Piezohump – A Radical Shift towards Renewable Energy Source

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***Abstract*—Energy is one of the principle driving forces in the present world, it is transforming our lives and shaping our future. However, the conventional energy sources are lessening due to increase in population and exploitation of energy day by day. To overcome this problem, we need to implement the techniques of optimal utilization of conventional sources for conservation of energy. The present research article includes how renewable energy can be harnessed when the vehicles passes over a speed breaker using piezoelectric material. The concept of piezoelectricity from speed breaker is to harness energy, which is lost inevitably on daily basis. Kinetic energy of moving vehicle induces mechanical deformation of embedded piezoelectric material therefore produce electricity. This green energy can be used to recharge batteries, lighting street or used to offset some of the power coming from the main grid. The energy, which was lost on consistent basis, can now be the source of energy and help for greener tomorrow.**

***Keywords*— Piezoelectric material, kinetic energy, speed breaker, direct piezoelectricity, green energy, conservation of energy, etc.**

I. INTRODUCTION

Electricity is needed at every point in our daily lives. Significant increase in energy costs and decrease in the supplies of fossil fuels, necessitates to develop methods for judicious use of energy which lay emphasis on protecting the environment as well. One of the novel ways to accomplish this is through energy harvesting. Energy harvesting, or energy scavenging, is a process that captures small amounts of energy that would otherwise be lost as heat, light, sound, vibration or movement.

This paper emphasis on harnessing significant energy when a vehicle moves over speed breakers. A lot of vehicles move over the roads frequently and each passing by vehicle has enough kinetic energy that is lost when it impacts speed breakers. We can capture kinetic energy which then converted to potential energy can serve our purpose. We can tap the energy generated and produce power by using the speed breaker as power generating unit. The kinetic energy of the moving vehicle can be converted into electrical energy by embedding piezoelectric generator in speed breaker. Energy harvesting also has the potential to replace batteries for small, low power electronic devices.

In this research, we propose to implement the same concept of energy harvesting in synthetic speed breaker.

II. FUNDAMENTALS OF PIEZOELECTRIC MATERIAL

Piezoelectricity is a physical phenomenon that can convert mechanical movements into electricity. The piezoelectric effect exists in two domains, the first is the direct piezoelectric effect that describes the material's ability to transform mechanical strain into electrical charge, the second form is the converse effect, which is the ability to convert an applied electrical potential into mechanical strain energy (figure 1).

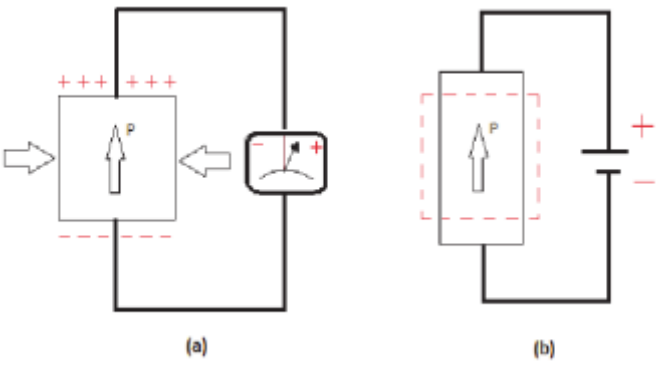

Fig.1 Electromechanical conversion through piezoelectricity phenomenon
(a)Direct piezoelectric effect (charge apparition)
(b)Reverse piezoelectric effect (deformation effect)

The piezoelectric materials that exist naturally as quartz do not exhibit interesting properties for the production of electricity, however artificial piezoelectric materials such as PZT (Lead Zirconate Titanate) present advantageous

characteristics. Piezoelectric materials belong to a larger class of materials called ferroelectrics. One of the defining traits of a ferroelectric material is that the molecular structure is oriented such that the material exhibits a local charge separation, known as an electric dipole. Throughout the artificial piezoelectric material composition, the electric dipoles are orientated randomly, but when a very strong electric field is applied, the electric dipoles reorient themselves relative to the electric field; this process is termed poling. Once the electric field is extinguished, the dipoles maintain their orientation and the material is then said to be poled. After the poling process is completed, the material will exhibit the piezoelectric effect.

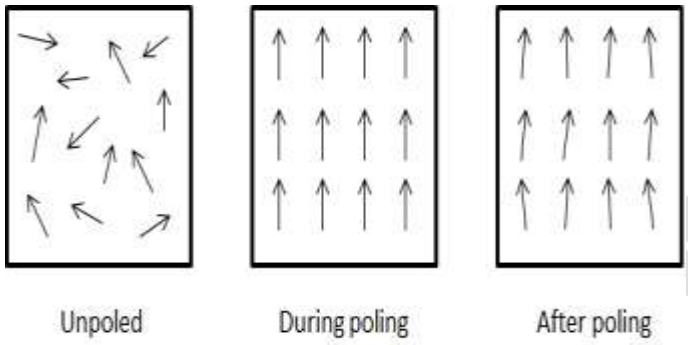

Fig.2 Polarization of ceramic material to generate piezoelectric effect

III. Speed Breaker

According to IRC 99-1998, a speed breaker is a hump surface across a roadway having a rounded shape with width greater than the wheelbase of most of the vehicles using the road. A speed breaker is a device that uses vertical deflection to slow motor-vehicle traffic in order to improve safety conditions on roads. Speed breakers are formed by providing a rounded (of 17-metre radius) hump of 3.7 metre width and 0.10 metre height for the preferred advisory crossing speed of 25 km/h for general traffic. Figure.3 showing recommended specification cross-section of speed breaker dimensions.

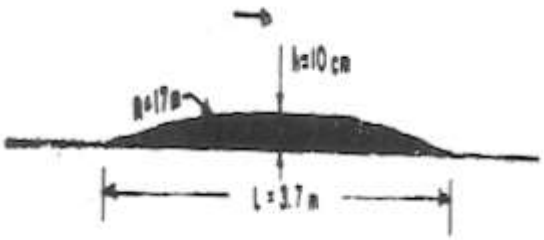

Fig.3 Longitudinal-section from IRC 99-1998

This design will also enable these vehicles to pass the hump at about 25 km/h. Speed breakers are generally a bump provided on roadway in asphalt road construction.

Rubber or synthetic speed breakers are the alternatives used which are in units. Synthetic speed breaker units are nailed in continuous over the width of the road. Synthetic speed breakers are available in different dimensions. We aim to adapt units of synthetic speed breakers with dimensions L:500mm x W:400mm x H:75mm as shown in sketch (figure.4). Each unit is split into two components: upper component and lower component. The trial dimensions for split of synthetic speed breakers are as shown in figure.5.

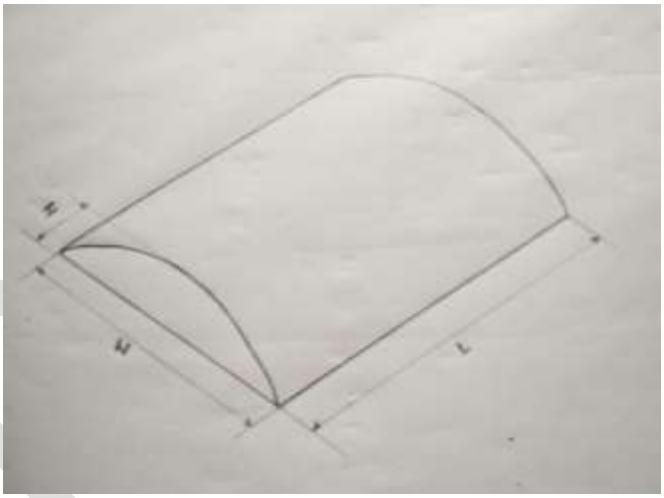

Fig.4 Isometric view of synthetic speed breaker unit

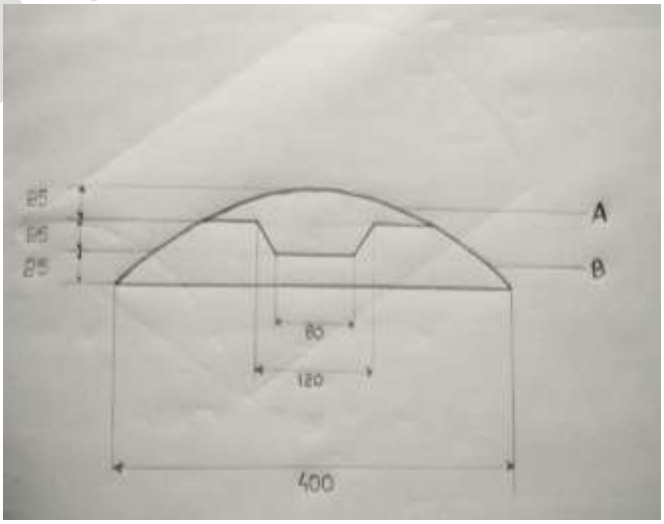

Fig.5 Trial dimensions in MM for splitting of synthetic speed breaker
A. Upper component
B. Lower component

IV. Methodology Used

When a vehicle passes over a speed breaker, the speed breaker deflects vertically. This deflection is released as thermal energy. For a synthetic speed breaker with embedded piezoelectric generators, part of the energy the vehicle

expands on speed breakers deformation is transformed into electric energy through direct piezoelectric effect instead of being wasted as thermal energy. The mechanical energy is derived from the compression stress created during the vehicles' movement on speed breaker. The vertical deflection of speed breaker is proportional to the vehicle weight. The only source for harvesting electric energy is this part of mechanical energy related to the speed breaker vertical deformation, which is a percentage from the total energy of the vehicle.

The piezoelectric material is sandwiched between upper and lower components of synthetic speed breakers. It is known that the vertical load of the vehicle's wheels yields compression stress, diminishing with depth. The generators are embedded at a depth of about 5-6cm (out of 7.5cm); the area where the compressive stress is maximal and hence the piezoelectric effect can be maximised. Two pieces, upper component and lower component are held together by detachable anchor-suspension locking system. The lower component is permanently fixed to pavement.

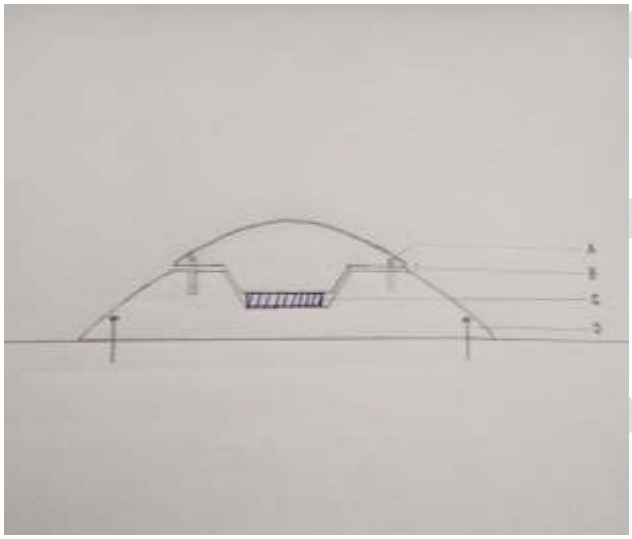

Fig.6 Showing piezoelectric generator placement and connections of components

A. Detachable anchor-suspension locking system
B. Clearance between components
C. Piezoelectric generator placement
D. Rigid connection of lower component with pavement

The external load results in the deformation of said speed breaker and hence the embedded piezoelectric generator. The deformation of the piezoelectric material generates charges that are the source for the electricity. The charges generated can be used to recharge batteries. The energy needed to deform the road is a function of various parameters such as: the surface quality of synthetic speed breaker, vehicle load, temperature and the stiffness of the piezoelectric generators is function of the piezoelectric material.

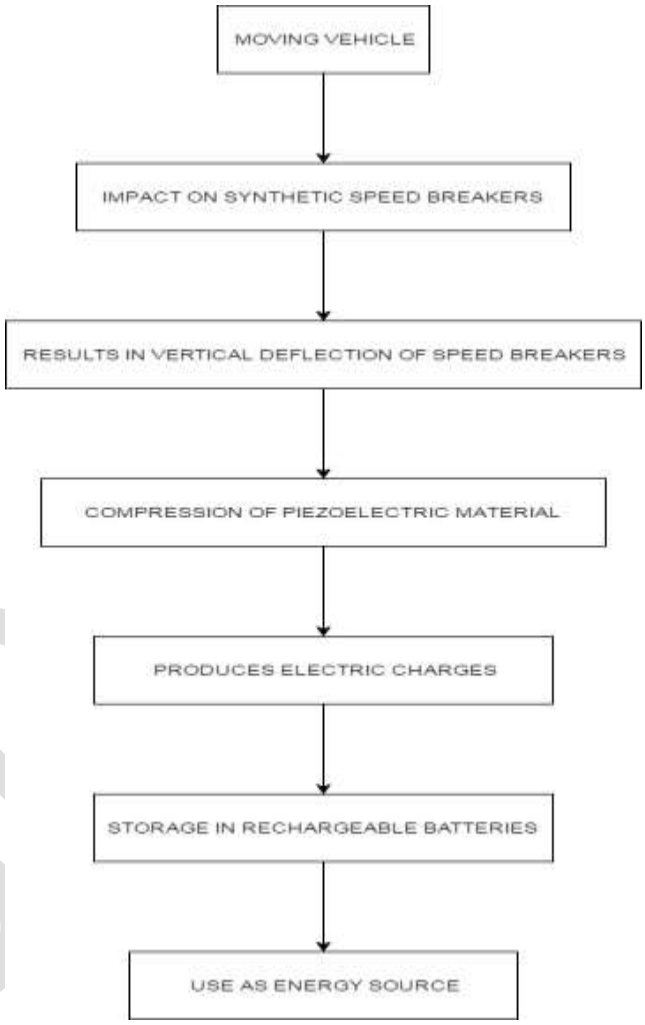

Figure.7 Shows flowchart of operation

V. Expected Outcome

By using this method, electricity generation is expected to be higher in rate compared to other implementation of piezoelectric generator. Electricity will be generated throughout the year without depending on other factors and it is pollution free power generation. No need of manpower during power generation. Low cost power generation from non-conventional resource.

The energy obtained can be used to recharge batteries, in lighting street lights, to replace low power electronic devices or to offset some power coming from main grid.

VI. Conclusion

Electricity plays a vital role in socio-economic development of the country. The energy demand is increasing drastically and the conventional sources are depleting very fast. The demand for electricity can be partly fulfilled by

harnessing renewable energy. Population, which is one of the reason for energy exploitation helps in generating renewable energy as the high traffic volume passes over speed breakers with piezoelectric generator. A large amount of energy is unutilized at speed breakers through friction, every time a vehicle passes over the speed breaker. The energy, which was lost on consistent basis, can now be a significant source of energy and help for greener tomorrow. This idea provides an alternative source of renewable energy generation and expected to have vital significance in upcoming years/decades.

REFERENCES

[1] Korra Ravi Kiran, Dr. M. Kumar, "STUDY ON SPEED BREAKERS AND ITS EFFECT ON SPEED AND VEHICLE OPERATING COST." ABSTRACT NUMBER: 141.

[2] E. Minazara1, D. Vasic1, and F. Costa1,"PIEZOELECTRIC GENERATOR HARVESTING BIKE VIBRATIONS ENERGY TO SUPPLY PORTABLE DEVICES." RE&PQJ, Vol. 1, No.6, March 2008.

[3] Fayeq Najuib, Nikita Gupta, Pradyumna Rawat, Priyank Agarwal, Nitin Kuma, "COLLAGE OF VARIOUS POWER SOURCES FROM ENERGY EFFICIENT TECHNIQUES." IJERMT, ISSN: 2348-4039, Vol-1, Issue-2, March 2014.

[4] Aniket Mishra, Pratik Kale, Atul Kamble, "ELECTRICITY GENERATION FROM SPEED BREAKERS." IJES, ISSN (e): 2319 – 1813 ISSN (p): 2319 – 1805, Vol-2, Issue-11, 2013.

[5] Ch Naveen Kumar, "ENERGY COLLECTION VIA PIEZOELECTRICITY." International Conference on Vibration Problems (ICOVP-2015).

[6] Parul Dhingra, Jhilam Biswas, Anjushree Prasad, Sukanya S. Meher, "ENERGY HARVESTING USING PIEZOELECTRIC MATERIALS." ICEDSP, 2012.

[7] IRC: 99-1988, TENTATIVE GUIDELINES ON THE PROVISION OF SPEED BREAKERSS FOR CONTROL OF VEHICULAR SPEEDS. ON MINOR ROADS.