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Experimental Analysis of Electricity Generation using roadways Speed Breaker and Oscillating mechanism.

Dr. Shaikh Zeeshan Akil[1], Mr. Shaikh Gulam Gaus Shafique[2], Monde Gulam Shaddan Dastagir[3], Shaikh Faiz Shadab[4]

[1]HOD, Mechanical Engineering, Jumma Masjid Charitable Trust Polytechnic, Nashik (MH, India)
[2,3,4]Diploma Scholar, Mechanical Engineering, Jumma Masjid Charitable Trust Polytechnic, Nashik (MH, India)

Abstract - *With the continuous rise in vehicle numbers, it has become essential to install speed breakers at strategic locations to control vehicle speed and reduce accidents. Typically, two or three speed breakers are placed in sequence to effectively slow down traffic. In this context, the author proposes a new concept where the first speed breaker is rigid, while the others are equipped with a spring-loaded rack and pinion mechanism designed to harness the mechanical energy generated by vehicles for power generation. As energy is a fundamental need across all sectors—from cooking to operating machinery—there is a growing demand for alternative sources. Currently, fossil fuels are the primary energy source, but they are limited, non-renewable, and becoming increasingly expensive. This has led to a push for alternative, sustainable energy sources. Significant research is being conducted in the field of renewable energy, including solar, wind, and ocean power, to develop efficient ways to meet energy demands. The proposed speed breaker system features a flexible component integrated with a spring and rack-and-pinion setup. Additionally, it includes a small dynamo that converts the mechanical energy from passing vehicles into electrical power.*

Key Words: Speed Breaker, Accident, Power Requirement, Fossil Fuel, Limited Source, Renewable Energy, etc.

1. INTRODUCTION

Conventional energy sources rely heavily on fossil fuels, which contribute to environmental pollution, are finite, and are becoming increasingly expensive. To extend the availability of fossil fuels and help protect the environment, there is a growing need to adopt alternative or renewable energy sources—either in combination with fossil fuels or as complete replacements. Renewable sources such as solar, wind, geothermal, tidal, and hydropower offer significant potential for energy generation and, importantly, are environmentally friendly as they do not produce pollution. One innovative method of generating electricity involves the use of a speed breaker mechanism. With the rising number of vehicles, speed breakers are commonly installed—usually in sets of two or three—to control vehicle speed. However, the first speed breaker is typically sufficient to slow the vehicle, while the subsequent ones serve to further reduce speed. This setup presents an opportunity to harness the mechanical energy from moving vehicles and convert it into electrical energy using specially designed speed breakers.

Figure 1 Concept of Speed Breaker

Taking this concept into account, the author proposes a project focused on energy generation through speed breakers. In this design, one or both of the latter speed breakers are made flexible and integrated with a rack-and-pinion mechanism, along with a dynamo. As a vehicle passes over the speed breaker, the structure is pressed downward, compressing a spring. This vertical motion is then converted into rotational motion via the rack and pinion, which drives the dynamo to generate electricity.

In today's world, energy has become a fundamental necessity for human life and is a key driver of a nation's economic growth. Most of the current energy demand is met by conventional sources, primarily fossil fuels. However, with the global population steadily increasing and fossil fuel reserves rapidly depleting, there is a pressing need to transition toward alternative solutions. Moreover, conventional sources are major contributors to pollution and global warming.

This research introduces a renewable, non-conventional energy solution using a speed breaker mechanism. The goal is to harness the mechanical energy generated when vehicles pass over speed breakers—energy that would otherwise go to waste—and use it to power street lighting and other roadside electrical needs in a sustainable, eco-friendly manner.

2. WORKING PRINCIPLE:

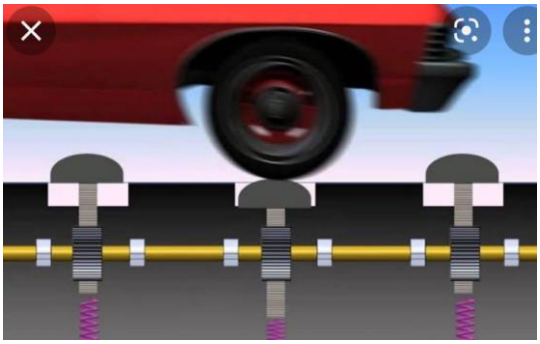

Figure 2 Conceptual diagram for speed breaker power generation

The pinion is connected to a dynamo, which generates electricity that can be utilized for street lighting or other related applications. Figure 1 illustrates the concept of a speed breaker designed to reduce vehicle speed. Figure 2 presents a conceptual diagram of the speed breaker power generation system. In this setup, each speed breaker unit is equipped with a rack and pinion mechanism. When a vehicle passes over the speed breaker, the rack moves downward, causing the pinion to rotate. This rotational motion drives the dynamo, resulting in electricity generation.

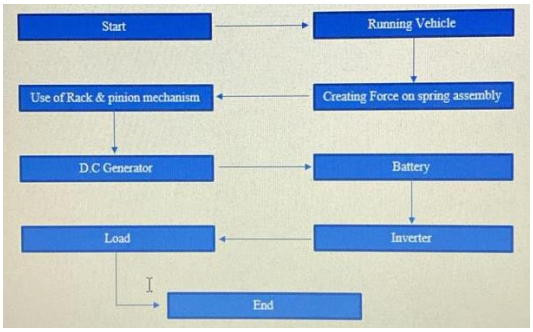

Figure 3 Working Principle of Speed Breaker Mechanism

3. GENERALISED COMPONENTS:

3.1 Coil Spring:

Figure 4 Coil Spring

A spring is an elastic device used to store mechanical energy, typically made from spring steel. While there are various types of springs, the term commonly refers to coil springs in everyday usage. When a standard spring—without variable stiffness—is compressed or stretched from its equilibrium position, it exerts a restoring force roughly proportional to the displacement. This relationship holds true for small deflections but may deviate with larger ones. The spring constant, or rate, measures how much force the spring exerts per unit of deflection. It is represented as the slope of the force versus deflection curve and is typically expressed in units such as newtons per meter (N/m) or pounds-force per inch (lbf/in).

3.2 Rack and Pinion:

Figure 5 Rack and Pinion

A rack and pinion is a type of linear actuator consisting of two interlocking gears that convert rotational motion into linear motion. The system includes a circular gear, known as the pinion, which meshes with a linear gear bar called the rack. When the pinion rotates, it drives the rack in a straight line, effectively transforming rotational input into linear movement. One common example is in rack railways, where a rotating pinion on a train engages with a rack mounted between the tracks, allowing the train to climb steep inclines. In gear theory, every pair of conjugate involute gears corresponds to a basic rack—essentially the gear profile of an infinitely large gear, represented as a toothed straight edge.

3.3 DC Motor:

Figure 6 DC Motor

In the context of electricity generation, a generator—such as one integrated with a speed breaker mechanism—converts mechanical energy into electrical energy for use in an external circuit. Mechanical energy can be sourced from devices like steam turbines, gas turbines, water turbines, internal combustion engines, or even manual tools like hand cranks. The first electromagnetic generator, known as the Faraday disk, was developed in 1831 by British scientist Michael Faraday. Today, generators are responsible for producing the vast majority of electricity supplied to power

grids. The reverse process—converting electrical energy into mechanical motion—is performed by electric motors. Interestingly, motors and generators share many similarities, and in some cases, motors can be mechanically operated to function as generators, making them useful for manual electricity generation as well.

3.4 Voltage Indicator :

Figure 7 Voltage Indicator

Voltage indicators are compact devices, often integrated with systems like speed breaker mechanisms, designed to measure both alternating current (AC) and direct current (DC) voltages. These indicators continuously display the current voltage level and are commonly used to monitor battery status or mains voltage. In industrial settings and research facilities, voltage monitoring is critical, making voltage indicators an essential tool. Additionally, many physical quantities are represented in the form of voltage, and scalable voltage indicators can convert these voltage values into meaningful measurements. Our voltage indicators are versatile and suitable for a wide range of applications. In addition to measuring AC and DC voltage, some models also support current and temperature measurement. Readings are typically shown on an LED display. For instance, the PCE-N20 series voltage transducers feature color-coded displays that change when predefined limit values are exceeded, providing clear visual alerts.

3.5 Metal Platform:

Figure 8 Metal Frame

To harness mechanical energy from the movement of a vehicle, a platform must be constructed that responds to pressure when someone stands, jumps, or presses on it. The platform material is carefully selected to ensure it is strong and durable enough to withstand the applied load without deforming.

3.6 Frame and Body

The frame and body of the power generation system play a crucial role, as they house all the subsystem components. They also protect the internal machine parts while providing the necessary structural support and freedom of movement for the system's operation.

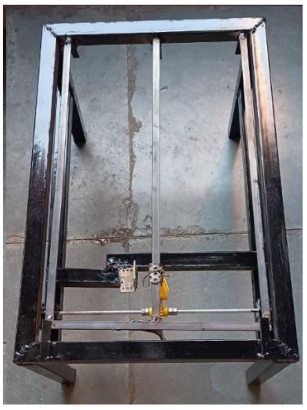

Figure 9 Metal Body

3.5 Semi Circular Roller:

Figure 10 Semicircular Rollers of PVC

In order to have the structure similar to the speed breaker the PVC pipe are used by cutting axially in two halves as shown in figure 10.

3.6 WORKING OF SPEED BREAKER POWER GENERATION

The speed breaker power generation unit utilizes vehicle movement as its energy source, operating on the principle of converting mechanical energy (vehicle motion) into electrical energy. The system is integrated into a speed breaker mechanism, where the force exerted by a vehicle's movement causes the stair-like step to move upward. This motion presses the platform, which in turn compresses the rack attached to it. As the rack moves downward, it generates rotary motion in the gear that meshes with it. The linear motion of the step is thus converted into the rotary motion of the shaft connected to the gear pinion.

Fig. -12: Assembly of Speed Breaker Mechanism

This rotary motion is then transferred to a sprocket arrangement welded to the same shaft, which drives the coupling (specially designed) via a chain drive mechanism. Ultimately, this motion powers a DC motor functioning as a generator, producing electrical energy.

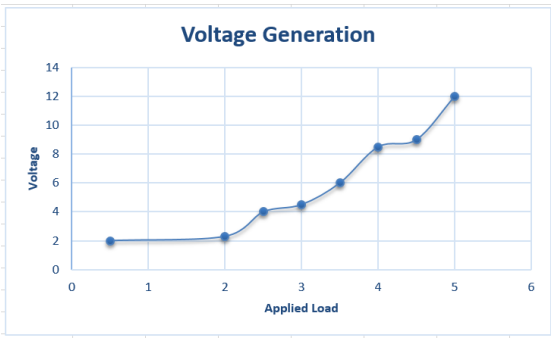

Fig. -12: Load vs Voltage reading

Since the amount of energy produced is relatively small compared to the operating voltage and current, the generated power is stored directly in a battery. This stored energy can then be used to charge the battery and accessed as needed.

4. CONCLUSIONS

The speed breaker power generation unit, which harnesses vehicle movement to generate electricity, is an innovative concept with significant potential. This system is particularly suitable for use in areas such as lawns or open spaces where pedal-powered transportation is common. It captures energy in the form of electricity, which can be stored in batteries for applications like street lighting or mobile charging stations. Additionally, the system can be integrated into playground equipment, providing both entertainment for children and a source of electricity. It can also be combined with other renewable energy sources, such as solar or wind power, to enhance its efficiency.

The system's performance can be optimized by adjusting the generator's operation through a well-designed electrical circuit to better manage the output energy. Using lightweight materials, such as composites, can help reduce the weight of the speed breaker mechanism without compromising its load-bearing capacity. Moreover, the system can be made more advanced by incorporating an electric grid to consolidate the output power from multiple speed breaker units operating in tandem. Overall, the speed breaker mechanism has a wide range of applications based on its output power. A single or a few units may generate enough energy to power lights and small electronic devices (such as computers and mobile phones), while a larger network of units can generate sufficient power to feed into the public electricity grid.

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