement = $\ln\frac{x_1}{x_2}$

The value of damping ratio can be found by using this formula:

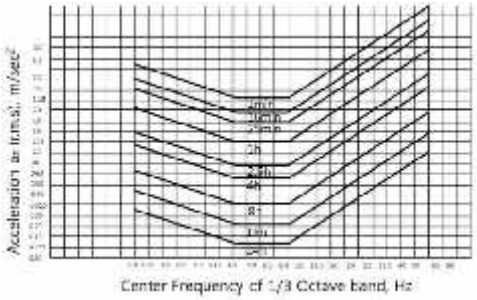
$$\zeta = \frac{C}{C_c} = \frac{C}{2\sqrt{km}}$$

Where: k = Spring content (N/m)
C = Damping constant damping
m = Load mass (kg)

3.3 The effect of vehicle's velocity toward human

The main movements that were experienced by the driver and passenger during the ride are velocity or deceleration and vibration. Endurance information about human body toward the velocity is very important as references on the endurance of vehicle's body design toward the impact.

The pleasure criteria based on velocity number according to ISO 2631 standard, will be shown in this following graphic:



Picture 9. The pleasure criteria graphic based on ISO 2631 standard

3.4 Loretz Law

The permanent magnet array of regenerative the electromagnetic shock absorber is connected to wheel axles of the vehicle and the coil windings array is connected to the framework or body of the vehicle. When the vehicle travels on rough roads, the relative displacement between framework or body and wheel axles causes relative displacement between coil windings array and permanent magnet array. At this point coil groups will be cutting the magnetic induction lines in the air-gap, thus current occurs in the coil and in the meantime damping force occurs correspondingly. The direction of the damping force is relatively opposite to the movement of the coil group. When the conductor moves perpendicularly to the direction of magnetic induction line, the Lorentz force can be defined as:

$$F = q \cdot V \cdot B$$

Where: F = Lorentz force (N)
q = quantity df electricity (C)
V = Velocity of electric charge (m/s)
B = Magnetic flux density (T)

4. DESIGN AND PARAMETER

4.1 Coil

The coil is used as a track movement of the permanent magnet. This coil will capture GGL from the result of magnet movement in it. This is the design of coil R2.

Picture 10: Coil

4.2 Permanent Magnet

This magnet is used as a moving component which is installed in the rod shock absorber. The rod movement which was installed the permanent magnet on the coil will cause the electricity force. This is the construction of permanent magnet on the rod shock absorber.

Picture 11: Permanent magnet

4.3 Full design concept

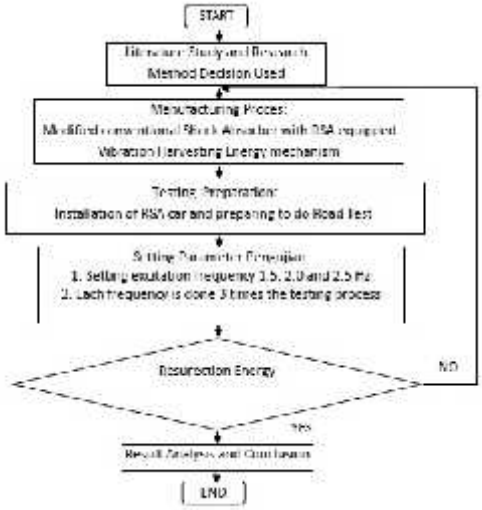
On this part, it is shown that the mechanism of harvesting energy attachment on the up and down rod movement which pass the coil.

Picture 12: Component detail RSA

When it assembled and ready to test:

Picture 13: RSA assembly ready to test

4.3 Research Methodology



Picture 14: Research Methodology

5. RESULT

From the road test by using bump 50 mm high to replace the road surface, the resurrection energy that was obtained on RSA are:

No	Frequency	Energy Ressurection			
		Test I	Test II	Test III	Average
1	1.5 Hz	2.3	2.6	2.5	2.5 mV
2	2.0 Hz	4.30	4.37	4.1	4.24 mV
3	2.5 Hz	5.4	5.8	5.6	5.6 mV

6. CONCLUSION

The resurrection energy from RSA is relatively small. It was caused by the limitation of the step length of the “stroke” area from the permanent magnet on passing the coil area. To wider the length of its step, we need to do a redesign and choose better material in order to get bigger resurrection energy.

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