International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Powering the Future: Generating Electricity through Speed Breakers

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ABSTRACT –

The "Electricity Generation Through Speed Breakers" Vehicles lose a significant amount of energy as friction when passing over speed breakers. This wasted energy can be harnessed to generate power by utilizing the vehicle's weight and motion. A smart speed breaker design is proposed to achieve this, capable of producing energy from vehicles moving in either direction. The system employs a rack-and-pinion mechanism to transform the speed breaker's reciprocating motion into rotary motion, driving a generator to produce electricity. The setup consists of a mechanical assembly featuring metal sheets, linkages, and a spring mechanism. When a vehicle passes over the speed breaker, it presses down, engaging the rack-and-pinion arrangement to activate the generator. The spring mechanism then restores the speed breaker to its original position This process of converting mechanical energy into electrical energy offers a clean and renewable source of energy, particularly in areas with heavy traffic. The electricity produced can be used for local purposes such as street lighting, traffic signals, or stored for later use. This approach provides a practical method for harvesting energy from everyday traffic activity, enhancing energy efficiency and sustainability in urban infrastructure.

KEYWORD:- Rack and pinion, speed breaker, kinetic energy, electrical energy, mechanical energy

1. INTRODUCTION

The need for sustainable energy solutions increases, interest in non-traditional power generation techniques is expanding. Using speed breakers to generate power is one such creative idea. With this method, the kinetic energy of cars passing over a specifically made speed breaker is captured and transformed into electrical energy[1].

Thousands of cars slow down and go over speed limiters every day, particularly on busy roadways like highways, toll plazas, and city streets. A mechanical system, usually a rack- pinion, crank-shaft, or spring-based arrangement, can be powered by the weight and motion of these vehicles to turn a generator and generate electricity.

This approach not only encourages the use of renewable energy but also enhances the current road infrastructure by transforming it into a provider of clean energy. The electricity generated can be utilized for street lights, traffic lights, or even stored in batteries for future use. This represents progress toward smart and energy- efficient urban areas, offering a practical method to harness energy that would otherwise go to waste[2].

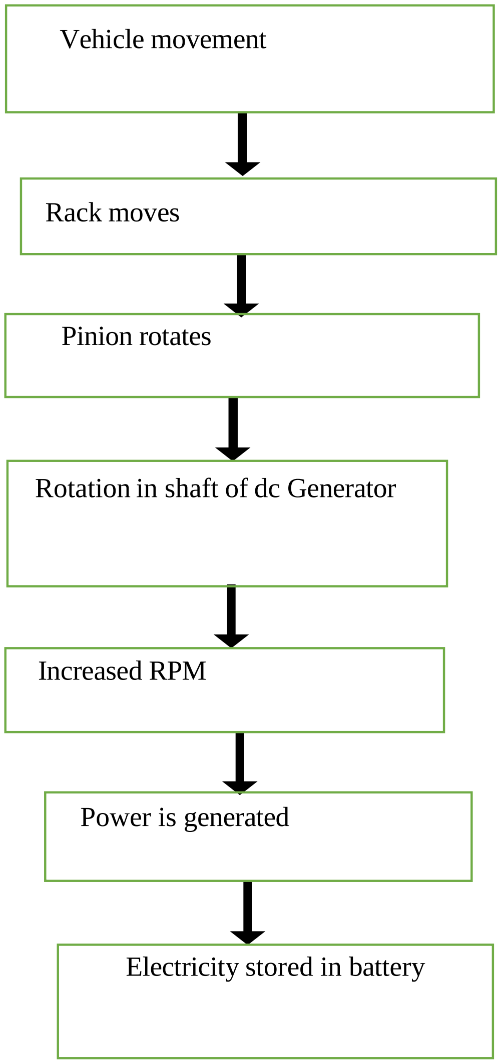
2. LITERATURE SURVEY

1. The power generation is directly proportional to the number of vehicles passing over the speed breaker[1]
2. This paper explores the feasibility of converting the kinetic and potential energy of vehicles into electrical energy using a speed breaker mechanism.[2]
3. The energy generated is typically small, making it suitable only for powering low- energy devices like streetlights or traffic signals[3]
4. Gaining regulatory approval for such new technology can be time-consuming and challenging, especially with regard to road safety and structural integrity[4]
5. Gupta et al. developed a rack and pinion- based mechanism where the vertical movement of a speed breaker is converted into rotational motion, which drives a DC generator. Their prototype, tested under simulated traffic conditions, showed promise in powering street lights and small electronic devices.[5]

3. RACK AND PINION MECHANISM

A straightforward yet effective method for converting linear motion into rotating motion is the rack and pinion mechanism. It is made up of a pinion, which is a toothed circular gear, and a rack, which is a straight, toothed bar. The pinion spins when the rack moves linearly, transmitting motion to linked parts like a generator or shaft. Vehicles press down on the rack in a speed breaker-based system, which rotates a pinion and powers a generator to generate electricity. The system is widely utilized in mechanical, steering, and automation applications and is small and dependable[3].

4. FLOW OF GENERATING ELECTRICITY THROUGH SPEED BREAKERS



5. COMPONENTS USED

6. **Rack and Pinion**

- When a car crosses the speed breaker, the rack (linear gear) descends.
- The rack's linear motion is transformed into rotational motion via a pinion, or circular gear.
- The shaft and generator are powered by this rotation.

7. **Spring**

- Returns the rack to its initial position following a vehicle's compression.
- Ensures uninterrupted operation and offers mechanical stability.

8. **DC Generator**

- Transforms mechanical energy into electrical energy from the movement of the vehicle.
- Generates direct current (DC), which an inverter can use to convert it to AC or store in a battery.
- The torque exerted and rotating speed determine the power output[5].

9. **L clamps**

- Keeps parts like the generator, pinion, and rack in position.
- Minimizes vibrations and guarantees correct alignment for effective operation.

10. **Supporting Frame**

- The primary framework that keeps everything together.
- Constructed with sturdy materials (like metal) to withstand loads from vehicles and outside factors.

11. **Shaft**

- Transmits rotational motion by connecting the generator to the pinion gear.
- Frequently constructed of metal to support heavy weights and constant spinning.

12. **Nuts and Bolts**

- Secure and fasten every component.
- Assure longevity and make maintenance and changes simple.

6. CALCULATIONS

For 50 kgs

Weight = 50kg

Height of the foot step = 12cm = 0.12m F = mg =50*9.8 = 490 N

Distance = Height of the foot step

= 12cm = 0.12m

Work = F * D

=490*0.12=58.8 j

P=work done/Time;

=58.8/60= 0.98 watts P=V*I

0.98=V*0.25=3.92V

For 60 kgs

Weight = 60kg

Height of the foot step = 12cm = 0.12m F = mg =60*9.8 = 588 N

Distance = Height of the foot step

= 12cm = 0.12m

Work = F * D

=588*0.12=70.56 j

P=work done/Time;

=70.56/60= 1.17 watts P=V*I

1.17=V*0.25=4.70 V

For 70 kgs

Weight = 70kg

Height of the foot step = 12cm = 0.12m F = mg =70*9.8 = 686.7 N

Distance = Height of the foot step

= 12cm = 0.12m

Work = F * D

=686*0.12=82.32 j

P=work done/Time;

=82.32/60= 1.37 watts P=V*I

1.37=V*0.25=5.5 V

For 80 kgs

Weight = 80kg

Height of the foot step = 12cm = 0.12m F = mg =80*9.8 = 784 N

Distance = Height of the foot step

= 12cm = 0.12m

Work = F * D

=784*0.12=94.08 j

P=work done/Time;

=94.08/60= 1.56 watts P=V*I

1.56=V*0.25=6.27 V

Generation calculations

S.no	**Weight**	**Theoretical Voltage**	**Practical Voltage**	**Theoretical Power**	**Practical Power**
1	50 Kgs	3.92 V	2.2 V	0.98 Watts	0.55 Watts
2	60 Kgs	4.70 V	2.5 V	1.17 Watts	0.625 Watts
3	70 Kgs	5.5 V	3.3 V	1.37 Watts	0.825 Watts
4	80 Kgs	6.27 V	5.4 V	1.56 Watts	1.35 Watts
5	100 Kgs	7.84 V	7.6 V	1.96 Watts	1.9 Watts

For 100 kgs

Weight = 100kg

Height of the foot step = 12cm = 0.12m F = mg =100*9.8 = 980 N

Distance = Height of the foot step

= 12cm = 0.12m

Work = F * D

=980*0.12=117.6 j

P=work done/Time;

=117.6/60=1.96 watts P=V*I

1.96=V*0.25=7.84 V

7. WORKING OF SPEED BREAKER BASED ELECTRICITY GENERATION

Vehicle kinetic energy is converted into mechanical energy by the speed breaker-based electricity generation system, and a DC generator is then used to convert the mechanical energy into electrical energy. The pinion gear rotates when a car passes over the speed breaker because it pushes the rack lower. The shaft receives the pinion's rotational motion and then passes it on to the DC generator[6]. After that, the generator generates electricity that can either be utilized immediately for things like traffic signals, street lights, or electric charging stations, or it can be stored in a battery[7].A spring mechanism is built to return the rack to its initial position once the vehicle passes, guaranteeing uninterrupted operation. The parts are held in position and misaligned by L-clamps and a supporting frame. The system is secured by nuts and bolts, guaranteeing long-term functionality and endurance[8]. By using the current movement of vehicles to generate power without the need for extra fuel, this system offers a sustainable and economical energy generation approach.

RESULTS

The Speed Breaker Power Generation System's promise as a workable renewable energy source is demonstrated by its implementation. The system uses a rack and pinion gear in conjunction with a generator to efficiently transform the kinetic energy of moving vehicles into electrical energy. Depending on traffic density, vehicle weight, and system design, experimental model and real-world testing findings show potential efficiency and power output. The weight of the car going over the speed breaker determines how much electricity it produces. Greater mechanical displacement is the result of heavier vehicles applying more force to the speed breaker. This causes the generator shaft to rotate more, which increases the amount of electricity produced.

Lighter cars generate less electricity because they use less force, which results in less displacement. The system is more efficient in high-traffic regions with heavier vehicles like buses and trucks because of this relationship, which emphasizes the direct proportionality between vehicle weight and electricity generation.

CONCLUSION

In conclusion, the speed breaker-based electricity generation system is a creative and environmentally friendly way to capture the energy of moving cars. Street lighting, traffic signals, and charging stations are just a few of the uses for the system's efficient conversion of kinetic energy into electrical energy, which is achieved through the use of a rack and pinion mechanism, shaft, and DC generator. While the supporting frame, L-clamps, nuts, and bolts offer stability and durability, the spring mechanism guarantees continuous operation.

This technology lessens reliance on traditional power sources by providing an economical and environmentally responsible energy generation alternative. Roads have constant car traffic therefore the system can work effectively with little upkeep and support renewable energy sources. We may move closer to a more environmentally friendly and energy-efficient future by incorporating such systems into urban infrastructure.

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