Team 18
Chargers

Power generation using speed breaker

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Abstract

Our project is about generating energy from the speed breaker for that we have used some short of arrangement that consists of card board, spring, led, battery, motor, coupling, supporting frame, pvc pipes. In this arrangement we are rotating motor to produce energy for that we have used a rack with both sided toothed, when the rack oscillates, it rotates two pinions attached with it on other side. If we consider 1 of the pinion, you will see that it is connected to yet another pinion (call it's sub pinion) with a one way rotation arrangement (which is used in cycle). So in first half of it's oscillation cycle the sub pinion rotates in a desired direction whereas in the other half of the oscillation it remains motionless (just like the cycle does not move backward when you rotates the pedal in the opposite direction).But during the second half of the oscillation, the pinion situated on the other side of the rack is rotating in desired direction. The sub pinion on either side of the rack is finally attached to the saft pinion. Which ensures the shaft pinion rotates in one direction only, irrespective of how much is the amplitude of its oscillation.

Introduction

- A large amount of energy is wasted by the vehicles on the speed breakers through friction, every time it passes over it. Energy can be produced by using the vehicle weight and speed. So here we propose a smart speed breaker that generates power. The reciprocating motion of the speed breaker is converted into rotary motion using the rack and pinion arrangement. We design a smart speed breaker that can pass vehicles coming from both sides and yet generate energy from it. The system makes use of mechanical assembly with metal sheets with linkages that press down with spring arrangement. The system makes use of the speed breaker press and then uses a rack and pinion arrangement to press down and run generator motor thus generating energy. The spring mechanism is the used to drive the speed breaker back into original position. It converts rotary motion into linear motion, but sometimes we use them to change linear motion into rotary motion. This mechanism is very economical and easy to install. By doing proper arrangements we may generate high power electricity from road traffic.

- The New York Times reported in 1906 on an early implementation of speed bumps in the U.S.A town of Chatham, New Jersey, which planned to raise its crosswalks five inches above the road level: "This scheme of stopping automobile speeding has been discussed by different municipalities, but Chatham was the first to implement it". According to information from Ministry of Transport, Nigeria has over 56,000km of roads and statistics provided by the Ministry of Road Transport & Highways in India show that the lengths of national highway by 2012 was 76,818 km. In year 2002, 58.8 million and in 2004, 72.7 million vehicles were plying on Indian roads. The annual rate of growth of motor vehicle population in India has been almost 10 percent during the last decade [9] [10] [12]. There is tremendous vehicular growth in India year by year. Nigeria has over 50 million vehicles plying on its roads with a growth rate of 15 % in 2012, [11]. On the Roads these vehicles waste tremendous amount of energy due to speed breakers, the increasing traffic and number of speed breakers on roads gave rise to the manufacturing of an innovative device which can channel the energy being wasted by vehicles on speed breakers to some useful work. Different models to harness this energy were introduced according to the road conditions. After each generation the efficiency of model increased and the limitations diminished. Different kinds of models have variant designs, some use gears, belts, dynamos etc with different applications at different places. Each model was encouraged due to limitations of previous ones. This paper illustrates various models and provides the review of different technologies used in the generation of energy with the help of speed breakers. 1.1. Use of Only Speed Breakers and not Rough or Plane Roads Now the question arises as to why only the speed breaker is used and not the rough or plane roads where the kinetic energy of the vehicle is more than that obtained on the speed breaker. The answer to this question is obvious; consider for example: A car or any heavy vehicle moving with a speed of 100 mph on the road and passing over this roller which is fitted at the level of the road then this roller will gain the speed of nearly 90 mph (due to losses). Now suppose a bicycle is moving with a speed of 20 mph and is going to pass this roller (which is moving at a speed of 90 mph), then due to this difference in the speed there will be a collision. That is the main reason for using this concept on the speed breaker, [7]. The rough or plane road will not provide the torque necessary for energy generation.

Speed-breakers are movement quieting devices generally introduced to decrease speed related mischances [2]. Speed breakers are intended to be rolled over at a foreordained agreeable rate while bringing on surpassing inconvenience at higher rates. The diminishment in normal vehicular speed essentially enhances the security of individuals in the neighbouring territories. These devices are most common in developing countries [3]. Consequently, speed-breakers are regular in numerous developing countries, including India, Chile, Egyptian Empire, Ghana and Pakistan [4].

The flow of traffic on rushed load is control by the use of Speed Breakers. The annual rate of motor vehicle growth in Pakistan is increasing day by day. The weight of vehicles in term of potential energy can be utilized for electricity generation purposes [5]. In this paper, we developed a method of generating electricity using speed breaker on the roads. To obtain maximum power, the flow of moving vehicles is very important. In this mechanism, a rack and pinions are used. This mechanism converts the kinetic energy of moving vehicles into electric energy with the help of speed breaker on the roads. This is generating many kilowatts of power by using downward as well as the upward motion of rack. Downward motion is caused by load and upward motion is due to restoring force utilizing store power in springs.

2. Methodology of working

When a car reaches on speed breaker, rack moves downward to generate linear motion [6]. Two pinions are attached to a rack which converts the linear motion of rack into rotary motion. Both pinions have unidirectional motion, like as bicycle sprocket. Two gears are mounted on pinion shaft's to transfer mechanical power to the common shaft having one gear. At final shaft, a flywheel is used to provide uniform motion. A belt is used to transfer mechanical motion of the common shaft to DC generator. The complete gear box is dipped in lubrication oil sump to minimize frictional losses. There are no chances of slipping between rack and pinions due to guide slots. DC generator generates DC power which is stored in batteries same as in solar technology [7]. The generated power can be used for the domestic purpose or commercially, which are present near the speed breaker.

2.1. Rack and pinion mechanism

The rack and pinion mechanism in AutoCAD 2013 is illustrated in Fig 1. Fig 1(a) shows that when a car reaches on the speed breaker, it applies its weight on the speed breaker. The rack is connected with the speed breaker and two pinions mesh across the rack. Due to the weight on the speed breaker, rack moves downward and linear motion is obtained. It rotates the pinions which are attached on the both sides of the rack. At this point, linear motion of rack converts into angular motion. Only right sided pinion transfer power and pinion mashed on left side keep rotating without transfer of power. Fig 1(b) and Fig 3 represent that four springs help the speed breaker to move upward and thus only left sided pinion transfer power and pinion mashed on right side keep rotating without transfer of power a complete cycle of linear to rotary motion is obtained. The pinions were designed to work as sprocket of the bicycle. At load, one side of pinion engages and another side of pinion disengage. Similarly, restoring force engages another side of the pinion and first side of pinion disengage. They transfer power in forward as well as the reverse stroke of speed breaker respectively and provide continuous angular motion.

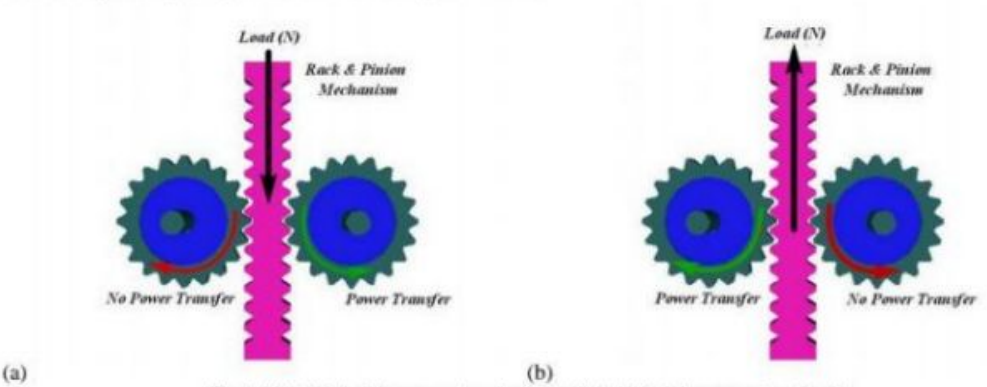

Fig. 1. Right sided pinion power transfer (a) and left sided pinion power transfer (b).

Fig 2 display working principle of rack and pinion mechanism and internal mechanism of SBPG in AutoCAD 2013. Gear of different teeth and diameter are mounted on both pinion's shaft to maximize the number of revolutions. A gear mounted on the common shaft is placed between both pinion's shafts. The flywheel is mounted on the common shaft. It keeps the rotation of the shaft in uniform angular motion. It stores the jerky rotations of pinion's shaft. Mechanical rotation is used to rotate the shaft of the generator through a belt. The shaft of maximum RPM (common shaft) is coupled with DC generator. A DC generator produces direct current [8]. According to Faraday's law of induction when coil moves inside the magnetic field, it generates electric current [9]. It rotates the rotor of the generator and in this way, the electricity is generated.

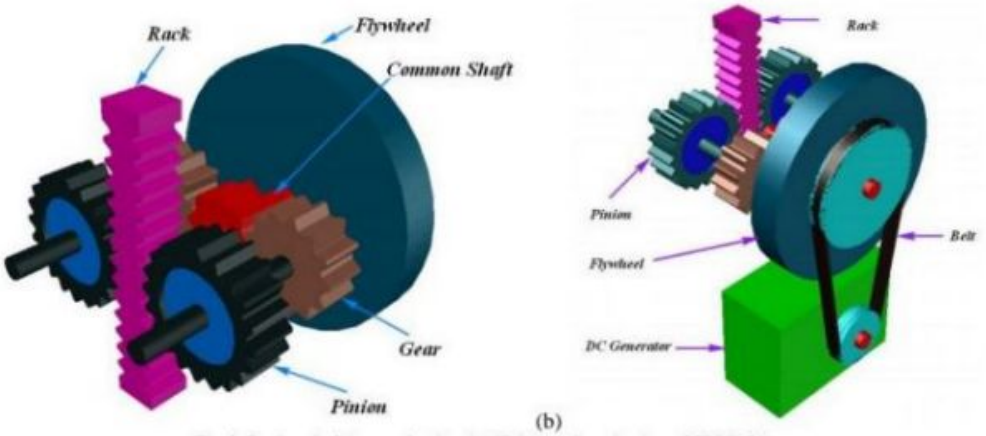

Fig. 2. Rack and pinion mechanism (a) 3D internal mechanism of SBPG (b).

Fig 3 represents the 3D model of SBPG mechanism is in AutoCAD 2013. Fig 3(a) identify 3D model by offing road and speed breaker. Four springs [10] are used to provide the upward motion. Utilizing energy (under the application of restoring force when the load is removed) rack moves upward and regain its original position. Two Support platforms for spring are welded to the frame to support the springs. Three supporting bars support whole mechanism. Guide slots lead speed breaker in the straight line and save it from trouble. Rubber beadings are used around the edges of SBPG to prevent water and dust from entering into it [11]. Fig 3(b) illustrate the complete 3D model of SBPG mechanism.

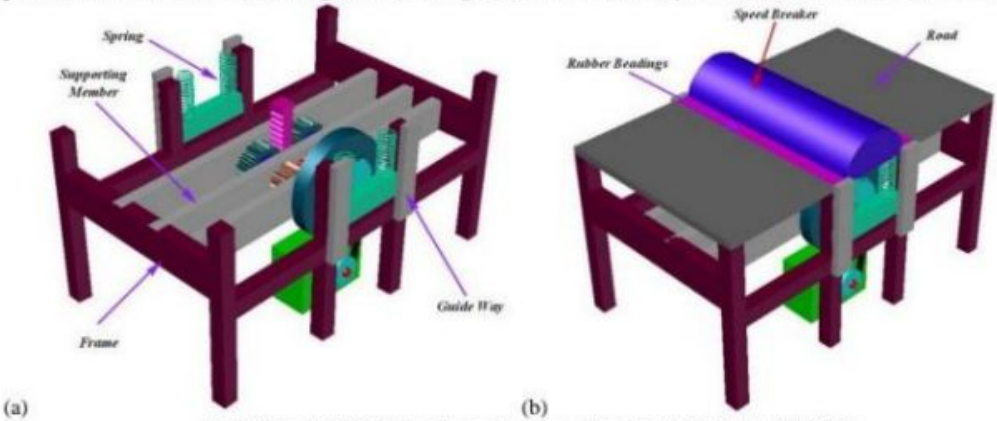

Fig. 3. 3D model of SBPG by offing road and speed breaker (a) 3D Model of SBPG (b).

2.2. Prototype Model

Fig 4 represents a prototype model of SBPG system. This was developed by our team for the purpose of participation in DICE Automotive 2015. We presented this model in DICE Automotive 2015 SSME NUST Islamabad.

Fig. 4 Prototype model of SBPG

3. Experimental study and results

Consider 100 cars of mass 400kg pass over a speed breaker in an hour. The height of rack is 14cm, the diameter of the final pulley is 18mm and having revolution speed (N) is equal to 37 RPM. Down word motion of speed breaker is due to the weight of moving the vehicle and upward motion of speed breaker is take place due to the utilization of energy from springs. Each car pushes speed breaker two times.

$$\text{Force} = F = mg \quad (1)$$

$$F = 400 \times 9.8 = 3920N$$

$$r = 9mm$$

$$T = r \times F \text{ (Nm)} \quad (2)$$

$$T = 9x\ 10^{-3} \times 3920$$

$$T = 35.28 \text{ (Nm)}$$

$$P = T.\omega \quad (3)$$

$$P = 35.28 \times 2\pi N/60$$

$$P = 35.28 \times (2 \times 3.14 \times 37)/60$$

$$P = 136.62 \text{ W}$$

Total generated in forward and reversed stroke.

$$P = 2 \times 136.62 \text{ W}$$

$$P = 273.24 \text{ W}$$

Revolution in one minute = 200/60 = 3.33rev/min

Power generated per minute = 273.24 × 3.33

= 909.89 W (minute)

Power generated in one Hour = 909.89 x 60

= 54.59 KW (hour).

Different masses are applied on the speed-breaker and the measured the electrical power. Fig 5 shows the linear relationship between the load and produce power.

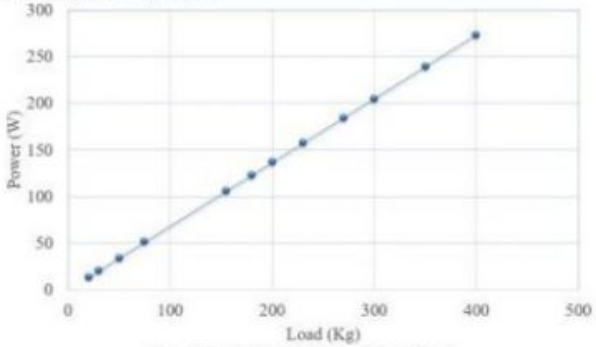

Fig. 5. Power variation due to load (kg)

3.2.Challenges

i. Selecting suitable generator.
ii. Selection of springs.
iii. Achieving proper balance of speed and torque.
iv. Such speed breakers can be designed for heavy vehicles, thus increasing input torque and ultimately output of generator and hence it will not work with light weight vehicle.
v. Require more suitable and compact mechanisms to enhance efficiency.
vi. We have to check mechanism from time to time in short span of period.
vii. Because of Rain water it may get damage.

4. Conclusions

This is generating many kilowatts power by using downward as well as the upward motion of rack. With the help of speed breaker mechanism, linear motion of rack is converted into rotary motion of pinion and thus is used to rotate the shaft of DC generator. It generates 273.24 watts with 400kg of load and 14cm of the height of the rack. DC voltages charge the batteries during the passage of moving vehicles. Using inverter (DC to AC conversion), we will be able to use batteries power for other useful applications. It can be implemented on the toll plazas, highways. Guide slots and lubricating oil sump is required to minimise friction losses. The initial cost of this arrangement is high but after the first cost, it will be free energy system.

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