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 rapid growth in energy demand and the depletion of fossil fuel resources have encouraged researchers to develop alternative energy generation techniques. One of the promising methods is the generation of electricity from road traffic using speed breakers. This research paper presents the design, fabrication, and performance analysis of a speed breaker-based power generation system using a rack and pinion mechanism coupled with a DC generator. The system converts the kinetic energy of moving vehicles into electrical energy. Experimental analysis was carried out under different loading conditions and traffic scenarios. The results show that the developed prototype can generate sufficient electrical power for low-power applications such as LED street lighting, traffic signals, and battery charging. The proposed system is economical, eco-friendly, and suitable for urban smart road applications.**

***Index Terms*—Speed Breaker Power Generation, Renewable Energy, Kinetic Energy Harvesting, Rack and Pinion Mechanism, DC Generator, Smart Road System, Sustainable Energy, Traffic Energy Conversion**

I. INTRODUCTION

Energy is an essential requirement for industrial growth and modern infrastructure. Conventional energy resources are continuously depleting and causing environmental pollution. Therefore, researchers are focusing on renewable and non-conventional energy resources.

Road transportation systems contain a large amount of wasted kinetic energy. Vehicles passing over speed breakers produce mechanical pressure and displacement that can be converted into useful electrical energy. The speed breaker power generation system captures this wasted energy and converts it into electricity using mechanical and electrical components.

The proposed research focuses on designing a practical and cost-effective system capable of generating electricity from vehicular motion on roads with high traffic density.

II. OBJECTIVES OF THE RESEARCH

The major objectives of this research work are:

1. To design a speed breaker-based power generation mechanism.
2. To convert mechanical energy into electrical energy efficiently.
3. To analyze generated power under different vehicle loads.
4. To reduce wastage of kinetic energy on roads.
5. To develop an eco-friendly and low-cost renewable energy system.

III. OBJECTIVES OF THE RESEARCH

Several researchers have proposed different techniques for road power generation.

- Rack and pinion mechanisms are widely used due to their simplicity and low cost.
- Hydraulic systems provide smooth operation but require high maintenance.
- Piezoelectric systems generate electricity using pressure-sensitive materials.
- Roller mechanisms provide continuous rotation and higher efficiency.

Most previous systems faced issues such as:

- Low efficiency
- Mechanical losses
- High maintenance cost
- Limited power generation

This research attempts to improve efficiency using optimized gear arrangements and energy storage systems.

IV. METHODOLOGY

Working Principle

When a vehicle passes over the movable speed breaker, vertical displacement occurs. This displacement moves the rack mechanism connected to a pinion gear. The rotational motion produced by the pinion rotates the shaft of a DC generator, producing electricity. The generated power is stored in a rechargeable battery and used for electrical loads.

V. SYSTEM COMPONENTS

Mechanical Components

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

Electrical Components

- DC generator
- Rectifier circuit
- Rechargeable battery
- LED indicators
- Voltage regulator

VI. MATHEMATICAL ANALYSIS

The kinetic energy of a moving vehicle is:

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

Where:

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

Electrical power generated is:

$$P = VI$$

Where:

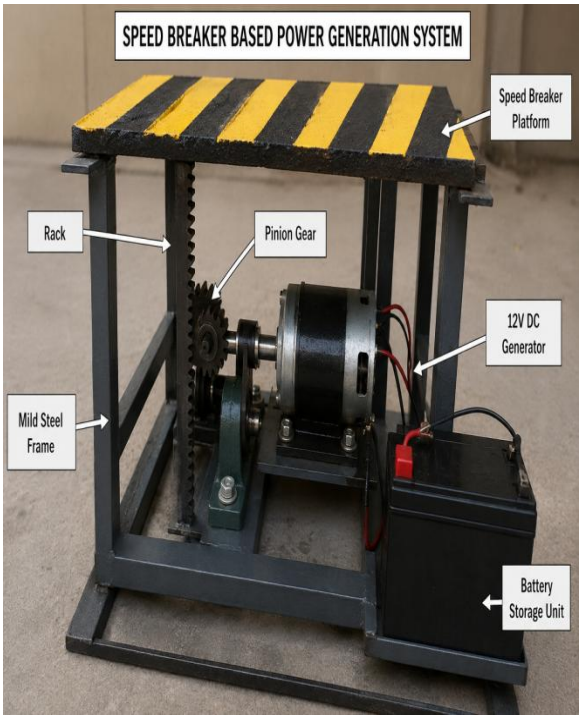
- P = Power (W)
- V = Voltage (V)
- I = Current (A)

VII. EXPERIMENTAL SETUP

The prototype model was fabricated using:

- Mild steel frame
- Rack and pinion mechanism
- 12V DC generator
- Battery storage unit

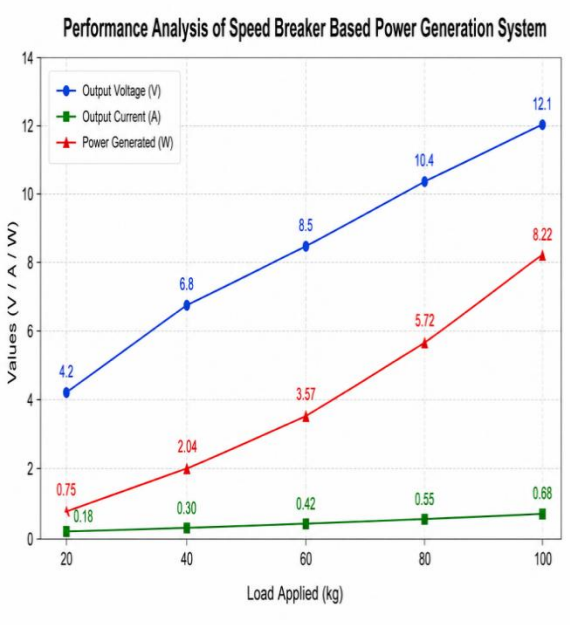
Different vehicle loads were simulated using applied weights on the speed breaker platform.



VIII. RESULTS AND DISCUSSION

Experimental Observations

Load Applied (kg)	Output Voltage (V)	Output Current (A)	Power Generated (W)
20	4.2	0.18	0.75
40	6.8	0.30	2.04
60	8.5	0.42	3.57
80	10.4	0.55	5.72
100	12.1	0.68	8.22



Result Analysis

- Power generation increases with vehicle load.
- Heavy vehicles produce higher displacement and more rotational speed.
- The rack and pinion mechanism showed good mechanical efficiency.
- Battery charging was successfully achieved.
- LED loads operated continuously using stored power.

The system demonstrated reliable operation in repeated testing conditions.

IX. ADVANTAGES

- Renewable and pollution-free energy source
- Utilizes wasted road energy
- Low operating cost
- Easy maintenance
- Suitable for smart cities and highways

X. LIMITATIONS

- Power generation depends on traffic density
- Mechanical wear and tear
- Limited power output for small vehicles
- Initial fabrication cost

XI. APPLICATIONS

- Street lighting systems
- Traffic signal operation
- Highway monitoring systems
- Battery charging stations
- Smart transportation infrastructure

XII. FUTURE SCOPE

Future developments may include:

- IoT-based monitoring systems
- Smart battery management
- Piezoelectric hybrid systems
- High-efficiency generators
- Large-scale highway implementation

Integration with smart city infrastructure can improve the practical implementation of this technology.

XIII. CONCLUSION

This research work successfully demonstrated the design and development of a speed breaker-based power generation system capable of converting vehicular kinetic energy into electrical energy. The fabricated prototype produced measurable electrical output under different loading conditions. Experimental results confirmed that generated power increases with vehicle load and displacement. The proposed system offers a sustainable, economical, and eco-friendly solution for small-scale electricity generation in urban and highway environments. With further improvements in efficiency and energy storage, this technology can contribute significantly to renewable energy applications and smart transportation systems.

REFERENCES

[1] Rajat Gupta, Suyash Sharma, and Saurabh 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] K. M. Ullah, K. M. Ahsan-uz-Zaman, S. Hosen, R. H. Khan, and S. Parvin, "Electrical Power Generation Through Speed Breaker," in 2016 9th International Conference on Electrical and Computer Engineering (ICECE), Dhaka, Bangladesh, 2016, pp. 30–33.

[6] Abhishek Jakhmola and Sujeet Kumar Mishra, "Green Energy Generation from Road Traffic Using Speed Breakers," Materials Today: Proceedings, vol. 38, pp. 160–168, 2021.

[7] Chavan Madhusudan, Dr. Suraj Rajesh Karpe, A. N. Mudiraj, B. D. Shinde, B. S. Deshmukh, and R. B. Aurade, "Power Generation Using Speed Breaker," Journal of Electrical and Power System Engineering, 2024.

[8] Akash Liladhar Gorle, Akash Narendra Patil, Akshay Vilasrao Thawale, Shridhar Vinod Giri, Brinda Darjee, and Leena H. Patil, "Literature Review on Electricity Generation using Speed Breaker," International Journal of Advanced Research in Computer and Communication Engineering (IJARCCE), 2018.

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

[10] Karande Vikas Sangappa, Topanna Prashnat, Shinde Vishwajeet, Shendage Navanath, and Thaware Swapnil, "Electrical Power Generation Through Speed Breaker," International Journal of Novel Research and Development (IJNRD), vol. 9, no. 5, pp. d63–d71, May 2024.

[11] Mohammed Hossam-E-Haider and Md. Rokonuzzaman, "Design of an Efficient Energy Generating System Using Speed Breaker for Bangladesh," in 2015 5th National Symposium on Information Technology: Towards New Smart World (NSITNSW), IEEE, 2015.

[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.