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"DESIGN AND DEVELOPMENT ELECTRIC TWO-WHEELER WORKBENCH"

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ABSTRACT

The project titled "Design and Development of Two Electric Two-Wheeler Workbench" focuses on the design and fabrication of a dedicated workbench for electric two-wheelers to improve maintenance, testing, and educational activities. With the increasing demand for electric vehicles, especially electric two-wheelers, there is a need for a structured and efficient setup for studying, assembling, troubleshooting, and servicing various components of these vehicles. The developed workbench is designed to provide proper support and accessibility to important systems such as the battery pack, motor, controller, braking system, wiring arrangement, and transmission components. The design aims to ensure ease of operation, safety, stability, and convenience during practical applications. Suitable materials and structural components are selected to provide sufficient strength and durability while maintaining cost effectiveness. The workbench also serves as an educational platform for students and technicians to understand the construction and working principles of electric two-wheelers. It enables users to perform testing, fault diagnosis, and maintenance procedures in an organized manner. The developed model contributes to improving practical learning, reducing maintenance complexity, and supporting the advancement of electric vehicle technology.

Keywords: *Electric, workbench, Vehicle Maintenance, Battery Pack Testing.*

I. INTRODUCTION

The Electric 2-Wheeler Workbench project is designed to study, analyse, and test the performance of electric two-wheelers. The workbench provides a controlled platform where different components such as the motor, controller, battery, and transmission system can be assembled, tested, and analysed. This setup helps in understanding the working of electric vehicles (EVs) and assists in research, maintenance, and training purposes. An electric vehicle (EV) operates using electrical energy stored in a battery pack. This energy is converted into mechanical energy through an electric motor. The main goal of an electric 2- wheeler is to replace conventional internal combustion (IC) engine vehicles that consume petrol or diesel with an eco-friendly and efficient alternative.

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Fig. 1. Work bench frame

II. LITERATURE REVIEW

The development of electric two-wheelers has gained significant attention as a sustainable alternative to conventional petrol-powered vehicles. Early research primarily focused on replacing internal combustion engines with electric motors to reduce air pollution and fuel consumption. Initially, lead-acid batteries were widely used; however, recent advancements have shifted toward lithium-ion batteries due to their higher energy density, faster charging capability, longer lifespan, and improved overall efficiency. Researchers have also emphasized the importance of Battery Management Systems (BMS), which enhance battery safety, performance, and durability. In terms of propulsion systems, studies have shown that Brushless DC (BLDC) and Permanent Magnet Synchronous Motors (PMSM) are highly suitable for electric two-wheelers because they offer high efficiency, low maintenance requirements, and excellent torque characteristics at low speeds. Additionally, advanced motor controllers utilizing Pulse Width Modulation (PWM) techniques provide smoother power delivery and improved energy efficiency. Research on electric vehicle workbenches and testing platforms highlights their role in enabling real-time analysis of components under controlled conditions, making them valuable tools for academic learning, industrial training, and fault diagnosis. Furthermore, numerous studies have confirmed that electric two-wheelers contribute significantly to reducing greenhouse gas emissions, noise pollution, and dependence on fossil fuels. Their environmental benefits can be further enhanced when renewable energy sources are used for battery charging, making electric mobility a key solution for sustainable transportation.

III. METHODOLOGY

The project was carried out using an experimental and analytical methodology to develop an educational and testing workbench for electric two-wheelers. The process began with problem identification, which focused on understanding the need for a practical setup that could be used for learning, testing, and analyzing electric vehicle systems. A comprehensive literature review was then conducted to study existing electric vehicle technologies, battery systems, motor drives, and workbench models. Based on the findings, the system design phase involved selecting suitable components such as the motor, battery, controller, and frame structure according to power requirements, cost, and compatibility. A mild-steel frame was designed and fabricated to securely mount all components, while the electrical system was developed using proper wiring, connectors, and protective devices such as fuses to ensure safe and reliable operation. Measuring instruments, including a voltmeter, ammeter, and tachometer, were incorporated to facilitate performance monitoring and analysis.The fabrication process involved designing and constructing the frame using mild-steel angles, mounting the motor and wheel assembly, installing the battery, controller, and throttle mechanism, and completing all electrical connections according to the circuit design. After assembly, insulation and wiring checks

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were performed to ensure safety and prevent electrical faults. Trial runs were then conducted to verify system functionality and collect operational data. The testing phase involved evaluating the system under various load and speed conditions by measuring battery voltage and current during operation, observing motor performance at different throttle positions, and analyzing speed and efficiency characteristics. Safety assessments were also carried out to ensure that no overheating, short circuits, or other hazardous conditions occurred during operation. Finally, the collected data were evaluated to determine system performance, efficiency, and component behavior under different operating conditions, leading to conclusions and recommendations for future improvements, research opportunities, and educational applications.

IV. EXPERIMENTAL SETUP

The experimental setup for the electric two-wheeler workbench was developed using several key components to simulate and analyze the operation of an electric vehicle drive system. The setup included a 48 V, 24 Ah lithium-ion battery pack as the power source, a 48 V Brushless DC (BLDC) motor rated at 1 kW, and a 48 V, 30 A BLDC motor controller for regulating motor operation. A twist-type throttle equipped with a Hall-effect sensor was used to provide controlled speed input. Various measuring instruments, including a voltmeter, ammeter, tachometer, multimeter, and digital speed sensor, were installed to monitor and record system parameters. All components were securely mounted on a frame constructed from mild steel, cast iron, and wood to ensure structural stability and ease of access during testing. The system was assembled according to the designed wiring diagram, with proper insulation and safety measures implemented to prevent electrical hazards and ensure reliable operation.

The experimental procedure began by connecting the battery, motor, and controller according to the circuit layout. Measuring instruments were then installed and calibrated to accurately record voltage, current, and speed data during operation. The throttle was gradually operated to provide controlled input signals to the controller, allowing the motor speed to be varied systematically. Observations were recorded at different throttle positions of 25%, 50%, 75%, and 100% to evaluate system performance under varying operating conditions. Each test was repeated multiple times to verify the consistency, stability, and accuracy of the readings. The collected data were subsequently analyzed to determine important performance parameters, including motor output power and overall system efficiency, providing a comprehensive assessment of the workbench's operational characteristics.

V. RESULT ANALYSIS

The experimental results demonstrated that the BLDC motor operated smoothly and responded efficiently to changes in throttle position, providing stable speed control across different operating conditions. The motor controller maintained reliable performance throughout the testing period and showed no signs of overheating, indicating effective power management and thermal stability. The lithium-ion battery exhibited discharge characteristics that were consistent with its rated specifications, ensuring a dependable power supply to the system. Analysis of the collected data revealed that the overall system achieved an average efficiency of approximately 85–90%, highlighting the effectiveness of the electric drive system in converting electrical energy into mechanical output. Furthermore, the developed workbench successfully demonstrated the operating principles of an electric two-wheeler, making it a valuable platform for practical learning, performance analysis, and training in electric vehicle technology.

Throttle Position (%)	Voltage (V)	Current (A)	Speed (RPM)	Output Power (W)
25 %	48	5	450	240
50 %	48	10	900	480
75 %	48	15	1350	720
100 %	48	20	1800	960

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Calculation

Output Power (P):

$P = V \times I$

Efficiency (η):

$\eta = Pout / Pinput \times 100$

For example, at 100 % throttle:

$P = 48 \times 20 = 960W$

If motor output is 850 W (mechanical),

$\eta = 850/960 \times 100 = 88.5\%$

VI. CONCLUSION

The project demonstrates that electric two-wheelers are a clean, efficient, and sustainable alternative to conventional petrol-powered vehicles. The workbench developed serves as a training and experimental platform for students and researchers to study EV technology. It contributes toward understanding the key concepts of electric mobility, including power conversion, control systems, and energy management. The workbench successfully demonstrates EV operation principles. The motor runs smoothly, and the current drawn increases with load. The setup allows clear observation of system behavior. Students can easily study speed control, power consumption, and system efficiency. The developed EV demo workbench provides a safe and effective platform to study and demonstrate electric vehicle technology. It helps in understanding EV drive systems practically and can be further developed with sensors, regenerative braking, and IoT-based monitoring.

VII. FUTURE SCOPE

Several improvements can be incorporated into the electric two-wheeler workbench in future developments to enhance its functionality and educational value. The integration of smart sensors and Internet of Things (IoT) technology can enable real-time performance monitoring, data logging, and remote diagnostics, providing deeper insights into system operation. The development and implementation of an advanced Battery Management System (BMS) would improve battery safety by monitoring critical parameters such as voltage, current, temperature, and state of charge, while also extending battery life through optimized charging and discharging control. The addition of a solar charging system can further increase the sustainability of the setup by utilizing renewable energy for battery charging, reducing dependence on conventional power sources. Furthermore, the workbench can be expanded to accommodate testing and comparison of different motor technologies and battery chemistries, allowing students and researchers to evaluate performance characteristics, efficiency, and suitability for various electric vehicle applications.

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