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SPEED BREAKER POWER GENERATION

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Abstract - *The project is about the design and manufacturing of speed breaker power generator. In this project we are trying to utilize one such source. Electricity is generated by replacing the traditional speed breakers with some simple mechanism. As vehicles pass over the speed breakers, the speed breaker itself goes down due to weight of the vehicle which results in displacement of a rack gear which rotates the pinion connected to shaft of the generator which in turn produces electricity.*

This method is an effective way to produce electricity as the numbers of vehicles on the road are ever increasing. Also, the cost of fabrication of the model is low. It can be effectively placed near traffic lights, at the entrance of parking lots and any other place where the traffic density is high. As vehicle passes over it, it starts moving. This method provides an efficient way to generate electricity from the kinetic energy of moving vehicles in roads, highways, parking lots etc.

In this report we explain in detail the various stages of research, design and manufacturing which was involved in the construction of various components such as springs, generator, rack and pinion mechanism. Most of the parts are assembled by the students themselves. It also mentions the reason behind using the specific materials and methods of construction for effective working of the system. In short, this report includes an overview of design and research undertaken in making the project successful.

The mantra of the group "In engineering, everything has a reason" is highlighted in the following report.

Keywords*: Non - Conventional energy source, generator, rack and pinion mechanism, speed breaker power, shaft, guiding pipes.*

1. INTRODUCTION TO SPEED BREAKERS

Speed bumps (or speed breakers) are the common name for a family of traffic calming devices that use vertical deflection to slow motor-vehicle traffic in order to improve safety conditions. Variations include the speed hump, speed cushion, and speed table.
The use of vertical deflection devices is widespread around the world, and they are most commonly found to enforce a low speed limit, under 40 km/h (25 mph) or lower.

Although speed bumps are effective in keeping vehicle speeds down, their use is sometimes controversial as they can increase traffic noise, may damage vehicles if traversed at too great a speed, and slow emergency vehicles. Poorly-designed speed bumps that stand too tall or with too-sharp an angle can be disruptive for drivers, and may be difficult to navigate for vehicles with low ground clearance, even at very low speeds. Many sports cars have this problem with such speed bumps. Speed bumps can also pose serious hazards to motorcyclists and bicyclists if they are not clearly visible, though in some cases a small cut across the bump allows those vehicles to traverse without impediment. Speed bumps cost Rs.1000-2000 and may need replacement over time due to wear.

1.1 MOTIVATION

An energy crisis is any significant bottleneck in the supply of energy resources to an economy. Industrial development and population growth have led to a surge in the global demand for energy in recent years. There is a current global need for clean and renewable energy sources. Fossil fuels are non-renewable and require finite resources, which are dwindling because of high cost and environmentally damaging retrieval techniques. So, the need for cheap and obtainable resources is greatly needed. [1]

1.2 MODIFICATIONS

This project attempts to show how energy can be tapped and used at a commonly used system, the road speed breakers. The number of vehicles passing over the speed breaker in roads is increasing day by day. A large amount of energy is wasted at the speed breakers through the dissipation of heat and also through friction, every time a vehicle passes over it. There is great possibility of tapping this energy and generating power by making the speed-breaker as a power generation unit. The generated power can be used for the lamps, near the speed breakers.

The present work an attempt has been made to fabricate a bump, which can utilize the kinetic energy of vehicles in power generation. This type of bump is best suited for the places where the speed breaker is a necessity. The places like Toll bridges or on vehicle parking stands are best for its utilization. The work also discusses the shortcomings of existing methods and the ways it is countered by this method.

2. LITERATURE REVIEW

2.1 SPEED BREAKER POWER GENERATION

It is very significant to design pollution free energy generation system. Speed breaker Power Generator (SBPG) is the most emerging technique which produces electrical power with minimum input. An experimental study to generate the electricity by SBPG is described in this paper. In this system, a rack and pinions mechanism is used for the production of electricity. When a car reaches on the speed breaker, the rack moves downward to generate linear to rotary motion using pinions. The rotary motion is transferred to DC generator which generates DC power which is stored in batteries same as in solar technology. The generated power can be used for the domestic purpose or commercially, which are present near the speed breaker. This examined that SBPG is generating 273.24W on single push under the application of 400kg. In an hour, passing 100 cars of 400kg can generate 54.59 kWh. This mechanism utilizes both downward as well as the upward motion of the rack. [2]

2.2 ELECTRICITY GENERATION BY SPEED BREAKER

Energy is the primary need for survival of all organisms in the universe. Everything what happens in the surrounding is the expression of flow of energy in one of the forms. But in this fast moving world, population is increasing day by day and the conventional energy sources are lessening. The extensive usage of energy has resulted in an energy crisis over the few years. Therefore to overcome this problem we need to implement the techniques of optimal utilization of conventional sources for conservation of energy. This paper includes how to utilize the energy which is wasted when the vehicles passes over a speed breaker. Lots of energy is generated when vehicle passes over it. We can tap the energy generated and produce power by using the speed breaker as power generating unit. The kinetic energy of the moving vehicles can be converted into mechanical energy of the shaft through rack and pinion mechanism. Then, this mechanical energy will be converted to electrical energy using generator which will be saved with the use of a battery. [3]

3. METHODOLOGY

3.1 VARIOUS MECHANISMS AVAILABLE

Table1. Available Mechanisms

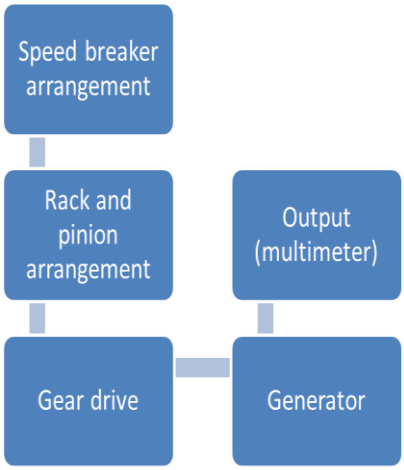
Serial No.	Type of Mechanism Available	Advantages	Disadvantages
01	Spring coil mechanism	Consumes less space. More durable. Better recoil.	• Accelerated corrosion due to lower temperatures. Sudden impact can cause spring breakage.
02	Rack- Pinion mechanism	Less backlash Greater feedback • Accurate displacement	• More guiding supports are required Additional gear reduction required
03	Crank-shaft mechanism	• No direct connection with speed breaker Easier to maintain	• Heavier in construction Occupies more space
04	Roller mechanism	• Easier in construction • Less costly	Less efficiency • Slippage

➢ Things to be considered while selecting a mechanism,

1) Practical Approach – It was seen that whether modeling the selected mechanism is practically possible or not.
2) Cost of the total project – The total cost of the project must be limited.
3) Feasibility - The construction of the project must be easy and can be done at a student level. Additionally, availability of certain components or processes is seen.
4) Efficiency – The efficiency obtained from the mechanism must be high.

3.2 METHOD SELECTED – RACK AND PINION MECHANISM

Electricity is a basic part of nature and it is one of our most widely used forms of energy. A large amount of energy is wasted at the speed breakers through the dissipation of heat and also through friction, every time a vehicle passes over it. In this research, a roller is fitted in between a speed breaker and some kind of a grip is provided on the speed breaker so that when a vehicle passes over speed breaker it gets displaced in vertically downward direction distance 7 cm. The rack which is connected to the speed breaker also moves down simultaneously with same distance 7 cm. The rack is in mesh with the pinion which is coupled with the shaft of gear which have 72 teeth which then meshed with pinion with 32 teeth which is coupled with the generator motor. This whole mechanism converts linear displacement in rotary motion. Hence shaft of generator rotates which generates current proportional to the number of revolutions of pinion. This produced current is stored in battery for future use. Later the rack gets displaced to the original position due to spring mechanism.



4. DESIGN

4.1 DESIGN APPROACH

The main objective of design phase is to make use of waste materials for manufacturing of the modified speed breaker. During brainstorming we decided what could be better than if we could use scrap car parts and did exactly the same. Everyday hundreds of cars get dumped into junkyard due to some tragic events.

Most of the major components of our project are derived from used cars. The most important component i.e. the "Rack and Pinion" mechanism was extracted from steering mechanism of a car. Also the springs which return the speed breaker to its original position were obtained from suspension of a car. This serves dual purpose, firstly it uses waste material from cars and another, that it is suitable to handle the weights of similar class vehicles passing over the speed breaker.

Also we needed to simplify the design in such a way that we could manufacture it using the techniques available to as at our level. We decided to use a bottom up approach for our design. For example, starting from the base plate, we used welding techniques to make supporting pipe structures on it. Then we could support the two springs which will be used to bring back the speed breaker into its original position into those pipes. In this way we could accomplish the changes or modifications necessary to design during manufacturing phase.

For designing CAD model of our project we have chosen to use solid works because of its ease to use and seamless, integrated workflow design. First we created all the main components one by one in solid works and then assembled them to make complete design.

4.2 DESIGN OF VARIOUS COMPONENTS OF THE SYSTEM

A) Base Plate

As discussed earlier the main purpose of base plate is to support the entire assembly. It houses two guidance pipes for the springs. It is as shown in fig.2.

Table2. Specifications of Base Plate

Dimensions	(mm)
Length	678
Breadth	275
Height	1
Inner Diameter	104
Outer Diameter	114
Quantity	1

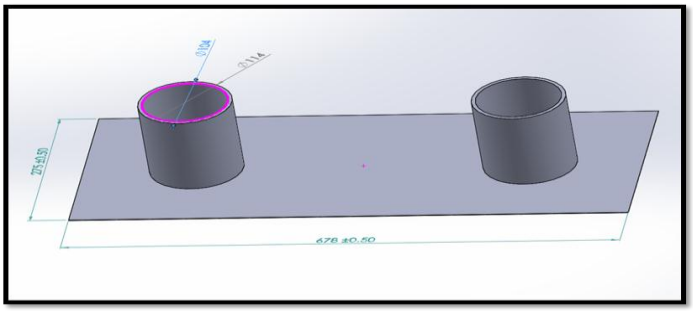


Fig 2. Base Plate

B) Top Plate

Top plate is the uppermost part of the mechanism on which the actual speed breakers lie. Similar to the base plate it also has guidance pipes for the spring. It is as shown in fig.3.

Table3. Specifications of Top Plate

Dimensions	(mm)
Length	678
Breadth	275
Height	1
Inner Diameter	63
Outer Diameter	73
Quantity	1

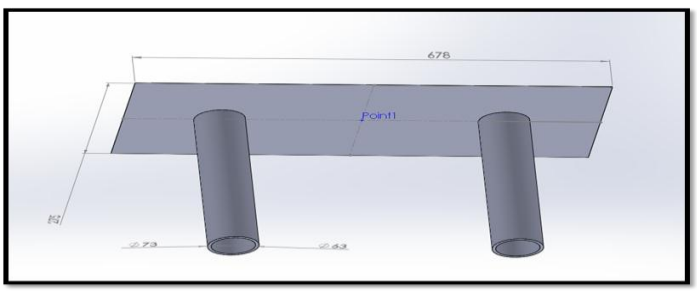


Fig3. Top Plate

C) Springs

The main function of the spring is to provide a reaction force after the vehicle passes over the speed breaker. This restores the speed breaker back to its original position. It is as shown in fig.4.

Table4. Specifications of Spring

Dimensions	(mm)
Length	370
No of turns	10
Diameter	72
Wire Diameter	10
Quantity	2

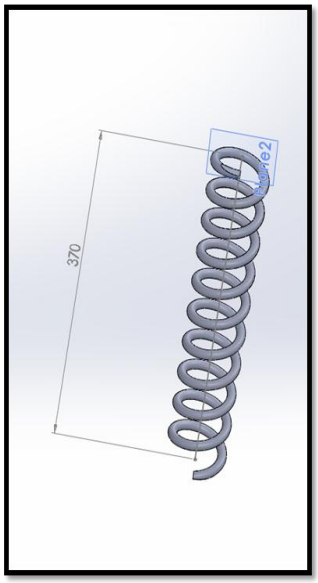


Fig 4. Spring

D) Rack And Pinion

Rack & Pinion is used to transfer vertical motion due to vehicle in rotary motion of the motor. This part is obtained from steering mechanism of a car, and then coupled with an idler in order to increase the number of rotations. It is as shown in the fig.5.

Table5. Specifications of Idle gear & Rack

Idler gear	
No of teeth	72
Diameter	111 mm
Shaft Diameter	12 mm
Rack	
Length	270 mm

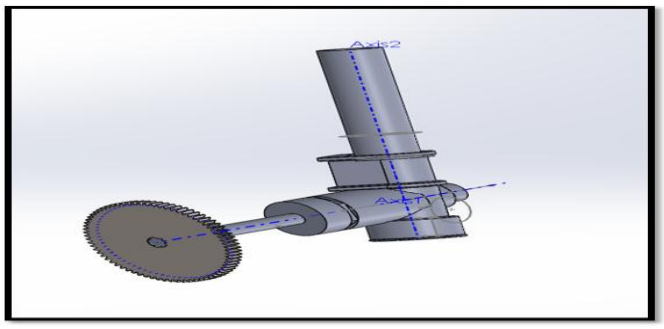


Fig 5. Rack and pinion with Idle gear

D) Motor And The Main Gear

Motor is an essential component which converts mechanical energy into electrical energy. It is coupled with main gear which will be coupled to idle gear in order to increase the number of rotations of motor. It is as shown in the fig. 6, 7.

Table 6. Specifications of Motor and Gear

MOTOR	
Voltage	110V AC
Frequency	50/60Hz
Power	14W
Rotating Speed	30r/min

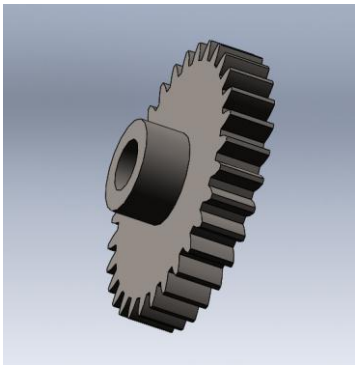


Fig 6. Main Gear

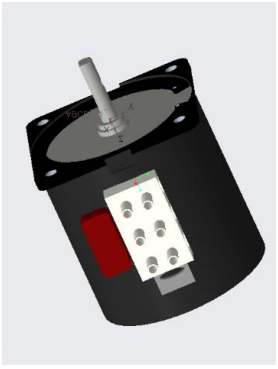


Fig 7. Motor

4.3 DESIGN AND ASSEMBLY

The following parts are assembled using a bottom up approach. The base plate lies at the lower most parts which would lie underground. Then the springs are fitted around the guidance pipes of the base plate. These springs provide upward force which will bring back the speed breaker to its original position. Then the top plate is fitted into the springs using guidance pipes. This acts as the actual speed breaker. Then the rack and pinion is fitted at the center of the top plate so that it can absorb maximum force of the vehicle. The rack and pinion are coupled with two idler gears one of which is then coupled to the motor. The partial assembly is shown in the figure 8 below.

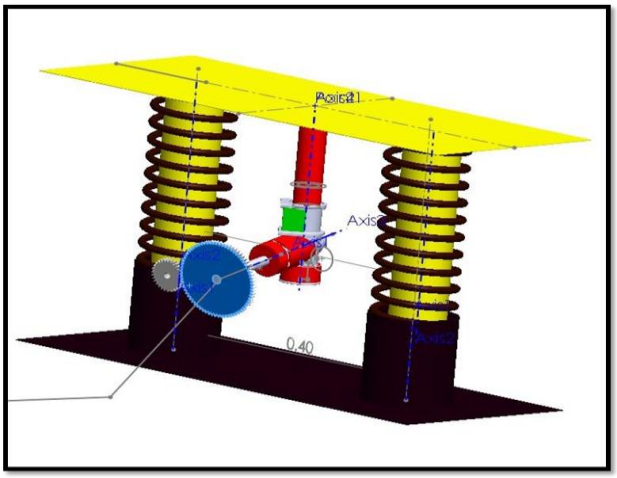


Fig 8. Partial Assembly

5. MANUFACTURING

5.1 MANUFACTURING PARTS

A) Base Assembly:

This part is mainly made by welding technique. The two guidance pipes are welded to the base plate which is 1 mm thick as shown in the fig. The pinion housing which has the main pinion and also one of the idler gears is welded to the base plate. It is as shown below,

Fig 9. Base with Pinion Housing

B) Top Assembly:

The rack is joint to the top portion by welding. Similarly the guidance pipes are also welded to the top plate. It is shown in fig.10.

Fig 10. Top Plate with Rack

C) Springs:

Two springs are used in our system to retain position of the speed breaker. The springs were an integral part of dampers used in Xylo car. The height of the springs is 370mm. They are shown in fig.11.

Fig 11. Springs

A) Motor:

The motor is coupled with small idler gear which will mate with larger idler gear, to increase the number of rotations. This is as shown in fig.12.

Fig 12. Motor

5.2 PRODUCTION ASSEMBLY:

All the different parts shown above were assembled to make a complete speed breaker which and generate power as a vehicle passes over it. It is shown in fig.13,14.

Fig 13. Assembly

Fig 14. Gears Mating

6. CALCULATIONS

6.1 REDUCTION RATIO

1) 3cm rack displacement gives 1 pinion rotation. Hence the larger gear coupled with the pinion shaft rotates 7/3 = 2.33 rotations (Total displacement of rack = 7cm).
2) No of Teeth on larger gear = 72, No of teeth on smaller gear = 32. Hence 1 rotation of larger gear is 72/32 = 2.25 rotations of smaller gear.
3) 2.33 rotations of larger gear give 2.33*2.25 = 5.25 rotations of smaller gear (generator gear).
4) Therefore, 7cm displacement of rack gives 5.25 rotation of generator shaft.

6.2 CALCULATIONS FOR DESIGNING

Spring design for 200 kg weight: -
Weight of vehicle = 200Kg * 9.81 = 1962.00 N
Therefore P=1.962 KN=2KN

Permissible shear stress is taken as 0.5 of Sut
Ƭ=0.5*Sut (ultimate tensile strength)
Ƭ=0.5*1050=525 N/mm^2

The spring stiffness k,
K= (4c-1/4c-4) + (0.615/c) ……. std formula
K= (4*8-1/4*8-4) + (0.615/8)
K=1.184

Calculation of wire diameter d,
Ƭ=k*(8pc/πd^2)
525=1.184(8*2000*8/ π*d^2)
D=11mm
Free length of spring =230mm

6.3 OBTAINED RESULT

Voltage (D.C) =1.5V
Current (D.C) =3.55 milliampere

7. COST REPORT

The cost breakdown is as follows;

Table 7. Cost Report

Serial No.	Name of Component	Quantity	Cost (Rs.)
01	Galvanized steel sheet	2	350
02	Metal Pipes (O.D = 72mm)	2	250
03	Metal Pipes (O.D = 114mm)	2	350
04	Rack and Pinion	1	700
05	Motor	1	1200
06	Bearings	2	200
07	Bolts	2	20
08	Nuts	2	10
09	Washers	4	12
10	Support Material	1	240
11	Welding Electrodes	12	80
12	Speed Breaker	1	500
Total Cost(Rs)			**3412**

8. CONCLUSION

In the coming days, demand for electricity will be very high as it is increasing every day, speed breaker power generator will prove a great boom to the world in the Future. The Aim of this research is to introduce another innovative method of green power generation in order to contribute toward developing the world by enriching it with utilization of available resources in more useful manner. Any country, especially Nigeria and other developing nations, can only develop when there is steady and available power supply for its citizens and not by getting breakdown in middle course of time or unreliable power sources. Now time has come for using these types of Innovative ideas and it should be brought into practice. It is suggested that further developments should be done to minimize above mentioned challenges. This research can also be modified by using camshaft and pulley stem or concepts of fluid mechanics can be used instead of gears, so as to minimize the inherent complexities and difficulties. By using the concept of power generation new ideas should be introduced which would help in reduction of friction and increase the efficiency of the generators.

9. FUTURE SCOPE

1) Heavy vehicles can generate high torque using larger pinion and powerful generator and hence the power generated from them will be quite high.
2) More suitable and compact mechanisms to enhance efficiency could be created.
3) As these systems are installed on open roads, water accumulates in heavy rainfall regions which may be a threat for working of this system. So, waterproof system can be developed to use this system in heavy rainfall regions also.
4) Multiple generators could be connected so that power generated would be more.

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