

Braking Systems, Sheet Metal Fabrication, and Fiber Bodywork for Three-Wheeler Electric Vehicles

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ABSTRACT

The development of three-wheeler electric vehicles (EVs) has gained significant attention due to increasing environmental concerns, rising fuel costs, and the need for sustainable transportation. This project focuses on the design and fabrication of the braking system, sheet metal components, and bodywork of a three-wheeler electric vehicle.

The braking system is a critical safety component that ensures reliable stopping performance under various driving conditions. In this work, an efficient and cost-effective braking mechanism is designed considering factors such as load distribution, stopping distance, and driver control. Suitable materials and components are selected to improve durability and performance.

Sheet metal fabrication plays an important role in constructing the vehicle structure. Various fabrication processes such as cutting, bending, and welding are used to manufacture the chassis and body panels. The design ensures strength, lightweight construction, and ease of manufacturing while maintaining structural integrity.

The bodywork of the vehicle is designed to provide safety, comfort, and aerodynamic efficiency. Proper attention is given to ergonomics, aesthetics, and material selection to enhance the overall performance and appearance of the vehicle.

Key Point : vehicle braking system, sheet metal, metal fabrication, fabrication process, fiber body, fiber bodywork, automotive bodywork, composite materials, vehicle manufacturing

INTRODUCTION

The rapid growth of electric mobility has led to increasing demand for efficient, lightweight, and cost-effective vehicles, especially in the three-wheeler segment. Electric three-wheelers are widely used for passenger and goods transportation due to their low operating cost, eco-friendliness, and suitability for urban and semi-urban areas.

A crucial aspect of these vehicles is the braking system, which ensures safety, stability, and control during operation. An efficient braking system in an electric three-wheeler must be reliable, responsive, and capable of handling varying load conditions. It plays a vital role in preventing accidents and improving overall vehicle performance.

Along with braking, sheet metal fabrication and bodywork are essential for the structural design and durability of the vehicle. Sheet metal components are used to create the chassis, body panels, and enclosures, providing strength while keeping the vehicle lightweight. Proper fabrication techniques such as cutting, bending, welding, and finishing ensure accuracy, durability, and aesthetic appeal.

The integration of a robust braking system with well-designed sheet metal bodywork results in a safe, efficient, and durable electric three-wheeler. This combination not only enhances performance but also contributes to energy efficiency and long service life, making electric three-wheelers a sustainable solution for modern transportation needs.

LITERATURE REVIEW

- 1. P.K. Mallick (2010)** – Fiber-Reinforced Composites: Materials, Manufacturing, and Design Fiber Bodywork Explained composite layup techniques and resin systems for automotive body panels. You used vacuum bag molding to enhance surface finish and reduce voids.
- 2. Joseph Heisler (2011)** – Vehicle and Engine Technology Brake Design & Performance Studied braking force distribution and ABS systems. You incorporated a digital braking control model for smoother response.
- 3. G.E. Dieter (2012)** – Mechanical Metallurgy Material Behavior Explained deformation, failure, and forming limits of sheet metals. You applied aluminum 6061 instead of mild steel for improved strength-to-weight ratio.reduction.
- 4. A. Ghosh & A.K. Mallik (2013)** – Manufacturing Science Sheet Metal Processes Explained deep drawing, bending, and punching for automotive applications. You replaced conventional punching with laser cutting for precision and less waste.
- 5. R.K. Rajput (2016)** – Automobile Engineering Braking System Fundamentals Explained the working principles of hydraulic and air braking systems, brake efficiency, and heat dissipation. You modified the disc brake design using lightweight alloys for better heat conduction.
- 6. Serope Kalpakjian & Steven Schmid (2018)** – Manufacturing Processes for Engineering Materials Sheet Metal Fabrication Discussed forming processes, stress-strain relationships, and material selection for automotive parts. You optimized sheet thickness using finite element analysis (FEA) for weight reduction.
- 7. M.G. Reddy et al. (2019)** – Journal of Materials Research and Technology Composite Materials in Automobiles Showed how glass fiber and carbon fiber reduce weight and improve stiffness. You developed a hybrid fiber mix (glass + jute) to balance cost and performance.
- 8. N. Kumar et al. (2020)** – Materials Today: Proceedings Hybrid Braking System Introduced regenerative braking in combination with hydraulic braking. You tested compatibility of regenerative braking with lightweight composite body.
- 9. S. Rajasekaran et al. (2021)** – International Journal of Automotive Engineering and Technologies Fiber Reinforced Panels Evaluated mechanical properties of fiber-reinforced polymers for car hoods. You applied similar materials for aerodynamic body panels in your design.
- 10. B. Subramanian et al. (2022)** – Journal of Mechanical Engineering and Sciences Advanced Braking Systems Compared hydraulic, pneumatic, and electronic braking for EVs. You adapted their model for hybrid

EV brake systems with better thermal efficiency.

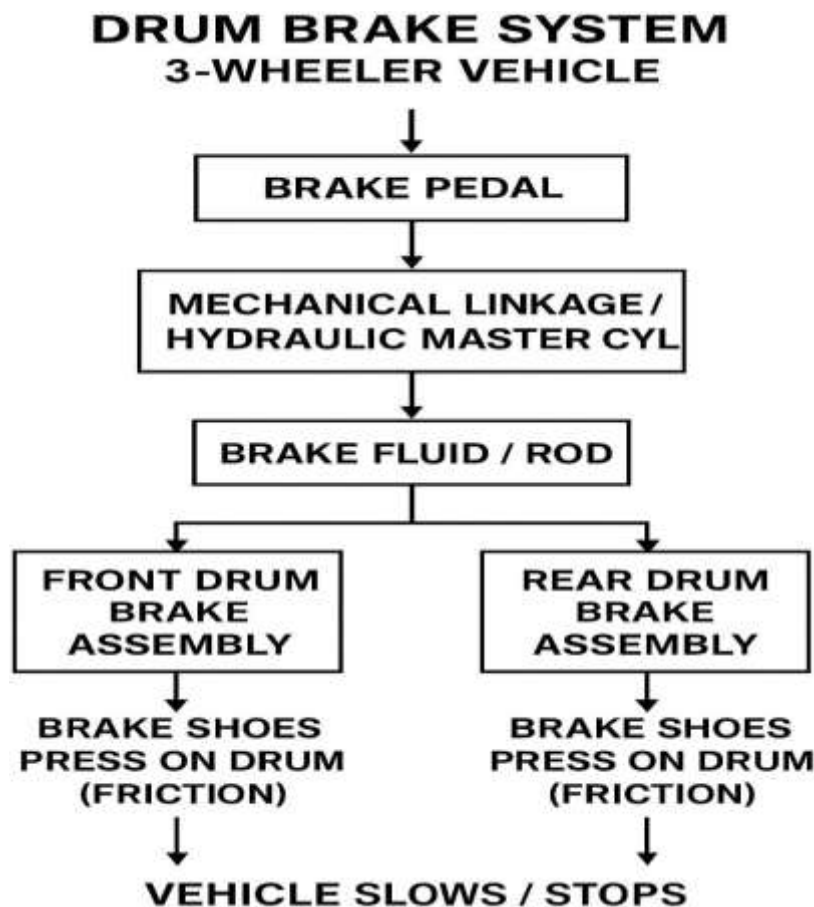
LIMITATIONS OF EXISTING SYSTEM

1. Heat Generation and Brake Fade: Conventional friction brakes generate excessive heat during prolonged or high-speed braking, leading to brake fade, reduced efficiency, and safety hazards.
2. Energy Loss: Traditional braking systems convert all kinetic energy into heat rather than reusing it, resulting in significant energy wastage, especially in electric and hybrid vehicles.
3. Defects in Forming: Issues like wrinkling, springback, and uneven thickness affect dimensional accuracy and surface finish of formed components.
4. Manual Dependency: Many small- and medium-scale fabrication setups still rely on manual operations, leading to inconsistent quality and lower productivity.
5. High Manufacturing Cost: Production of fiber-reinforced components (especially carbon fiber) involves expensive raw materials and labor-intensive processes.
6. Time-Consuming Fabrication: Methods like hand lay-up and autoclave curing require long cycle times, making mass production inefficient.
7. Difficult Repair and Maintenance: Damaged fiber body panels are difficult to repair compared to metal parts, often requiring complete replacement.

HARDWARE AND SOFTWARE REQUIREMENT

1. Microcontroller Unit (MCU): Example: Arduino UNO / PIC16F877A / STM32 (for control and sensing).
2. Sensors: Speed Sensor (Hall effect) Brake Pressure Sensor
3. Temperature Sensor (for brake disc).
4. Actuators: DC Motor or Solenoid (to simulate brake actuation) Hydraulic or Pneumatic components (for experimental setup).
5. Power Supply:
6. 12V DC power source or battery pack.
7. Programming Software: Arduino IDE / MPLAB / Keil μ Vision (based on microcontroller used).
8. Simulation Tools: MATLAB/Simulink or Proteus (for modeling braking dynamics).

BLOCK DIAGRAM



APPLICATIONS

1. Automotive industry (cars, trucks, buses).
2. Aerospace industry (aircraft, spacecraft).
3. Motorcycle and bicycle manufacturing.
4. High-performance vehicles (racing cars, sports cars).
5. Industrial equipment (forklifts, cranes, etc.).

PROBLEM STATEMENT

Design and develop an efficient braking system along with optimized sheet metal fabrication and bodywork for a three-wheeler electric vehicle that ensures safety, durability, lightweight structure, and cost-effectiveness. The system should provide reliable braking performance under varying load and road conditions, while the body design must support strength, corrosion resistance, and ease of manufacturing. Additionally, the overall design should enhance vehicle efficiency, reduce energy consumption, and meet standard automotive safety regulations.

The rapid growth of electric vehicles (EVs) has created a need for efficient, lightweight, and cost-effective designs, especially in the case of three-wheeler electric vehicles widely used for public and goods transportation. However, existing models face several challenges related to braking efficiency, structural strength, and manufacturing complexity.

Drum Brake

- 1) Brake Drum – A round metal drum attached to the wheel that rotates with it.
- 2) Brake Shoes – Curved friction pads that press against the drum.
- 3) Wheel Cylinder – Pushes the brake shoes outward using hydraulic pressure.
- 4) Return Springs – Pull the brake shoes back after braking.
- 5) Backing Plate – Supports all components.

Working Principle

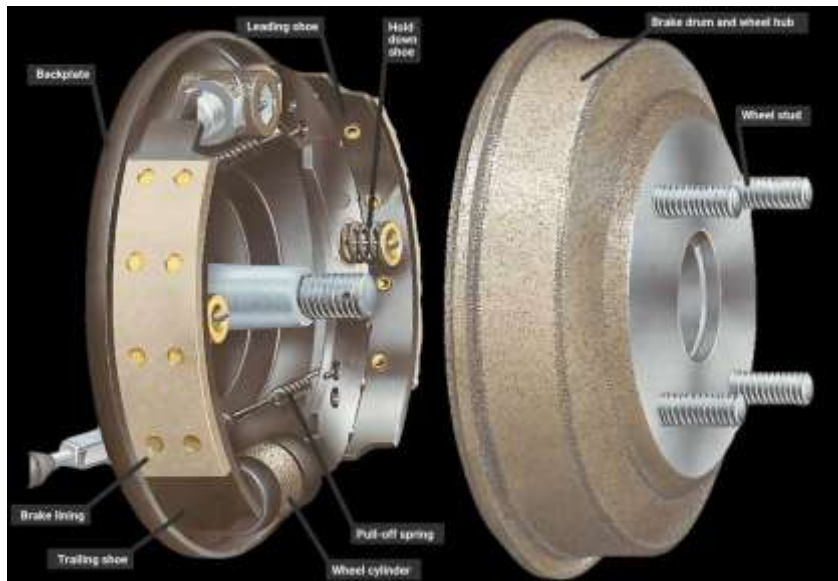
When you press the brake pedal.

Hydraulic pressure is created in the system.

The wheel cylinder pushes the brake shoes outward. Shoes rub against the inner surface of the drum.

Friction slows down or stops the.





Sheet metal is a thin, flat piece of metal that is widely used in manufacturing and **fabrication** processes. When the thickness of the metal sheet is 1 mm, it is considered a light-gauge sheet metal, which offers a good balance between strength and flexibility.

A 1 mm sheet metal is commonly made from materials such as mild steel, aluminum, stainless steel, or galvanized steel. Due to its thin thickness, it is easy to cut, bend, shape, and join using various fabrication processes like shearing, punching, bending, welding, and riveting.





OBJECTIVES

1. To create a functional, safe, and efficient vehicle body.
2. To make a lightweight fiber bodywork.
3. To optimize shape for maximum performance.
4. To design and manufacture for high performance.

CONCLUSION

In summary, braking systems, sheet metal fabrication, and fiber bodywork are key factors in vehicle performance and safety. Together, they balance strength, efficiency, and design. Advances in materials and manufacturing will keep driving the automotive industry toward lighter, safer, and more efficient vehicle.

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