Review Paper on Design and Development of a Speed Breaker Based Power Generation System

Prof.Gourav G. Deshpande[1], Mr. Vinayak H.Kale[2], Ms.Aishwarya M. Kanase[3], Mr.Ashish D. Jadhav[4]
[1] *Assistant Professor, Mechanical Engineering, SMSMPITR AKLUJ (MS).*
[2,3,4] *B Tech Students, Mechanical Engineering, SMSMPITR AKLUJ (MS).*

***Abstract*—The increasing demand for electrical energy and the depletion of conventional energy resources have encouraged researchers to explore alternative and renewable energy sources. One such innovative method is the generation of electricity through speed breakers installed on roads. This system converts the kinetic energy produced by moving vehicles into electrical energy using mechanical and electromechanical arrangements. The generated electricity can be utilized for street lighting, traffic signals, and other low-power applications. This review paper presents various techniques, mechanisms, components, advantages, limitations, and recent developments in speed breaker-based power generation systems. The study also discusses different energy conversion methods such as rack and pinion mechanisms, roller mechanisms, hydraulic systems, and piezoelectric technology. The paper concludes that speed breaker power generation is an eco-friendly and cost-effective solution for sustainable energy generation in urban areas.**

***Index Terms*—Electricity Generation, Piezoelectric Sensor, Hydraulic Energy System, Vehicular Energy Harvesting, Sustainable Energy Smart Road Technology, Mechanical to Electrical Energy Conversion.**

I. INTRODUCTION

Energy plays a vital role in the development of modern society. The rapid increase in population, industrialization, and transportation has led to higher energy consumption worldwide. Conventional energy sources such as coal, petroleum, and natural gas are limited and create environmental pollution. Therefore, renewable and non-conventional energy resources are becoming increasingly important.

Road traffic contains a large amount of unused kinetic energy. Whenever vehicles pass over speed breakers, mechanical pressure and vibration are produced. This wasted energy can be converted into useful electrical energy using suitable mechanical arrangements and generators.

The speed breaker power generation system mainly consists of:

- Speed breaker mechanism
- Mechanical transmission system
- Generator or dynamo
- Energy storage battery
- Control circuitry

The system is especially useful in high-traffic areas such as:

- Highways
- Toll plazas
- Parking areas
- Railway stations
- Shopping malls
- Urban roads

II. WORKING PRINCIPLE

The system works on the principle of conversion of mechanical energy into electrical energy.
When a vehicle moves over the speed breaker, the vertical displacement or pressure applied on the breaker causes movement in the mechanical system. This movement rotates a shaft connected to a generator or dynamo, producing electricity.
The generated energy depends on:

- Vehicle weight
- Vehicle speed
- Traffic density
- Displacement of speed breaker

- Generator efficiency

The kinetic energy relationship is represented as:

$$KE = \frac{1}{2} mv2$$

Where:

- KE = Kinetic Energy
- m = Mass of vehicle
- v= Velocity of vehicle

III. LITERATURE REVIEW

3.1 Rack and Pinion Mechanism

Several researchers developed systems using rack and pinion arrangements. In this method, the vertical motion of the speed breaker is converted into rotational motion using gears.

Advantages

- Simple construction
- Easy maintenance
- Low cost

Limitations

- Mechanical wear
- Friction losses
- Lower efficiency at low traffic

3.2 Roller Mechanism

In this system, cylindrical rollers rotate when vehicles pass over them. The roller shaft is connected to a generator.

Advantages

- Continuous rotation
- Better power transmission
- High durability

Limitations

- Slipping issues
- Complex installation

3.3 Hydraulic Power Generation System

Hydraulic systems use fluid pressure generated by vehicle load to rotate hydraulic turbines connected to generators.

Advantages

- Smooth operation
- High load capacity

Limitations

- High installation cost
- Fluid leakage problems

3.4 Piezoelectric Energy Generation

Piezoelectric materials generate electric charge when mechanical stress is applied.

Advantages

- Compact design
- No moving mechanical parts
- High reliability

Limitations

- Small power output
- Expensive materials

IV.COMPONENTS OF SPEED BREAKER POWER GENERATION SYSTEM

Mechanical Components

- Speed breaker platform
- Springs
- Shaft
- Bearings
- Rack and pinion gear
- Flywheel

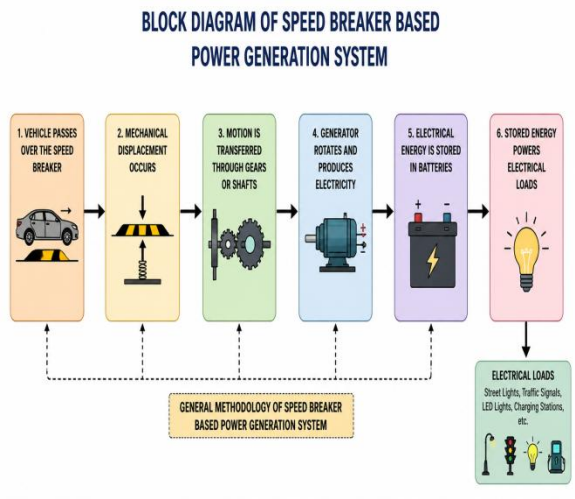
Electrical Components

- DC generator
- Battery
- Rectifier
- Voltage regulator
- Inverter
- LED load

V. METHODOLOGY

The general methodology used in speed breaker power generation systems includes:

1. Vehicle passes over the speed breaker.
2. Mechanical displacement occurs.
3. Motion is transferred through gears or shafts.
4. Generator rotates and produces electricity.
5. Electrical energy is stored in batteries.
6. Stored energy powers electrical loads.



Block Diagram of Speed Breaker Based Power Generation System

1. Vehicle Passes Over the Speed Breaker

When a vehicle moves over the speed breaker, it exerts pressure due to its weight and motion. This pressure creates mechanical force on the movable speed breaker mechanism. The kinetic energy of the moving vehicle acts as the primary source of input energy for the system.

2. Mechanical Displacement Occurs

The pressure applied by the vehicle causes a small vertical displacement of the speed breaker. The movable platform compresses springs or mechanical supports placed beneath it. This up-and-down motion converts the vehicle's kinetic energy into mechanical motion.

3. Motion is Transferred Through Gears or Shafts

The vertical movement of the speed breaker is transferred to mechanical transmission components such as:

- Rack and pinion mechanism
- Gear arrangement
- Chain drive
- Shaft system

These components convert reciprocating motion into rotational motion. The rotating shaft helps drive the generator efficiently.

4. Generator Rotates and Produces Electricity

The rotational motion obtained from gears or shafts is connected to a generator or dynamo. When the generator shaft rotates, electromagnetic induction takes place, producing electrical energy.

The generated electricity may be:

- Direct Current (DC)
- Alternating Current (AC)

Depending on the type of generator used.

5. Electrical Energy is Stored in Batteries

The electricity generated from the generator is supplied to a rechargeable battery through a rectifier and charge controller. The battery stores electrical energy for future use and ensures continuous power supply even when there is no vehicle movement.

Main purposes of battery storage:

- Energy backup
- Stable voltage supply
- Efficient energy utilization

6. Stored Energy Powers Electrical Loads

The stored electrical energy is used to operate various electrical devices and public utility systems such as:

- Street lights
- Traffic signals
- LED lamps
- Charging stations
- Roadside monitoring systems

This makes the system useful for smart city and sustainable energy applications.

VI. ADVANTAGES

- Renewable source of energy
- Eco-friendly system
- Reduces energy wastage
- Suitable for smart cities
- Low operating cost
- Easy installation in traffic zones

VII. LIMITATIONS

- Low power generation in low-traffic areas
- Mechanical wear and tear
- Maintenance requirements
- Initial installation cost
- Energy output varies with traffic flow

VII. APPLICATIONS

- Street lighting
- Traffic signals
- Highway lighting
- Charging stations
- Smart transportation systems
- Railway stations
- Public parking areas

IX. RECENT DEVELOPMENTS

Recent research focuses on:

- Smart IoT-based monitoring systems
- Hybrid renewable systems
- High-efficiency generators
- Piezoelectric smart roads
- AI-based traffic energy prediction
- Advanced mechanical designs

Researchers are also integrating:

- Solar panels
- Battery management systems
- Wireless energy monitoring to improve overall efficiency.

X. FUTURE SCOPE

Future improvements may include:

- Integration with smart city infrastructure
- Use of advanced composite materials
- Automatic maintenance systems
- Improved piezoelectric materials
- Large-scale highway implementation
- Hybrid renewable energy systems

This technology has significant potential in densely populated urban areas with heavy traffic movement.

XI. CONCLUSION

The speed breaker-based power generation system is an innovative and sustainable method for utilizing wasted kinetic energy from moving vehicles. Various mechanisms such as rack and pinion, roller, hydraulic, and piezoelectric systems have been studied and implemented by researchers. Although the system has some limitations such as maintenance and variable power generation, it offers an environmentally friendly and economical solution for small-scale electricity generation. With advancements in smart technologies and energy harvesting systems, speed breaker power generation can become an important component of future smart transportation infrastructure.

REFERENCES

[1] Rajat Gupta, S. Sharma, and S. Gaykawad, “A Revolutionary Technique of Power Generation Through Speed Breaker Power Generators,” International Journal of Engineering Research & Technology (IJERT), vol. 2, no. 8, Aug. 2013.

[2] Dheerendra Singh and Hemant Sangwan, “Power Generation using Power Breaker,” International Journal of Engineering Research & Technology (IJERT), vol. 9, no. 12, Dec. 2020.

[3] Vedant Ajay Utikar, Suraj Ramu Gowda, Arnav Ashutosh Kulkarni, and Manas Milind Kulkarni, “Power Generation using Speed Breaker,” International Journal of Engineering Research & Technology (IJERT), vol. 10, no. 9, Sept. 2021.

[4] L. Arockia Angel, “Electric Power Generation by Speed Breaker Connected with Wind Turbines,” IJERT Conference Proceedings, vol. 6, no. 14, Jan. 2019.

[5] Swapnil Daphal, “Electric Power Generation by Speed Breaker,” International Journal of Innovations in Engineering Research and Technology, 2021.

[6] Prof. D. V. Bharitkar et al., “Automatic Smart Speed Breaker Based On Day-Night Sensor and Power Generation,” International Journal of Recent Advances in Engineering and Technology, vol. 14, no. 1s, 2025.

[7] “Design and Fabrication of Power Generation through Speed Breaker,” Global Journals of Research in Engineering, vol. 21, no. A2, 2021.

[8] Soumya L. M., Rashmi M. N., and Shashikala N., “Electrical Power Generation Using Speed Breaker Mechanism: An Innovative Approach to Energy Harvesting,” International Research Journal on Advanced Engineering Hub (IRJAEH), vol. 2, no. 11, Nov. 2024.

[9] Akash Liladhar Gorle et al., “Literature Review on Electricity Generation using Speed Breaker,” International Journal of Advanced Research in

Computer and Communication Engineering (IJARCCE), 2018.

[10] Dave Jaymin J., "Power Generation from Speed Breakers by Air Compression Method," International Journal of Engineering Development and Research, vol. 3, no. 2, pp. 75–80.

[11] Naveen Kumar Y., Rakshit S. Shekhar, and Rajesh, "Design and Fabrication of Reciprocating Ramp for Power Generation," International Journal of Advance Research, Ideas and Innovations in Technology, vol. 4, no. 4, 2018.

[12] M. Iswarya and G. R. P. Lakshmi, "Generation of Electricity by Using Speed Breakers," in 2017 IEEE International Conference on Power, Control, Signals and Instrumentation Engineering (ICPCSI), Chennai, India, 2017, pp. 896–899.

[13] M. E. Hossain, M. R. Hasan, K. T. Ahmed, and M. N. M. Shawon, "Design and Performance of Power Generation Using Speed Breaker with the Help of Rack and Pinion Mechanism," in 2017 4th International Conference on Advances in Electrical Engineering (ICAEE), Dhaka, Bangladesh, 2017, pp. 7–11.

[14] C. K. Das, S. M. Hossain, and M. S. Hossan, "Introducing Speed Breaker as a Power Generation Unit for Minor Needs," in 2013 International Conference on Informatics, Electronics and Vision (ICIEV), Dhaka, Bangladesh, 2013, pp. 1–6.

[15] H. C. Mat Haris, M. A. N. M. Nor, M. H. Fazalul Rahiman, and N. F. A. A. Rahman, "Development of Energy Harvesting Using Speed Breaker," in 2016 IEEE Conference on Systems, Process and Control (ICSPC), Melaka, Malaysia, 2016, pp. 53–57.

[16] A. P. Rao, A. K. Kumar, and S. Suresh, "Power Generation from Speed Breaker by Rack and Ratchet Mechanism," International Journal of Current Engineering and Technology, 2014.

[17] A. S. Fawade, "Air Compression and Electricity Generation by Using Speed Breaker with Rack and Pinion Mechanism," International Journal of Modern Engineering Research (IJMER), vol. 5, no. 1, pp. 23–28, Jan. 2015.

[18] M. F. B. Bintu et al., "Hybrid Power Generation Using Speed Breaker," in 2022 International Conference on Innovations in Science, Engineering and Technology (ICISET), Chittagong, Bangladesh, 2022, pp. 457–461.

[19] E. Vijay, K. Yadav, Durgesh, S. Prajapati, and A. Porwal, "Electric Power Generation Through Speed Breakers," International Advanced Research Journal in Science, Engineering and Technology, vol. 7, no. 2, 2020.

[20] S. Srinivas Raju, H. Naresh, and N. Raghuvardhan, "Design and Fabrication of A System for Harnessing Energy From Road Traffic," Materials Today: Proceedings, vol. 5, no. 2, pp. 6189–6194, 2018.