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Energy Generation in Speed Breakers by using Piezoelectric Sensors

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Abstract - *The demand for power is increasing day by day. To meet the current necessity of an undisrupted power supply we need to think of multiple renewable resources. One such solution to the energy crisis could be energy generation using piezoelectric effect. This effect is incorporated in our speed breaker model to harness electricity. The electricity generated by the configuration is stored in the batteries for later use in the day to day applications.*

Key Words: **Piezoelectricity**, **Renewable Energy**, **Speed breaker**, **Piezoelectric effect**

1.INTRODUCTION

The project emphasises use of piezoelectric effect. The word Piezoelectric is derived from the Greek piezein, which means to squeeze or press, and piezo, which is Greek for "push". Piezoelectric Effect is the ability of certain materials to generate an electric charge in response to applied mechanical stress. When piezoelectric material is placed under mechanical stress, a shifting of the positive and negative charge centers in the material takes place, which then results in an external electrical field. When reversed, an outer electrical field either stretches or compresses the piezoelectric material. This effect is utilized in the following manner. When a vehicle passes over a speed breaker, stress is induced in the PZT(Lead Zirconate Titanate) plate. This develops a voltage proportional to stress induced. The voltage thus developed is passed through an active rectifier followed by a DC to DC converter. The generated electrical energy can be stored for the later use in the form of batteries.

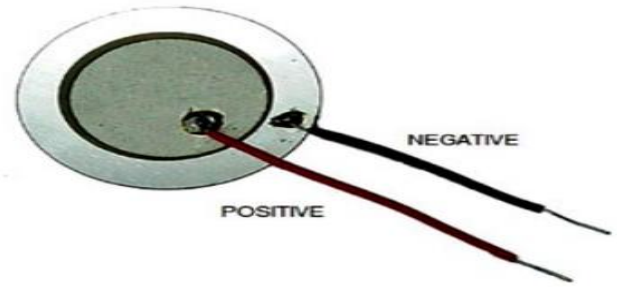

Fig -1: Piezoelectric Plate

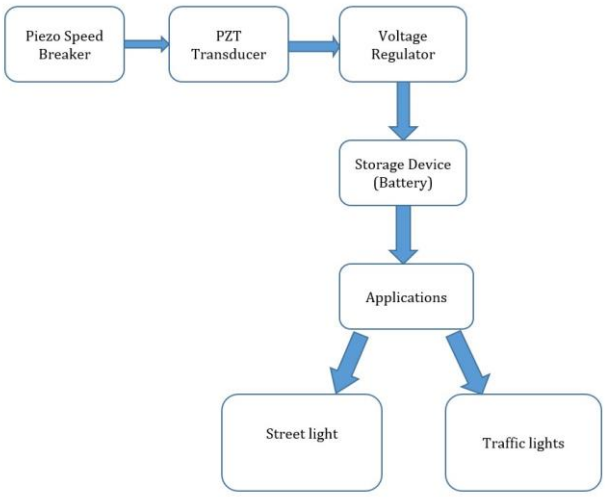

Fig -2: Block diagram

1.1 Actual Model for piezoelectricity

We considered a simple road model for the current study. The vehicles moving along the road will cover the area of the speed breaker. The 1 mm vertical displacement of the speed breaker is allowed to push the trigger on to the piezoelectric plates. As the stress is applied on the plates required voltage is produced which is then stored in the batteries.

After the voltage generation some modulation of the output current is required for the further completion of the process. According to the manufacturer's catalogue, 1 unit of PZT can generate a voltage of 104 V by application of 750 N of force.(cad images)

1.2 PZT Piezoelectric Sensor

A piezoelectric sensor is a piezoelectric device that uses piezoelectric effect to measure changes in pressure, acceleration, temperature, strain or force by converting them to electric charge. A piezoelectric sensor requires no external voltage or current source as they are able to generate an output signal from the strain applied. This makes them a popular choice for many applications. The use of these sensors is growing significantly throughout different industries and they are sometimes incorporated into other sensors.

A piezoelectric sensor converts physical parameters like acceleration, strain or pressure into an electrical charge which can then be measured. They are highly sensitive and very small in size making them well suited to everyday objects.

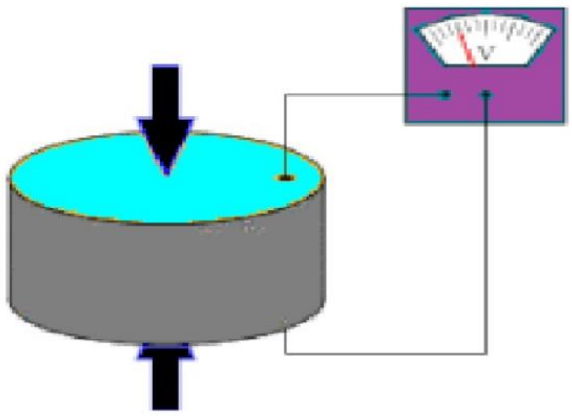

Fig -3: PZT Sensor

Piezoelectric sensors are strong, lightweight and constructed of flexible plastic enabling them to be available in a range of sizes, shapes and thicknesses. They will often be moulded or glued into place within applications. Other characteristics also include high strength, elastic compliance, high mechanical strength and high stability. The ceramic materials such as PZT have a piezoelectric constant/sensitivity that is roughly two orders of magnitude higher than those of the natural single crystal materials and can be produced by inexpensive sintering processes.

2. CALCULATIONS FOR PZT

The size of PZT plate commercially available is 25*25*3.5mm. To develop a sufficient amount of static voltage required to charge lead acetate battery which charges at 10A/12.6V, we are using 10 such plates connected in parallel fashion with inbuilt circuit resistance.. We have introduced a rubber pad which will help to retain the upper cover of the speed breaker.

2.1 Calculation of dimensions of rubber pad

Since we are using a nitrile rubber pad which has Young's Modulus of 4MPa. Since allowable deflection is 10mm with an optimum load of 7500N the dimension of padding comes out to be 3000*80*25mm. This meets our current requirements.

2.2 Calculation of Power Generation

The speed breaker is designed to have a deflection of 10mm on application of 7500 N on 10 plates. For single pzt sensor with 750N load the amount of static voltage developed is calculate by:

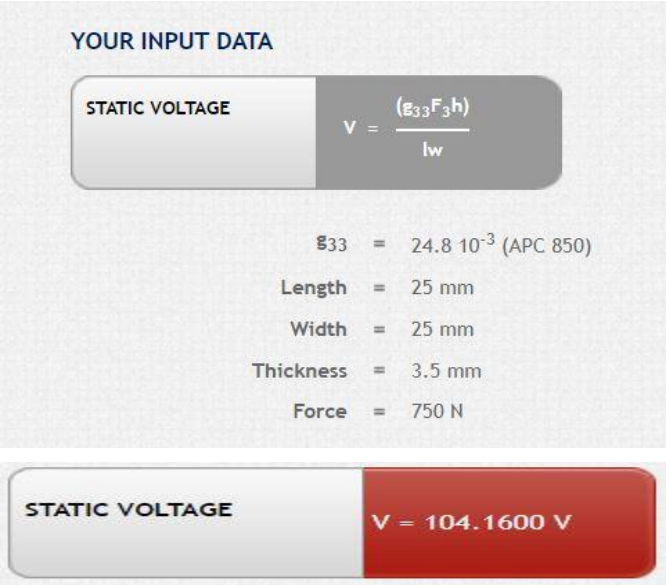

Fig -4: Sample Voltage Calculation for a Four Wheeler

The voltage developed is 104V.

Table -1: Vehicle Type and Voltage Generation

Vehicle Type and Voltage Generation	
Type of Vehicle	Voltage Generated(Volts)
Two Wheeler(Bike)	17
Four Wheeler(Car)	104
Heavy Four Wheeler(Bus)	1000

The above table shows the amount of voltage that can be generated by different types of vehicles.From this table, it is quite clear that a bus can generate a voltage of 1000 V. A two wheeler can generate a maximum voltage of 17 V.

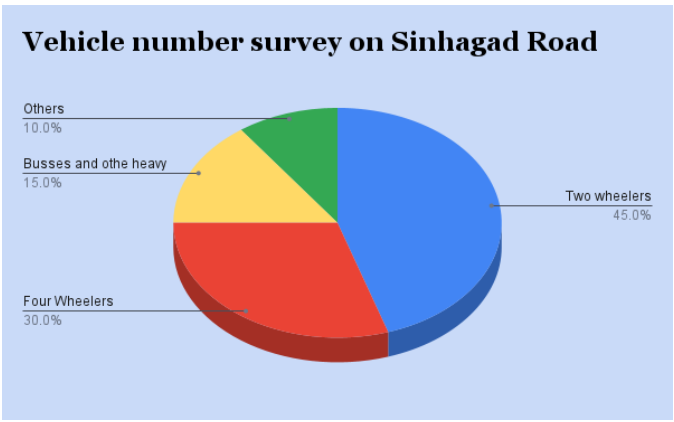

Chart -1: Vehicle passing over a speed breaker

This pie chart shows the total number of the vehicles passing on the Sinhagad Road in Pune, the road which we considered for the study of the number of vehicles. This chart shows 45% of the vehicles are two wheelers which produce significantly low voltage and 15% of the vehicles are heavy vehicles which are able to generate an extreme amount of voltage.

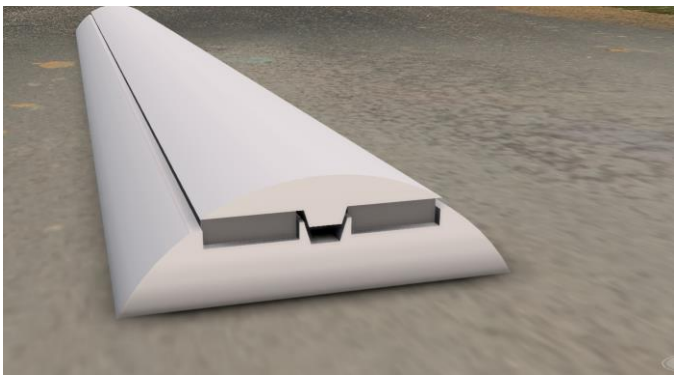

Fig - 5: Our cad model of the speed breaker(image 1)

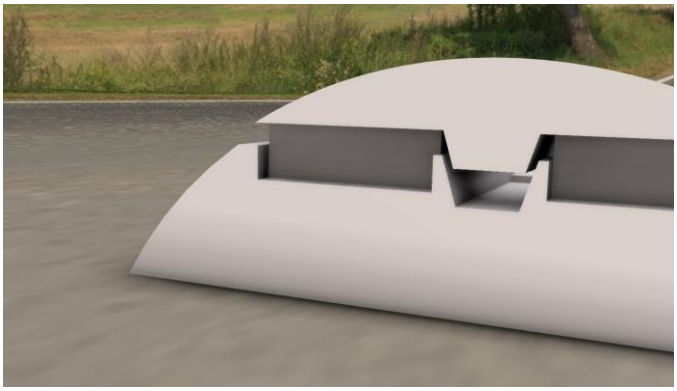

Fig - 6: Our cad model of the speed breaker(image 2)

These images show our cad model in a realistic world rendered using 3D experience native application. The vehicle tries to describe the working model of the speed breaker after real life implementation.

3. CONCLUSION

As we all know that conventional energy sources are depleting day by day. Hence, we need to focus our attention on sustainable and new renewable energy sources by improving current methods of generating new ideas..Thus, a new method which we studied is harvesting energy by using PZT sensors. From our observations and calculations we found that the method is quite practical involving multiple future scopes and research.

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