



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 12, Issue 5, May 2023

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 8.423

9940 572 462

6381 907 438

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Modelling and Fabrication of Electric Cargo Vehicle with Foldable Carrier

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ABSTRACT: This paper presents the fabrication of an electric cargo vehicle with a foldable carrier. The vehicle is designed for urban transportation and delivery purposes. The vehicle is powered by a 250W hub motor and a 4 series 12V battery system. The foldable carrier provides flexibility and convenience for carrying cargo. The vehicle is designed to be environmentally friendly and efficient, with a top speed of 25km/h and a range of 30km on a single charge. The fabrication process involved designing the frame, integrating the motor and battery system, and constructing the foldable carrier. The tricycle was tested for functionality and performance, and the results show that it meets the design requirements and specifications.

KEYWORDS—: Hub motor, BLDC controller, lead acid battery, Throttle, CAD models, foldable carrier.

I. INTRODUCTION

The use of electric vehicles is rapidly increasing due to concerns about climate change, air pollution, and the rising cost of fossil fuels. Electric vehicles have become popular for urban transportation and delivery purposes due to their compact size and ability to carry load. In this paper, we present the fabrication of an electric cargo tricycle with a foldable carrier. The tricycle is designed to be efficient, environmentally friendly and convenient for carrying loads.

Electric cargo vehicles are a growing trend in urban transportation, offering a cost-effective, eco-friendly, and convenient alternative to traditional motorized vehicles. These bikes are designed with large carrying capacities, allowing them to transport a wide range of goods. In addition to their utility, electric cargo vehicles also have numerous benefits, including reduced air pollution, lower noise levels, and the opportunity for low-impact exercise. However, despite their increasing popularity, there are still many misconceptions about the limitations of electric cargo vehicles. In this report, we aim to provide an overview of the current state of the art in electric cargo bike design and use, as well as a review of the benefits and challenges of these vehicles. By understanding the potential of electric cargo vehicles, we can better assess their role in the future of urban transportation.

Urban transport is the source of several problems like noise, air pollution and greenhouse gas emissions. Transport of both goods and people needs to become more efficient and less environmentally harmful and more equally accessible in society. Short trips with loads (such as grocery shopping) have been identified as a main hinder for people who do not own a car to keep up their everyday life in an urban setting. Cycling has the potential to reduce the environmentally negative aspects of urban transport, while being less expensive and thus more accessible to low-income households than a car. With electric cargo (E-cargo) vehicles, it is possible to travel longer distances and carrying heavier loads without getting tired or sweaty, but the higher price tag

means that E-cargo vehicles are not yet available to all as in many other transport segments, professional organizations are the earlier adopters of new innovations. Electric cargo vehicles have gained popularity in recent years as a cost-effective, eco-friendly, and convenient alternative to traditional motorized vehicles for goods transportation. However, many existing cargo vehicles are limited by their fixed carrying capacity and lack of versatility. A cargo bike with a foldable carrier has the potential to overcome these limitations, offering increased carrying capacity and the ability to transport a wide range of goods.

In this project, we propose to design and fabricate an electric cargo vehicle with a foldable carrier that is both functional and user-friendly. The goal of this project is to create a prototype that can serve as a proof-of-concept for a production model, and to evaluate the performance and reliability of the prototype through testing and analysis.



|| Volume 12, Issue 5, May 2023 ||

| DOI:10.15680/IJIRSET.2023.1205045 |

II.PROBLEM STATEMENT

There are several problems that are commonly faced in the current goods transportation system:

Traffic congestion: Heavy traffic can lead to delays in delivery, increased fuel consumption, and reduced efficiency.

Air pollution: Traditional motorized vehicles, such as trucks and vans, can contribute to air pollution through the emission of greenhouse gases and other pollutants

Limited carrying capacity: Many traditional vehicles are not designed to carry large or awkward-shaped items, which can limit their utility for certain types of goods.

High costs: The cost of owning and operating traditional vehicles, particularly in urban areas, can be high due to factors such as fuel expenses, maintenance costs, and insurance fees.

Limited accessibility: Traditional vehicles may not be accessible to everyone, including those who may have mobility limitations or live in areas with crowded street.

III.DESIGN OF VEHICLE

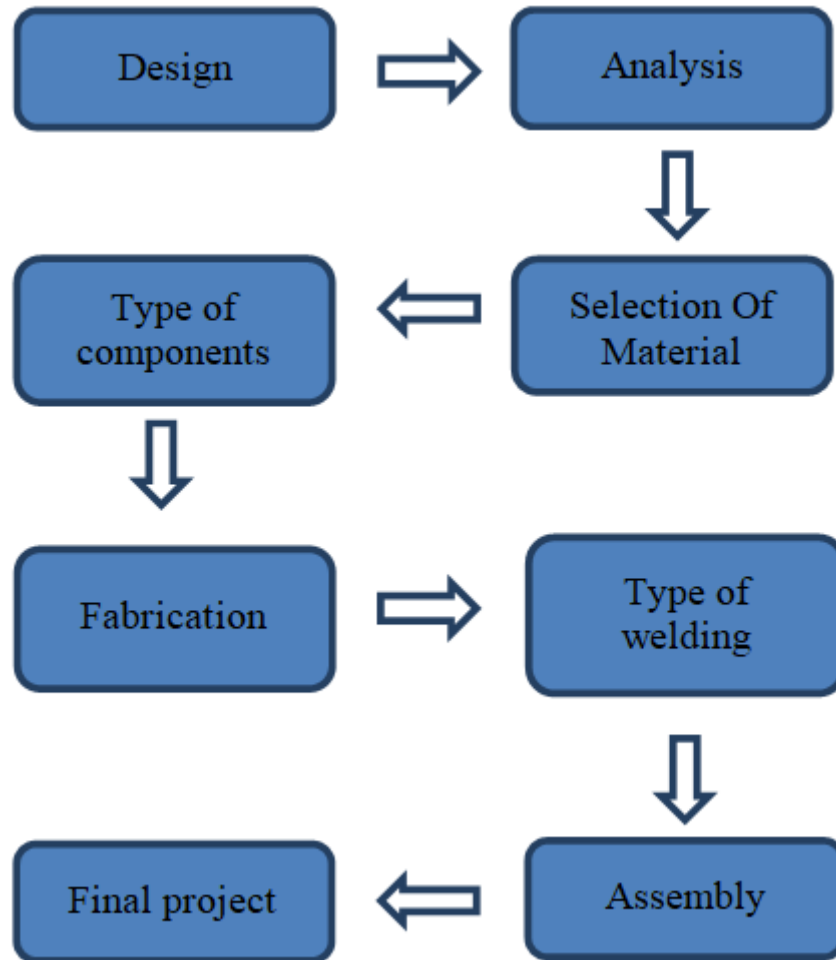


Normal diagram of vehicle

Diagram of folded vehicle



IV.METHODOLOGY



V.WORKING PRINCIPLE

The vehicle has lead-acid battery mounted near the rear wheel that provide electricity to a motor. The electric motor drives the rear wheel and the hub motor is mounted inside the rear wheel. DC to AC convertor is used to convert high voltage supply to low voltage supply. Here the electrical energy is converted into the rotation energy which gives momentum to the vehicle. On the steering handle there is an accelerating throttle which help in the acceleration of the vehicle with the help of speed controller.

The carrier space of the vehicle is designed in a way that can be folded and utilized in a small area. The overall size of the vehicle can be reduced by a proper mounting system. This type of mechanism will provide a smooth use of the vehicle.

VI.DEVELOPMENT AND CONSTRUCTION

Frame

Frame is the most significant rigid structural member that carries the various components of the vehicle in proper orientation. Basic types of frames are:

- Tubular frame: Single cradle frame, double cradle frame, backbone frame.
- Pressed steel frame. Tubular frame is easy to fabricate as compared to pressed steel frame.

Our vehicle is designed using the simplest form of double cradle frame. This helped us in decreasing the number of members to be used in the frame and thus keeping the mass to the lowest and most desirable value.

1.Design of Frame

The chassis is the component in charge of supporting all other vehicle's subsystems taking care of the driver's safety at all the times. The chassis design should withstand impacts created by crash or rollover. It must be very strong and durable taking into account the weight distribution for a better performance.

2. Material of Frame

Material selection of the chassis plays crucial part in providing the desired strength, endurance, safety and reliability to the vehicle. To choose the optimal material considering the properties good bending stiffness, minimum weight and maximum strength for the pipes from Mild Steel, Stainless Steel and Aluminum. Along these lines, post-retail investigation on cost, accessibility, and properties of these three materials. The material finalized was Mild Steel with the grade of M.S. IS1239. of the following dimensions: outer diameter 25.4mm and thickness 3mm.

Electric System

The motor is known as the 'heart' of an electric vehicle. The motor takes the power from the battery and powers the driving wheel. Brushless DC hub motor is the one which we have decided to use due to better efficiency and compactness. It is a permanent magnet DC motor with brushes replaced by rotor position sensors and semiconductor switches. As this motor is placed directly in the wheel, smooth torque is obtained. Frictional losses, wear and tear are minimized. Specification of motor to be used: Power: 1 KW, Voltage: 48 volts.

Battery packs are like 'fuel' which provides the power to the vehicle. Based on availability and cost, lead acid battery proved to be fitting with the requirements of the vehicle. Deep discharge lead acid battery was chosen for the purpose. These batteries are sealed and don't require any water to be filled up. Battery packs are rated in volts (V) and ampere-hours (AH) of energy. Controller can be considered as 'brain' of the electric vehicle, as it provides output into the motor as per the input provided by the driver. Controller basically controls the current flowing into the motor from the battery based on proper communication with the accelerator. The controller used in our prototype provides overload protection. Similar to petrol vehicles, our project vehicle is also equipped with the accelerator to control the speed.

Components with specifications

1.Hub motor

A hub motor is a type of electric motor that is located in the hub of a wheel. It consists of a rotor, which is mounted on the hub, and a stator, which is mounted on the frame of the bike. Hub motors are typically used in electric bikes and scooters, as they provide a simple and efficient way to add an electric drive system to a vehicle.

2.Battery

The battery of an electric cargo bike stores the electrical energy that powers the motor. There are several types of batteries that could be used, including lead-acid, lithium-ion, and nickel-metal hydride. The choice of battery will depend on factors such as capacity, weight, and cost. Here we use 12v 7Ah lead-acid battery.

3.Controller

The controller of an electric cargo bike regulates the flow of electrical current from the battery to the motor. It may also include features such as a display for battery level and speed, as well as controls for adjusting the level of assistance provided by the motor.

4.Full twist throttle

This type of throttles is used in all bikes to control the speeds of vehicle. Its look like bike handle and fit correctly to handle. To operate throttle simply put hand on the handle and turn to your side for acceleration and for slow downturn to opposite direction.

5.Wheel

We mainly use two rear wheel and a front wheel which is attached to a hub motor which help to rotate on an axle bearing. Wheel allows heavy objects to be moved easy transportation while supporting a load.

General Specifications of the Vehicle

Specification	Values
Frame Material	MS IS 1239
Material dia. & thickness	25.4mm & 3mm
Rear Wheels	Dia:200mm
Motor	Type: BLDC Hub Motor Power: 1KW Volts: 48V Efficiency: 80%
Battery Pack	Type: Deep Discharge Lead Acid Voltage: 4 x 12V
Vehicle Weight	100 Kg (aprox)
Vehicle Load Carrying Capacity	1Tone (aprox)

VII.RESULTS AND ANALYSIS

It is concluded that, the analysis done on carriage frame for 100kg load the frame is made up of 15x15mm square pipe with 1.5mm thickness, it is strong enough to withstand load. The deployment of such type of vehicle will work for 1hr by full charging of series connected four 12v and 7ah batteries.

These types of vehicle can be allocated to delivery boys thereby assigning a group to them to particular area in the city reducing the need excess travelling from one corner of the city to other for delivery work.

Also, it will help in reducing the traffic congestion and reduce the pollution level which are very high at present time.

Finding alternatives to vans or trucks for deliveries in congested areas can improve efficiencies, and therefore business costs, for delivery companies; it can also reduce emissions from urban freight and help reduce congestion on streets to help people and goods move faster through our cities. Improving goods movement in Toronto through cycle logistics will bring the following benefits.



diagram of vehicle before folding



diagram of vehicle after folding

VIII. CONCLUSION

Foldable electric cargo vehicles are a significant advancement in the transportation industry. The foldable feature allows for easy storage and transportation, making it ideal for urban environments with limited space. Additionally, being electric powered helps in reducing carbon emissions, making it environmentally friendly. The cargo vehicle's ability to carry heavy loads makes it an excellent choice for e-commerce businesses, delivery services, logistics companies, and even personal use. Despite the numerous benefits, the pricing of these vehicles may still pose a challenge for some potential buyers. However, with technological advancements, there is hope that prices will reduce in the future, making foldable electric cargo vehicles a staple in the transportation industry.

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Impact Factor: 8.423



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