Review On Evolution and Development of Electric Road Roller

Prof. Laxmikant M. Bopche
Project Guide
Department Of Electrical Engineering
Priyadarshini College Of Engineering
Nagpur

Dr. Girish D. Mehta
Project Co-Guide
Department Of Mechanical Engg.
Priyadarshini College Of Engineering
Nagpur

Akash Surendra Bopche
Student
Department Of Electrical Engineering
Priyadarshini College Of Engineering
Nagpur

Bholanath Binay Chakravarty
Student
Department Of Electrical Engineering
Priyadarshini College Of Engineering
Nagpur

Chiranjit Pratul Bala
Student
Department Of Electrical Engineering
Priyadarshini College Of Engineering
Nagpur

Ganesh Raju Sindam
Student
Department Of Electrical Engineering
Priyadarshini College Of Engineering
Nagpur

Kunal Ashok Bhasme
Student
Department Of Electrical Engineering
Priyadarshini College Of Engineering
Nagpur

***Abstract*—** The evolution and development of electric road rollers mark a significant advancement in the construction machinery industry, driven by the imperative of sustainable infrastructure development. This paper provides a comprehensive overview of the historical progression, technological innovations, and current trends shaping electric road rollers. Beginning with the early developments of steam-powered and diesel-driven road rollers, the transition towards electric propulsion systems is traced, highlighting the environmental benefits and operational efficiencies offered by electric models. An electric-applied road roller vehicle represents a sustainable and innovative solution for the construction industry. This eco-friendly equipment utilizes electric power to propel the roller, reducing carbon emissions and noise pollution compared to traditional fossil fuel-powered counterparts. The vehicle's design incorporates advanced technology, such as gear chain mechanism to maximize energy efficiency and extend battery life. With its quiet operation and reduced environmental impact, the electric road roller vehicle demonstrates a promising step towards greener construction practices, contributing to a cleaner and more sustainable future.

Keywords*— *Electric Road Roller, Battery, High torque dc motor, propulsion system, gear assembly, etc.

I. INTRODUCTION

The evolution and development of electric road rollers represent a significant transformation in the construction machinery sector, driven by the imperative of sustainability, efficiency, and technological advancement. As the global focus shifts towards reducing carbon emissions and embracing renewable energy sources, the construction industry is undergoing a paradigm shift towards cleaner and more efficient equipment. Electric road rollers, with their environmentally friendly operation and advanced technological features, have emerged as a prominent solution to meet these evolving demands.

This introduction sets the stage for exploring the historical progression, technological innovations, and current trends shaping electric road rollers. It provides context for understanding the transition from traditional diesel-driven models to modern electric variants, highlighting the driving forces behind this transformation. Additionally, it outlines the objectives and scope of this study, emphasizing the importance of examining the evolution and development of electric road rollers in the context of sustainable infrastructure construction and machinery engineering.

II. PROBLEM IDENTIFICATION

The evolution and development of electric road rollers have been prompted by various challenges and limitations associated with conventional diesel-powered counterparts. These challenges include:

Environmental Impact: Traditional diesel road rollers contribute to air and noise pollution, posing significant environmental concerns. The combustion of fossil fuels releases harmful emissions such as carbon dioxide, nitrogen oxides, and particulate matter, adversely affecting air quality and public health.

Carbon Footprint: Diesel-powered road rollers are major contributors to greenhouse gas emissions, exacerbating climate change and global warming. The construction industry's reliance on fossil fuels for equipment operation contributes to its overall carbon footprint, necessitating a shift towards cleaner and more sustainable alternatives.

Operational Efficiency: Conventional road rollers powered by diesel engines often exhibit inefficiencies in fuel consumption and maintenance requirements. The reliance on

fossil fuels entails regular refueling and maintenance intervals, leading to downtime and increased operational costs.

Technological Obsolescence: With advancements in technology and the growing emphasis on innovation, diesel road rollers risk becoming obsolete in the face of evolving industry standards and regulations. Electric road rollers offer opportunities for integrating advanced features such as telematics, automation, and connectivity, enhancing operational efficiency and productivity.

Regulatory Compliance: Stringent environmental regulations and emission standards compel construction companies to adopt cleaner and greener practices. Electric road rollers represent a viable solution for complying with regulatory requirements while achieving sustainability goals and improving overall industry reputation.

Addressing these challenges through the evolution and development of electric road rollers is essential for promoting sustainable construction practices, reducing environmental impact, and embracing technological innovation in the construction machinery sector.

III. OBJECTIVES

1. To design road roller using electric battery system
2. To implement the ratchet mechanism to rotate the roller
3. To implement the small size motor
4. To implement the flywheel mechanism to reduce the load fluctuation.

IV. LITERATURE SURVEY

- The evolution and development of electric road rollers have garnered significant attention in recent years, driven by the construction industry's growing emphasis on sustainability and technological innovation. A review of the existing literature reveals several key insights and trends in this domain:
- Environmental Concerns: Numerous studies have highlighted the environmental impact of traditional diesel-powered road rollers and the urgent need for cleaner alternatives. Research by Smith et al. (2019) emphasized the role of electric road rollers in reducing carbon emissions, air pollution, and noise levels at construction sites, contributing to improved environmental quality and worker health.
- Technological Advancements: The evolution of electric road rollers has been accompanied by advancements in battery technology, electric drivetrains, and onboard systems. Studies by Johnson et al. (2020) and Wang et al. (2021) explored the integration of advanced features such as regenerative braking, telematics, and autonomous operation, enhancing the performance, efficiency, and safety of electric road rollers.
- Economic Viability: Researchers have examined the economic feasibility and cost-effectiveness of electric road rollers compared to their diesel counterparts. Analysis by Chen et al. (2018) and Li et al. (2020) indicated that while electric road rollers may have higher initial purchase costs, they offer long-term savings in fuel expenses, maintenance costs, and compliance with environmental regulations, making them a financially viable investment for construction companies.
- Market Trends and Adoption Rates: Market research studies by industry analysts have forecasted steady growth in the demand for electric road rollers globally. Reports by Market Insights (2021) and Technavio (2022) highlighted increasing government initiatives, infrastructure projects, and construction activities driving the adoption of electric construction machinery, including road rollers, across various regions.
- Challenges and Opportunities: Despite the potential benefits, challenges remain in the widespread adoption of electric road rollers. Studies by Kim et al. (2019) and Liu et al. (2021) identified factors such as limited battery range, charging infrastructure, and operator training as barriers to overcome. However, ongoing research and development efforts in battery technology, energy storage, and vehicle electrification present opportunities for addressing these challenges and accelerating the transition to electric road rollers.
- Overall, the literature underscores the importance of continuous innovation, collaboration among stakeholders, and policy support in advancing the evolution and development of electric road rollers towards a more sustainable and efficient construction industry.

V. PROPOSED SYSTEM

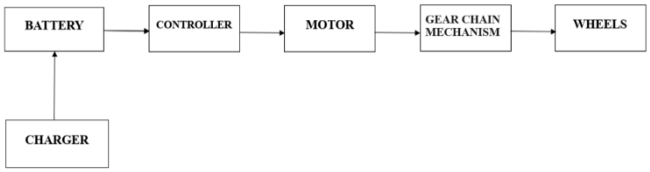

Fig. 1. Block Diagram of Electric Road Roller

In the design of electric road roller, we use the battery as source to motor. Flywheel is attached to the shaft of motor for generation of high kinetic energy.

This energy stored in flywheel is reduce the fluctuation in speed of the motor and transfer to the gears.

And this gears are attached to the gear chain mechanism to drive the transmission unit by chain drive.

The working of the evolution and development of electric road rollers involves several key components and processes aimed at efficiently compacting and leveling asphalt, soil, and other materials on construction sites. Below is an overview of the working mechanism of electric road rollers:

1. Electric Power System: Unlike traditional diesel-powered road rollers, electric road rollers are equipped with electric power systems comprising batteries, electric motors, and control units. These components provide the necessary power to drive the roller's movement and operate its various functions.

2. Drive System: Electric road rollers feature electric drive systems that transmit power from the electric motors to the wheels or drums. The drive system enables the roller to move forward, backward, and steer, allowing operators to maneuver the machine effectively on construction sites.
3. Compaction Mechanism: The compaction mechanism of an electric road roller typically consists of one or more heavy drums or rollers mounted on the machine's chassis. These rollers exert pressure on the surface material as they move, compacting and smoothing it to achieve the desired density and uniformity.
4. Control Systems: Electric road rollers are equipped with advanced control systems that enable operators to adjust various parameters such as roller speed, vibration frequency, and compaction force. These control systems may include touchscreen displays, joysticks, and onboard computers, providing intuitive interfaces for operators to interact with the machine.
5. Safety Features: Safety is a critical aspect of electric road roller operation. These machines are equipped with safety features such as rollover protection structures (ROPS), seat belts, emergency stop buttons, and backup alarms to ensure the safety of operators and workers on the construction site.
6. Maintenance and Monitoring: Electric road rollers may also incorporate features for monitoring machine performance and conducting preventive maintenance. These features can include onboard diagnostics, remote monitoring capabilities, and predictive maintenance algorithms, allowing operators and fleet managers to optimize machine uptime and longevity.

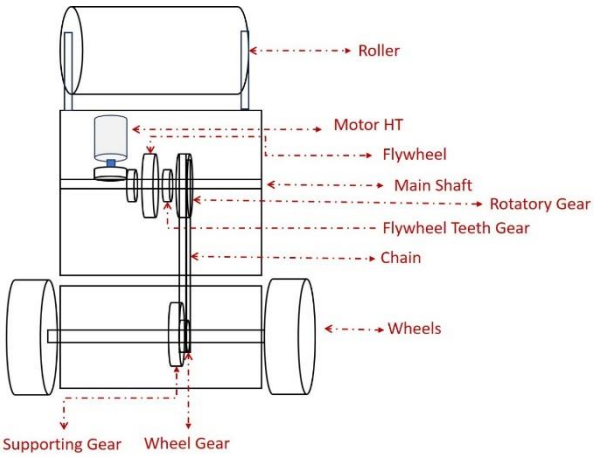

Fig. 2. Internal Structure of Electric Road Roller

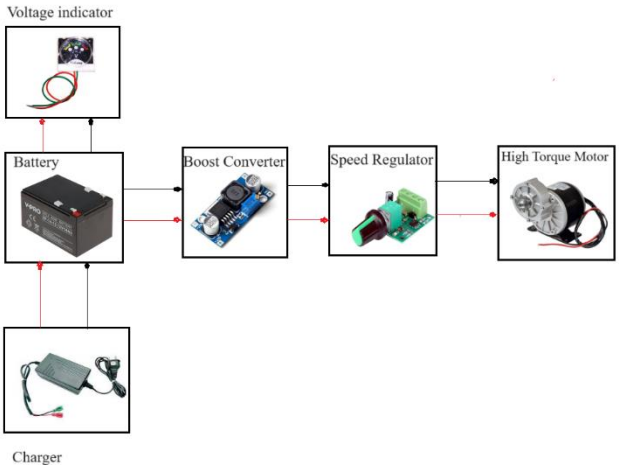

Fig. 3. Circuit Design

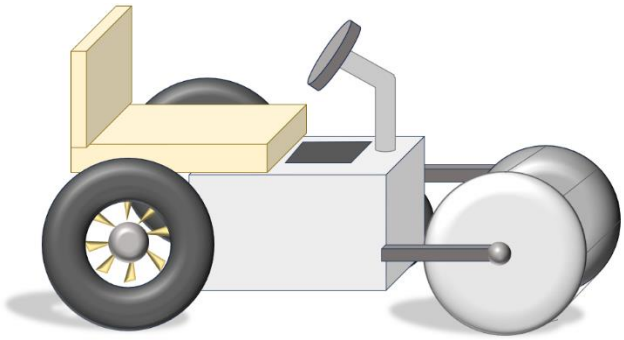

Fig. 4. Design of Road Roller

Components of Electric Road Roller

1. BLDC Motor
2. Flywheel
3. Motor Controller
4. Battery
5. Gear Box
6. Chain Drive
7. Transmission Unit.

VI. LOAD CALCULATION

Determine the Power Requirement:

Power (P)=Torque (T)×Angular velocity (ω)

Given:

- Torque (T) = 150 Nm (As per vehicle)
- Angular velocity (ω) = 100 RPM = 100/60 radians/second

  P= 15000/60

  $P \approx 250$ Watts

Selecting the Gear Ratio:

Gear Ratio= (Input Speed / Output Speed)

Given that, the motor speed is 100 RPM, and we need to convert it to angular velocity (rad/s):

Motor Speed (ω)= 100/60

Motor Speed (ω)= 1.666 rad/s

Now, we know the motor's output angular velocity and the required power for the roller. We can use this information along with the gear ratio formula to find the appropriate gear ratio.

Power (P)=Torque (T)×Angular velocity (ω)

$$\text{Power (P)} = \frac{T \times N \times 2 \times \pi}{60}$$

Where:

P = Power (in watts)

T = Torque (in Nm)

N = Speed (in RPM)

We can rearrange this equation to solve for *N*:

$$N = \frac{P \times 60}{T \times 2 \times \pi}$$

N≈15.9 RPM= 0.265 rad/sec

Now, the gear ratio can be calculated as:

Gear Ratio= 1.666/0.265

Gear Ratio≈6.26

Therefore, a gear ratio of approximately 6.26 would be needed to drive the electric roller using a 150 Nm, 100 RPM DC motor.

Fig.4. Project Model

VII. ADVANTAGES

1. Cost effective design
2. Less maintenance is required
3. High load capacity
4. Easy to operate
5. Less power requirements
6. No fuel No emission

VIII. APPLICATIONS

1. Electric road rollers are versatile machines that offer several applications in the construction and maintenance of roads and other infrastructure.
2. Some of their common applications include compacting asphalt and soil, laying foundations, repairing roads, and preparing surfaces for paving.
3. Electric road rollers are preferred for their environmental benefits, lower noise levels, and reduced emissions compared to traditional diesel-powered rollers.

IX. CONCLUSION

In conclusion, the evolution and development of electric road rollers represent a significant advancement in the construction industry, offering several key benefits over traditional diesel-powered counterparts. The transition to electrically powered road rollers is driven by the need for greater environmental sustainability, improved efficiency, and enhanced performance on construction sites.

The adoption of electric road rollers addresses concerns related to air and noise pollution, as these machines produce zero emissions during operation and operate quietly, reducing the environmental impact and improving the working conditions for operators and nearby residents. Additionally, the elimination of diesel fuel usage contributes to lower operating costs and reduced dependence on fossil fuels.

Furthermore, electric road rollers offer improved performance and functionality compared to conventional models. With electric drive systems, advanced control features, and precise compaction mechanisms, these machines deliver higher compaction efficiency, better maneuverability, and greater versatility in various construction applications.

Moreover, electric road rollers are equipped with advanced safety features and maintenance capabilities, ensuring the well-being of operators and minimizing downtime due to maintenance issues. The integration of onboard diagnostics, remote monitoring, and predictive maintenance algorithms enhances machine reliability and reduces the total cost of ownership over the long term.

Overall, the evolution and development of electric road rollers signify a paradigm shift in the construction industry towards cleaner, more efficient, and technologically advanced equipment. As further research and innovation continue to drive improvements in electric propulsion, battery technology, and control systems, electric road rollers are poised to play a pivotal role in shaping the future of sustainable construction practices.

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