

# Energy Harvesting through Speed Breakers Using Piezoelectric Materials

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**ABSTRACT:** In today's situation energy becomes a basic need for human life. Conventional energy sources like petroleum and gasoline generate most of the energy in today's world. Since population is increasing day by day and the conventional energy sources are getting exhausted at a very fast rate, nonconventional sources are needed to be developed for power generation which are clean, sustainable and environment friendly. In this paper, we propose a renewable non-conventional energy source using piezoelectric technique. Speed breakers are one of the common tools to reduce the speed of oncoming vehicles, this paper includes how renewable energy can be gathered when a vehicle passes over a speed breaker using piezoelectric materials. The concept of using piezoelectricity from speed breaker is to produce energy, which is lost daily. The kinetic energy of oncoming vehicles results in a mechanical deformation of the embedded piezoelectric material in the speed breakers, therefore producing electricity. This clean energy can be used to recharge batteries, lighting the streets or to power traffic lights.

**KEYWORDS:** Kinetic energy, piezoelectric materials, speed breakers, non-conventional energy source, energy harvesting, green energy, renewable etc.

## I. INTRODUCTION

Energy is needed at every point in our daily lives. We obtain energy through various methods, out of which conventional methods is most commonly used one. Conventional sources of energy such as coal, petroleum and natural gas have been used extensively over the years and have depleted significantly. The conventional sources of energy are also the cause of global warming and pollution of the environment. Hence, it is necessary to come up with alternative energy sources. Non-conventional energy derived from windmills, solar, bio-gas etc. are renewable and clean energy. Adopting to non-conventional energy sources is essential because it is sustainable, renewable, clean and is environment friendly. The most commonly used non-conventional energy is derived from solar and windmills.

This paper emphasizes on harnessing energy through speed breakers using piezoelectric materials. Piezoelectricity is the appearance of an electrical potential across the sides of a crystal when subjected to mechanical stress.

Many vehicles move over the roads frequently and each vehicle has enough kinetic energy that is lost when it impacts speed breakers. We can capture this kinetic energy which is then converted to potential energy. 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 a piezoelectric generator in the speed breakers.

## II. RELATED WORK

### [1] Speed Bump with Piezoelectric Cantilever System as Electrical Energy Harvester

A speed bump is designed with spring module, cantilever with piezoelectric module, and electrical energy converter circuit. It includes the modifications of the size of the speed bump to comply with government regulation, the spring characteristics, the cantilever knocking mechanism and the mechanical coupling system.

### [2] Energy Harvesting for Back-up Power Supply Using Speed Humps

An idea of rotational conversion using flywheel and gear mechanism is used underneath the road surface at the point of road where a speed-breaker is raised. The linear motion of a rack is converted into rotational motion applied by the oncoming vehicular load. A pulley structure is geared such that it is ultimately making the generator to rotate for producing an output voltage.

### [3] Electrical Power Generation through Speed Breaker

A system is designed to tap into the energy generated by moving vehicles and produce power by using the speed breaker as power generating unit. The kinetic energy of the moving vehicles is converted into mechanical energy through rack and pinion mechanism and this mechanical energy is again converted to electrical energy using generator which is used for lighting the street lights. Vehicle pressure on the speed breaker is converted into rotary energy through rack and pinion using hydraulic press. Consequently, the rotary energy rotates generator that generates electrical power which is stored through battery using a charging circuit.

### [4] Power Generation using Piezoelectric Crystal, Hydraulic Press & Electromagnetic Induction

A new mechanism is designed to generate power from speed bumps. A combination of hydraulic mechanism, piezoelectric crystal mechanism & electromagnetic induction is used. When a vehicle passes over the speed bump which is made of cylinder and piston arrangement, then the electric energy is generated.

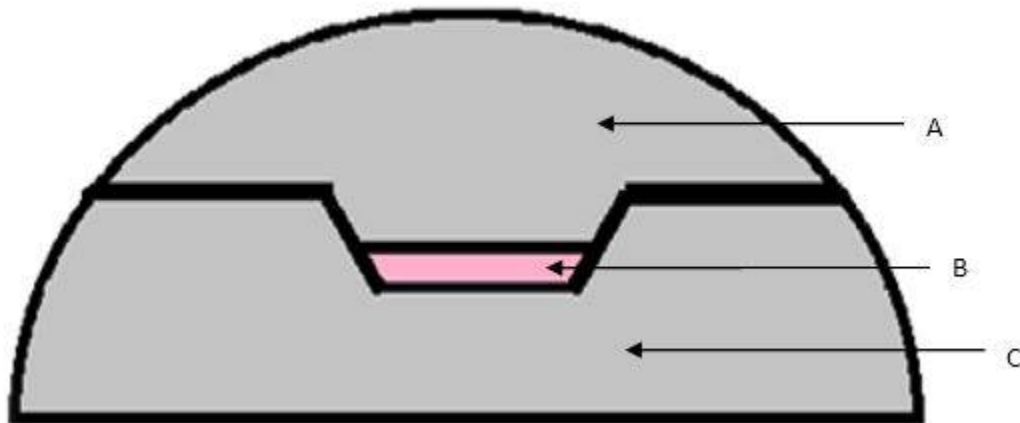
## III. METHODOLOGY

Whenever an oncoming vehicle passes over a speed breaker, the speed breaker is made in such a way that it deflects vertically. This deflection is released as thermal energy. Using a synthetic speed breaker with embedded piezoelectric generators, part of this 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. Energy is harvested in this part of speed breaker vertical deformation, which is a percentage from the total energy of the vehicle.

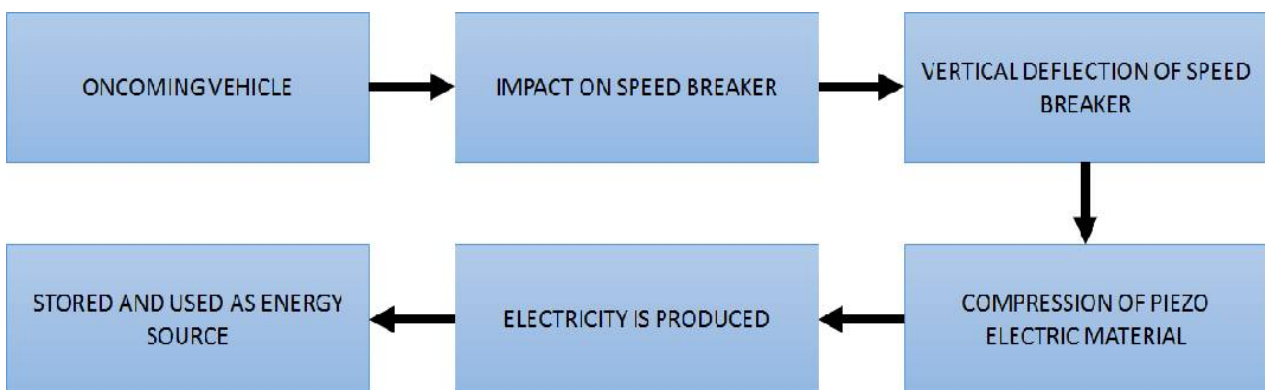
The piezoelectric material is sandwiched between upper and lower components of synthetic speed breakers as illustrated in Fig 1. It is known that the vertical load of the vehicle's wheels yields compression stress, which diminishes with depth. The piezoelectric generators are embedded in such a way that the compressive stress is maximal and hence the piezoelectric effect can be maximized. The speed breaker is divided into three parts, the upper part, part with piezoelectric material and lower part. The upper part can be detached from the lower part, and the lower part is fixed to the road.

In India, there is a lack of speed breakers in critical zones of roads and accident prone areas, hence by implementing the synthetic speed breakers at the critical zones of roads, the streets and roads are more secure and the number of accidents caused can be minimized. By doing this, the amount of energy generated is also more.



**Fig 1: Piezoelectric material placement inside the synthetic speed breaker**  
 A. Upper detachable part of speed breaker  
 B. Piezoelectric material(generator)  
 C. Lower fixed part of speed breaker

The generation of energy through speed breakers is illustrated in Fig 2. Whenever an oncoming vehicle is passing through the synthetic speed breaker, when the impact on speed breaker occurs, the vertical deflection of speed breaker takes place resulting in the compression of the piezo electric materials placed inside the speed breaker. This compression of piezoelectric material in turn results in the formation of electrical energy. The electrical impulses generated are supplied to a electricity energy converter module. This module uses a 10000  $\mu$ F capacitor to collect the electrical charges. This electrical energy can be then captured and used for lighting street lights and powering traffic lights or stored and can be used as needed. Hence, the kinetic energy which was being wasted whenever a vehicle passed through a speed breaker is now collected through piezoelectric generator in the form of electric energy.



**Fig 2: Generation of energy using piezoelectric material**

**IV. CONCLUSION AND FUTURE ENHANCEMENTS**

Electricity plays a very important role in socio-economic development of the country. The demand for energy has increased drastically and the conventional sources are depleting at a very fast rate. The demand for electricity can be

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partly fulfilled by harnessing renewable energy. This system is non-conventional power generation and harnessing technique which is also eco friendly. A large amount of kinetic energy is unutilized at speed breakers, every time a vehicle passes over the speed breaker. The energy, which was lost on a consistent basis, can now be a significant source of energy and help for a greener tomorrow.

In future enhancements, a microcontroller and application software can be implemented to monitor the energy collection process. The microcontroller can be used to measure the capacitor voltage and send the data to the application software for recording and visualization.

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