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FABRICATION OF CHASSIS FOR ELECTRIC UTILITY VEHICLE

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Abstract - *This project focuses on the fabrication of a lightweight and durable chassis for an electric utility vehicle (EUV), aimed at promoting sustainable transportation solutions. The chassis serves as the structural backbone of the vehicle, designed to accommodate electric powertrain components, batteries, and other subsystems while ensuring safety, stability, and performance. Material selection, structural analysis, and fabrication techniques were carefully considered to achieve an optimal balance between strength and weight. Computer-aided design (CAD) and Solidworks tools were used for modeling, Analysis using Ansys and followed by fabrication. The final chassis design successfully meets the functional and structural requirements for an EUV and sets the foundation for further integration and vehicle development. This work contributes to the growing field of electric mobility by providing a cost-efficient and reliable platform for utility-focused electric vehicles.*

Key Words: Electric Utility vehicle, Chassis Design, Performance, Material Selection, Light Weight, Performance, Electric power train, Battery integration, Safety, Fabrication technique.

1.INTRODUCTION

The chassis is the fundamental structural framework of any vehicle, being the one on which all other assemblies are supported. It provides the necessary strength, stiffness, and support to resist the weight of the vehicle body, passengers, and mechanical components and to accommodate any dynamic loads imparted during operation. In motor vehicle engineering, the chassis is a critical assembly in ensuring stability, handling, and general safety. For electric vehicles, the chassis design is even more critical due to the unique location of components such as battery packs, electric motors, and power electronics. Unlike conventional internal combustion vehicles, EV chassis must carry heavy battery systems without sacrificing structural integrity and minimizing weight to enhance efficiency and range. A well-designed chassis not only responds to the functional requirements of the vehicle but also goes a long way in framing the performance, longevity, and efficiency of the vehicle. As such, the production of a suitable chassis is a key step in the development of an electric utility vehicle, balancing the principles of mechanical engineering with today's sustainability goals.

1.1 Construction of Chassis

A typical chassis frame is the long sections which are located on either side are called longitudinal members. These longitudinal or side members are joined together with cross members with the help of rivets or bolts. Generally, five or six cross members are used to give good strength and stability to the chassis. Sometimes diagonal cross bracing is also provided for torsional rigidity. The longitudinal members are upswept in the front and rear to provide the space for movement of axle. It also helps in keeping the frame height low also the frame tapers from rear to front to provide better steering lock by providing a smaller turning circle. The brackets are provided in the frame to support the body also for mounting different parts such as suspension springs, engine, brake shaft etc. The extended part of chassis frame over the front axle is known as front overhang. Whereas beyond the back axle is known as rear overhang. The engine, clutch and transmission are all bolted together into an assembly and are mounted usually on the front end of this frame by means of rubber blocks. These rubber blocks help in isolating the engine from road shocks and also isolating the vehicle from engine vibrations. All these members used in making the chassis frame are made up of pressed steel.

1.2 Material Selection

Selection of material for chassis is Cold Rolled Steel Rectangular Section is consisting for their high strength to weight ratio, Excellent torsional stiffness, Surface finish, easy to fabricate, good durability and strength.

Properties	Value
Yield Strength	250 MPa
Tensile Strength	370 – 500 MPa
Modulus of Elasticity	200 – 210 GPA
Elongation at Break	10 – 20%
Hardness (Brinell)	70 – 100 HB
Density	7.85 g/cm^3
Toughness	Moderate

2. Literature Review

[1] Narayanan (2022): focused on the design optimization of an electric vehicle (EV) chassis using Finite Element Method (FEM). The project involved creating a CAD model of the chassis and analyzing it under various load conditions. FEM was used to identify stress points and areas for structural improvement. The goal was to reduce weight while maintaining strength and safety. The study supports efficient and reliable EV chassis design through simulation-driven development.

[2] Kumar and Dhingra (2015): worked on the design and fabrication of a go-kart chassis using Finite Element Analysis (FEA). The chassis was modeled using CAD software and tested under simulated load conditions. FEA helped identify stress distribution and deformation zones. The project aimed to optimize strength while minimizing material usage. The study

demonstrates how simulation enhances design efficiency before actual fabrication.

[3] Kumar and Mishra (2017): This focused on designing a vehicle chassis and analyzing its crashworthiness using computer-aided engineering tools. The chassis model was created using CAD and tested through Finite Element Analysis (FEA). The study evaluated the structure's ability to absorb impact energy during collisions. Results helped identify weak zones and improve safety features. The project supports safer and more durable chassis design in modern vehicles.

[4] Chau and Wong (2002): This studied power management strategies in hybrid electric vehicles (HEVs). The project focused on optimizing energy flow between the internal combustion engine, electric motor, and battery system. Various control strategies were analyzed to improve fuel efficiency and reduce emissions. Simulation models were used to evaluate performance under different driving conditions. The study provides insights applicable to electric vehicle power systems and chassis integration.

[5] Yadav (2014): He explores the fundamentals of vehicle dynamics and control in automotive systems. The study covers key areas such as suspension design, steering geometry, braking, and stability. It emphasizes how these factors influence handling, comfort, and safety. The work also discusses count e structural improvements. The work supports safer, more efficient EV chassis development.

[8] Goel and Kaushik (2021): This focused on developing a chassis specifically for compact urban electric vehicles (EVs). The study emphasized lightweight design, space optimization, and structural roll systems that enhance vehicle performance during different driving conditions.

These concepts are crucial for designing stable and responsive electric vehicle chassis systems.

[6] Tarun & Raju (2018): This study focuses on selecting suitable lightweight materials and fabrication

techniques for electric vehicle (EV) chassis frames. The authors compare materials like aluminum alloys, carbon Fiber, and high-strength steel based on-to-weight ratio, cost, and manufacturability. The project aims to reduce overall vehicle weight without compromising structural integrity. Emphasis is placed on welding and joining methods suitable for EV applications. The study supports efficient chassis design for enhanced EV performance and range.

[7] Anitha & Senthilkumar (2019): This project involves designing an electric car chassis frame and evaluating its performance using Finite Element Analysis (FEA). The study assesses stress distribution, deformation, and safety factors under various loading conditions. CAD modeling and simulation tools were used to optimize the frame design. Results help identify weak points and guides integrity suitable for city driving conditions. CAD modeling and simulation tools were used to validate the chassis under urban load scenarios. The chassis was designed to support battery placement and enhance maneuverability. This project highlights the importance of compact, efficient design for urban EV applications.

[9] Mohan and Kut Tappan (2020): This explored various welding techniques used in aluminum chassis fabrication for electric vehicles (EVs). The study compared methods like TIG welding, MIG welding, and friction stir welding in terms of strength, heat input, and joint quality. Aluminum lightweight properties were emphasized alongside the challenges it poses during welding. The goal was to identify the most effective technique for durable and efficient chassis construction. This work aids in improving the reliability and manufacturability of EV chassis systems.

[10] Reif and Dietsche (2014): This provides an in-depth overview of chassis design, covering fundamentals, driving dynamics, components, and mechatronics. The study delves into the integration of mechanical and electronic systems, highlighting how they impact vehicle stability and performance. The authors also address the evolution of chassis design, incorporating advanced materials and technologies. This work serves as a comprehensive guide to understanding the complex interactions within modern vehicle chassis. It is highly relevant to the development

of efficient and dynamic chassis for electric vehicles (EVs).

[11] Sharma and Patel (2018): This conducted a comparative analysis of mild steel and aluminum alloy for chassis fabrication. The study evaluated the two materials based on properties such as strength, weight, cost, and ease of manufacturing. Mild steel was found to offer greater strength but at the cost of increased weight, while aluminum alloys provided lighter chassis structures with adequate strength. The authors also discussed the impact of material choice on vehicle performance, especially in terms of fuel efficiency and handling. This research is valuable for optimizing material selection in the design of electric vehicle chassis.

[12] Lien Kamp (2012): This explored innovative chassis concepts for electric cars, focusing on lightweight structures, modular designs, and energy efficient solutions. The study examined how the unique requirements of electric vehicles (EVs), such as battery integration and powertrain efficiency, influence chassis design. New concepts like the integration of electric motors within the wheels and optimized frame geometries were discussed. The research aimed to improve the overall performance, safety, and cost effectiveness of EVs through innovative chassis technologies. This work provides insights into advanced chassis solutions specifically tailored for the evolving electric vehicle market.

[13] Hu, Li, and Peng (2012): This conducted a comparative study on equivalent circuit models for lithium-ion (Li-ion) batteries, focusing on how these models can accurately represent battery behavior under various operating conditions. The study analyzed different models based on parameters like battery voltage, capacity, and efficiency. The authors evaluated the trade-offs between model complexity and accuracy in predicting battery performance. This research is crucial for optimizing battery management systems in electric vehicles (EVs) by

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improving the accuracy of battery state predictions. Their findings are applicable to the development of more efficient power management systems for EV chassis designs

3. Methodology

Key Aspects of Chassis Fabrication

1. **Requirement Analysis** – Define vehicle load parameters, performance needs, and application environment.
2. **Concept Design** – Select suitable chassis layout (e.g., ladder frame, space frame).
3. **Material Selection** – Analyze material properties and select cold-rolled sections.
4. **CAD Modeling** – Develop 3D models using software such as SolidWorks or AutoCAD.
5. **Analysis** – Test the design for Structural.
6. **Fabrication** – Execute material cutting, welding, grinding, and final assembly.
7. **Integration and Mounting** – Assembly the chassis members.
8. **Testing** – Perform mechanical and load tests to evaluate structural behavior.

4. DESIGN AND ANALYSIS

The design and analysis of chassis fabrication begin with identifying the functional requirements such as strength, durability, and weight considerations based on the vehicle's intended use. Suitable materials like Cold Rolled Steel Rectangular Section are selected to balance cost, strength, and weight. A 3D model of the chassis is created to define dimensions, structure, and integration points for components. Analysis is performed to simulate stresses and deformations under Various loading. The chassis is then fabricated using processes like cutting, welding, and bending, ensuring dimensional accuracy and structural integrity. Finally, the fabricated chassis undergoes physical testing to verify its performance, strength, and safety under real-world conditions.

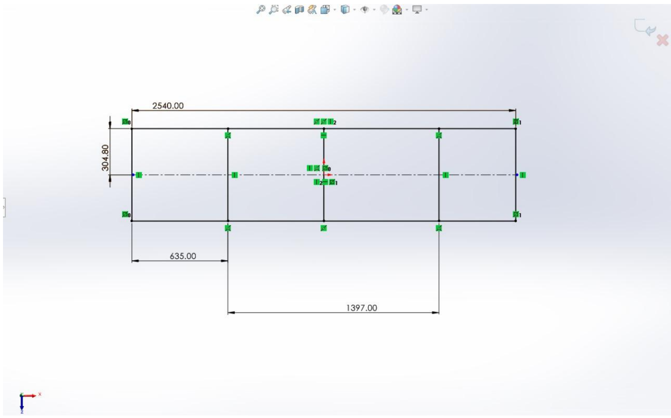

Fig 1: Line diagram of Chassis

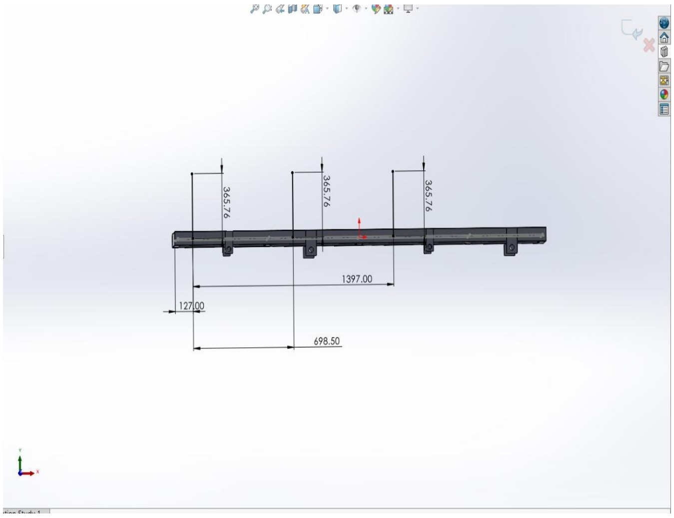

FIG 2: Side view

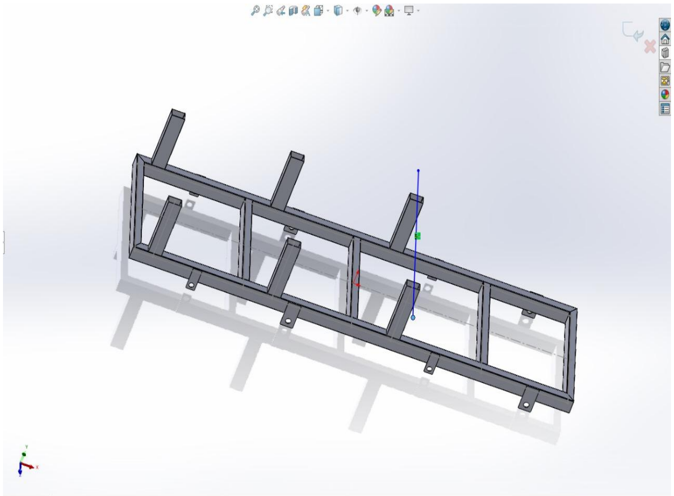

FIG 3: Front View

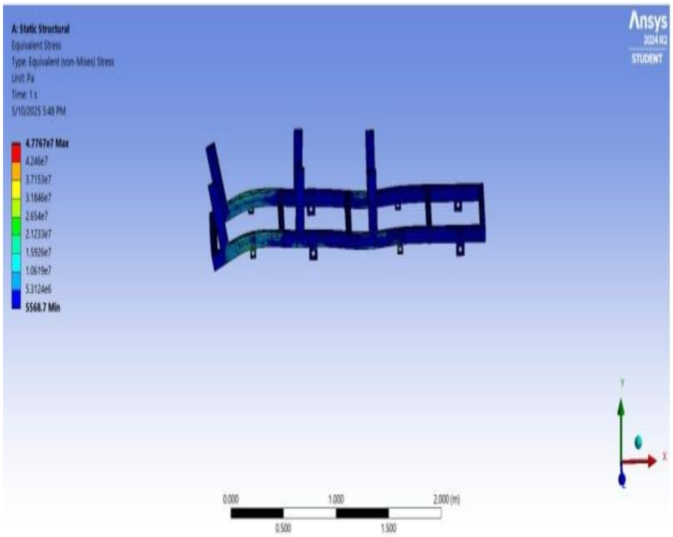

FIG 6: Equivalent Stress

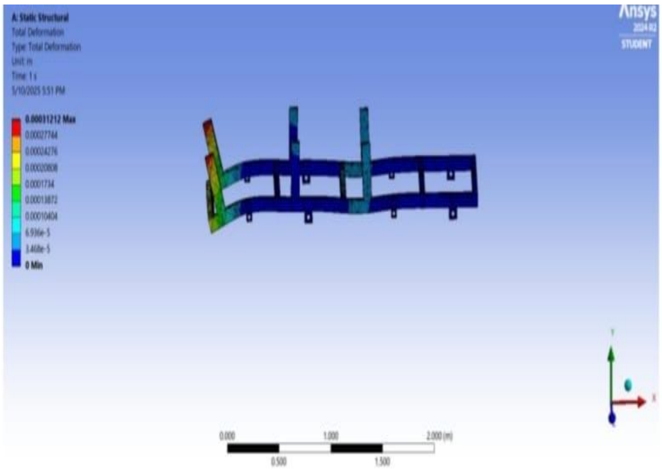

FIG 4: Deformation

Result Summary:

A. Total Deformation

Maximum Deformation: 0.312 mm
Minimum Deformation: 0 mm
Interpretation: The deformation is very low, which indicates that the structure is stiff and stable under applied load.

B. **Von Mises Stress**

Maximum Von Mises Stress: 47.77 MPa
Minimum Von Mises Stress: 5.57 KPa
Yield Strength: 250 MPa

$$\text{Factor of Safety (FOS)} = \frac{\text{Yield Strength}}{\text{Maximum Von Mises Stress}}$$

$$Fos = 250/47.77 = 5.23$$

The Structure subjected to a 700 kg vertical load is well within both deformation and stress. The Von Mises Stress remains far below the yield strength, indicating that no yielding and structural failure will occur. The low deformation also supports that the structure. With a factor of safety of 5.23, the design is considered structurally safe and reliable for the given loading condition**.**

5. FABRICATION PROCESS

Fabrication process of the electric utility vehicle chassis, from raw material preparation to final assembly. The goal is to convert the designed structure into a physical chassis using suitable manufacturing techniques, tools, and safety measures.

Step in Fabrication process:

1. Cutting: The raw metal is cut into size, based on the chassis design.
2. Welding: Cut components are accurately joined using Arc welding to form the basic chassis frame.
3. Bending: Metals are bent using benders to achieve required frame curvatures and geometry
4. Machining: Precision features like holes, slots, and threads are added using drilling and milling machines
5. Assembly: All parts are aligned and fastened together, completing the chassis structure with mounts for batteries and drivetrain.

FIG 7: Fabrication Chassis

6. CONCLUSIONS

The Chassis Fabrication of the electric utility vehicle chassis is a crucial step in producing a stable and efficient EV platform. Through the selective choice in material selection, accurate engineering design, and high standards of fabrication processes, the chassis meets the required standards in strength, durability, and weight optimization. It provides a robust structural foundation that can support the electric drivetrain, battery pack, and other critical components with safety and stability. The structure of this chassis not only leads to improved vehicle performance but also meets sustainability goals by enabling a cleaner mode of transportation. The achievement of this phase paves the way for electrical and mechanical system integration, bringing the project nearer to full vehicle assembly and testing.

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