Design and Development of Electric Moped Chassis

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Abstract

This paper intends to provide brief information about various components in an electric moped and propose an optimal design for Chassis. To attain optimal design, a conventional moped chassis is identified as a reference and according to the specifications and features of an electric vehicle, this conventional chassis is modified. The Model is designed in CATIA and simulation was performed in ANSYS giving a desired fabricated model which is eccentric and light-weight.

Keywords
Electric moped, Conventional chassis, Eccentric, Light weight, Simulation.

1. Introduction
India is one of the top most countries in the automotive industry in the world having a large population of nearly 15 million. For travelling from one place to another, people are adopted to use 2-and 3-wheelers which results in a great amount of pollution causing the environmental problems. Most of the companies are extracting more amount of fossil fuels for their economic growth and productivity. Due to this petrol prices are also increased by more than half of their existing cost in the last few years. In order to decrease these drawbacks and to protect the renewable sources, an alternative came into existence known as the Electric vehicle (EV). The initial investment may be higher than conventional engines, but considering the present situation, it is preferable to develop electric vehicles. Compared to conventional vehicles, electric vehicles have more advantages and have a huge impact on the future. In General gasoline vehicles have tailpipe which produces emissions into the air, and poisonous gases which causes many health issues like respiratory problems, irritations, etc.
Coming to the paper, presents the design and development of an electric moped chassis. In brief, all components of EV are discussed and a new chassis is designed and analysed. Before that one has to know about the basic definition of an Electric vehicle and why it is developed. An electric vehicle also referred to as an electric drive vehicle uses one or more motors for the propulsion. An electric vehicle may be charged through an external system or may be powered by a battery replacing the fuel tank in a gasoline vehicle. The EV became famous by three important factors: Advancement in battery technologies, encouragement by the government through policies and schemes for the reduction of air pollution, to decrease the petroleum usage as they are diminishing. Electric vehicles are used for road transportation like short distance applications like online deliveries. They are also applicable for rail, underwater and aerospace.
EVs are arisen in the mid19th century when electrical energy is mostly preferred for providing ease of operation and comfort for the person who is using it. As days are passing by, global warming and pollution are increasing gradually. Electric vehicles development will be more useful for the future generation. The paper describes the new chassis developed for the EV.
The 2-wheeler chassis is comprised of a few components. They are wheels, brakes and suspension. The main component of a vehicle is Chassis. It acts as a skeleton for the vehicle where the parts of the EV are mounted. For the fabrication of chassis materials like steel, aluminium or any alloy can be used. The chassis should be torsion-resistant that it shouldn't bend or buckle on uneven road surfaces which may be harmful to the person who is driving. Mostly the frame is made of hollow tubes of different materials. The Components mentioned above are discussed in the following sections.

1.1 Objectives
1. To validate the chassis like stress analysis and loading conditions, suggesting the design rules based on the output.
2. Identifying all mechanical properties of chassis and studying various loading conditions.

2. Literature review
K.W.E Cheng (2009) ellaborates recent Development on Electric Vehicles, *International Conference on Power Electronics Systems and Applications*. The paper describes the development and the comparison of different part of components. The major components in battery technology, charger design, motor, steering and braking are examined.[1]
D. Barapatre, C. Kanfade, A.Bari, R.Nile, R.Wagh, R. Nimbalkar (2016) explains about Electric vehicle, *International*

Journal Engineering Research Technology.This report explains how an electric vehicle works and compares the electric vehicle to the internal combustion engine and hybrid vehicle. The report provides some of the advantages and disadvantages of the electric vehicle.[2] D. Mohan Kumar, R. Sabarish1, Dr M. Prem Jeya Kumar (2018) explains about Structural and modal analysis of scooter frame. *International Journal of Pure and Applied Mathematics*. This project discusses the stress and deformation developed in chassis during the different load cases and identifying the failure modes by the modal analysis.

3. Working principle

The electric vehicle is driven by a motor, charged by a rechargeable battery or battery pack not with a gasoline engine. EVs don't look like an electric, most of the vehicles look like conventional vehicles. In some cases, both electric cars and two-wheelers are manufactured by converting gasoline vehicles. One can identify an electric vehicle by its one advantage that it is almost silent. The electric vehicle is simple in structure. The components of the block diagram will be shown in Figure 1.

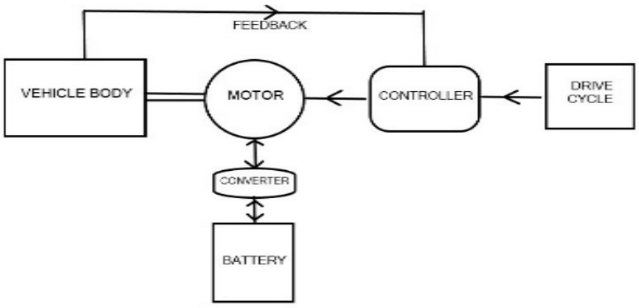


Figure 1. Key components of Electric vehicle

The key components of EV:

Battery:

The main energy storage is Battery. It supplies power to the controller. Batteries are classified into three types. They are lead-acid, nickel-metal hydride and lithium-ion batteries. These range are in voltage. Nowadays all-electric vehicles use lithium-ion batteries as their weight is reduced. Over the few years, the price of these batteries has decreased and specific energy also doubled which attracted the companies a lot. For an electric vehicle, one can use a 48v or 72v capacity pack for manufacturing the vehicle.

Motor:

There are many motors suitable for electric vehicle. Some of them are DC motors, Induction motors, BLDC motors, etc. Different motors have their features and characteristics. Based on them, a specific motor is chosen.

Wheels:

For electric vehicles, alloy and spoke wheels are the two types used in fabrication. More percentage will be alloy wheels as they are rigid, and have high horsepower and torque. They can handle the entire vehicle at high speeds compared to spoke wheels.

Brakes:

The Braking of a vehicle should have both mechanical and electrical braking systems. The mechanical system is nothing but disc brake or drum brakes. There may be some situations that for both front and rear one can use drum or disc and in another case, the front may be disc or drum and rear may be disc or drum brake. The disc brakes are light in weight, reliable and adjustable.

Suspension:

The suspension maintains friction between the road and wheel which gives a smooth ride.The chassis gives good support for the suspension system. A group of springs and shock absorbers will make a contact between wheels and the road protecting from the bumps and uneven surfaces.Not only these components, but many other parts are used for manufacturing electric vehicles. They involve steering, controllers, BMS, wiring, etc.

4. Methodology

Take the different and various types of chassis for the thickness of the tube, its diameter and some other related dimensions for designing the chassis. Based on the positions of components, the chassis design is changed compared to the conventional one. By using CATIA software, the chassis is designed.

CATIA (Computer Aided Three-dimensional Interactive Application) is used for 3D Modelling, sketching and many more. The following flow chart will show some basics steps of the process (Figure 2).

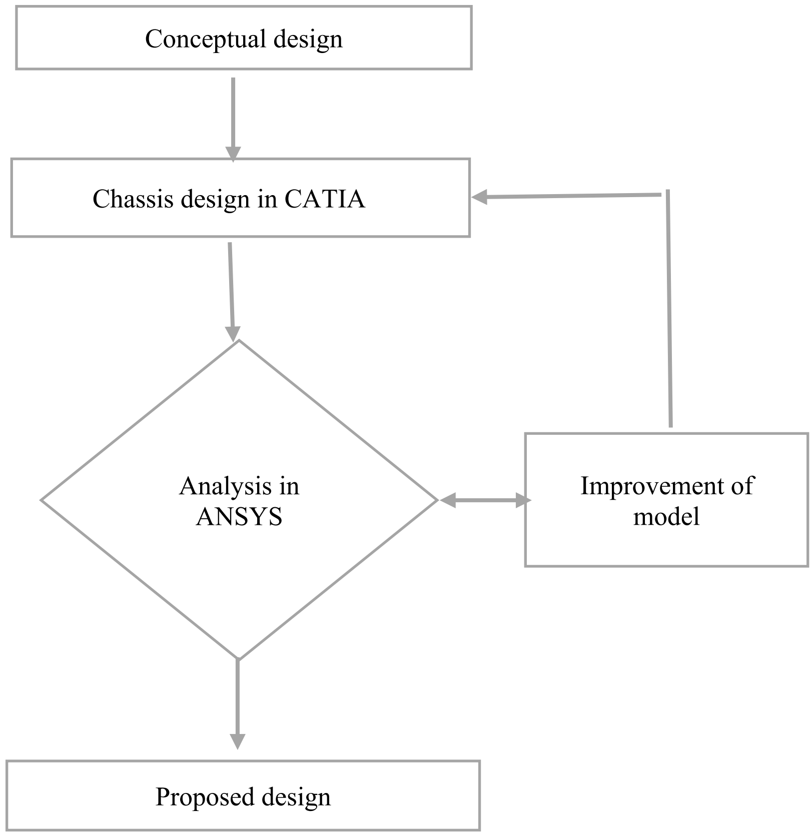


Figure 2. Steps of chassis design

4.1 Chassis design

The Chassis is the main part of a vehicle, The frame acts as a skeleton and supports the major components and systems by taking various loads of the bike. Different components are mounted on the frame providing them with strength to carry their specific individual loads. The frame also supports various components like seat, bodyworks, accessories, etc. Battery and motor are also mounted on the frame. The frame must be able to resist against shocks and impacts of the vehicle and provide stiffness thus protecting the user and vital parts of the vehicle. The design of the frame also depends on the transmission, steering and suspension. The analysis depends on various factors.

4.2 Material selection

As all know from earlier days on wards the most used material for the chassis fabrication is Steel. Many alternatives are available like aluminium alloys, carbon fibre and other composite materials. All has their own benefits but steel is used among them because of its high strength, cheap, ductile, corrosion resistance and reliable. Two medium MS (AISI 1080) pipes are used for the chassis production (Figure 3 and 4). For the handle bar, metal plates are placed. MS Angular are used for the cross-sectional areas of chassis (Figure 5).

Mechanical properties of the material selected are-

Modulus of elasticity	-	205 GPa
Hardness and Brinell	-	126
Ultimate stress	-	400 Mpa
Poisons ratio	-	0.29
Shear modulus	-	80 GPa

Figure 3. MS Steel pipes

Figure 4. MS Angular

4.3 Chassis model

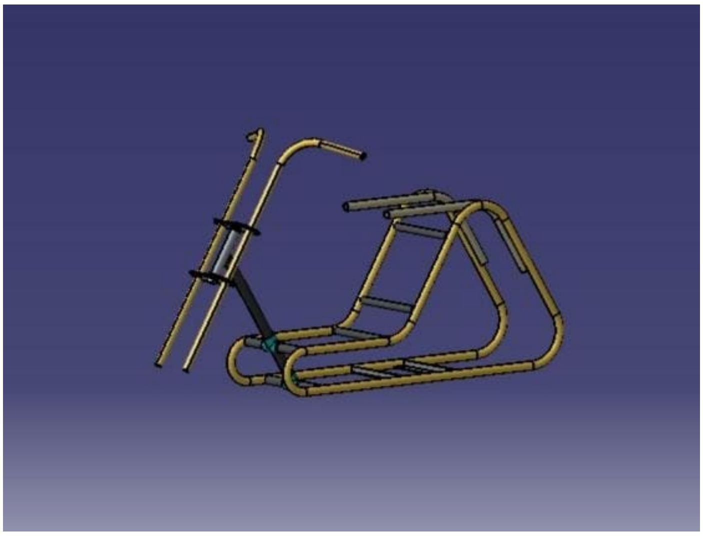


Figure 5. CATIA Model

a) Rake angle selection

Steering head angle which is also called as rake angle which is the most important consideration while design a chassis it plays a major role in providing stability to vehicle .the rake angle considered for this chassis is 28.7 degrees (Figure 6).

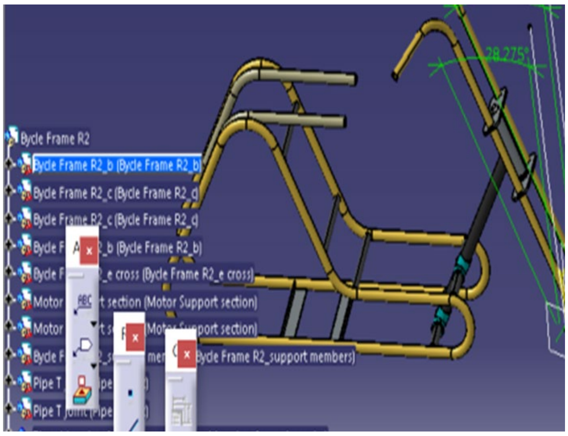


Figure 6. CATIA Model

b) Wheel base geometry

A base line is drawn to initiate the design of the frame. Wheel base distance is given based the various accessories and their dimensions which are needed to fit in the space provided. After the sufficient design for arrangement of the accessories such as motor, battery, controllers, and seat tubes are done finally top tube, bottom tube and supporting were are considered and developed towards completion of the design (Figure 7 and 8).

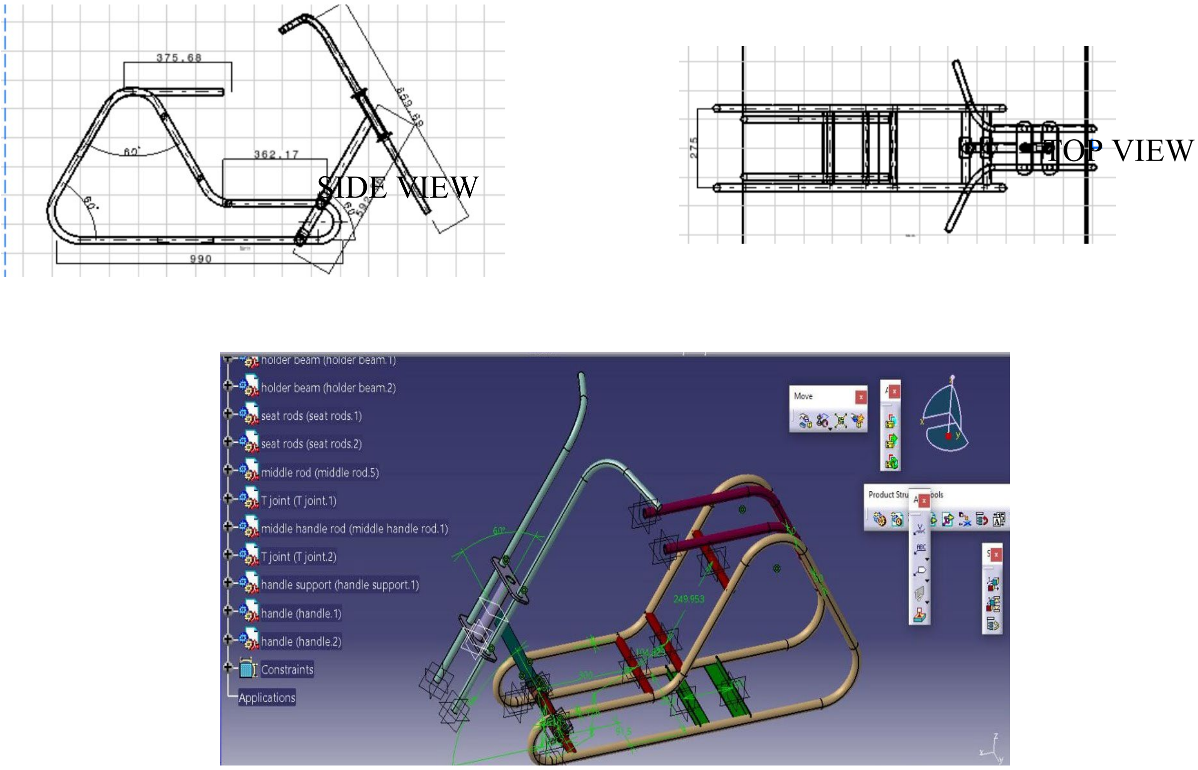


Figure 7. Dimensional view of chassis

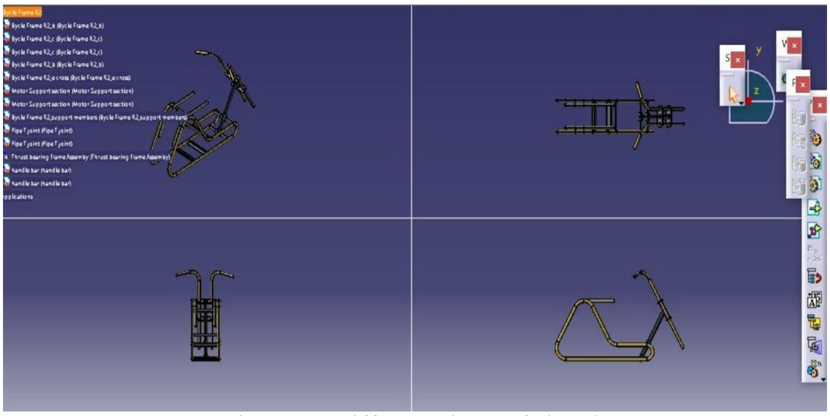


Figure 8. Different views of chassis

4.4 Analysis

4.4.1 Chassis- Natural Frequency and structural Analysis

The rear and front wheels are fixed (Figure 9, 10, 11). The frequency and static analysis are presented in Table 1 and 2.

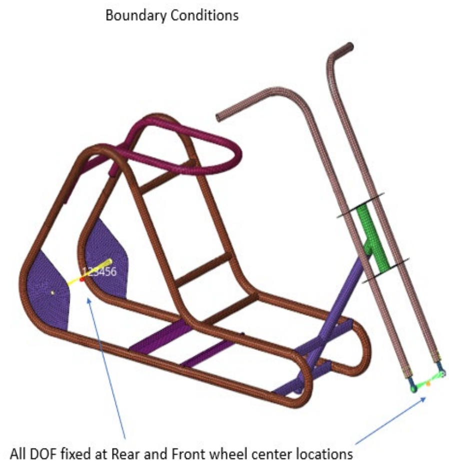


Figure 9. Natural frequency analysis

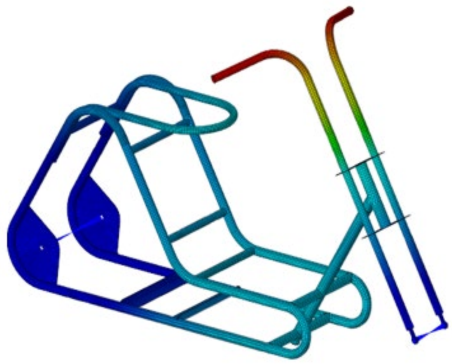


Figure 10. Mode 1

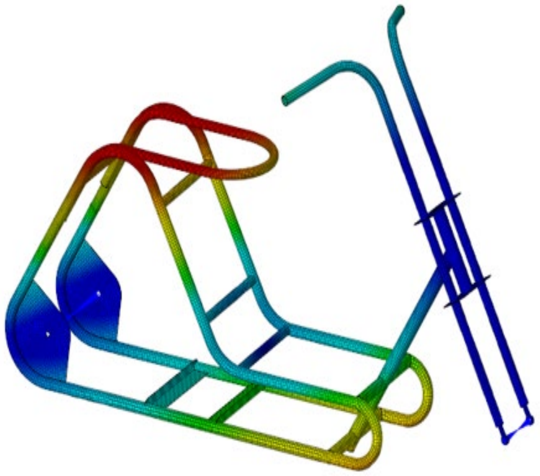


Figure 11. Mode 6

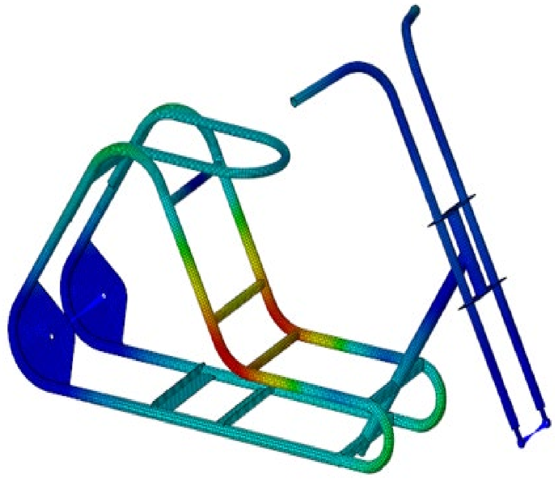


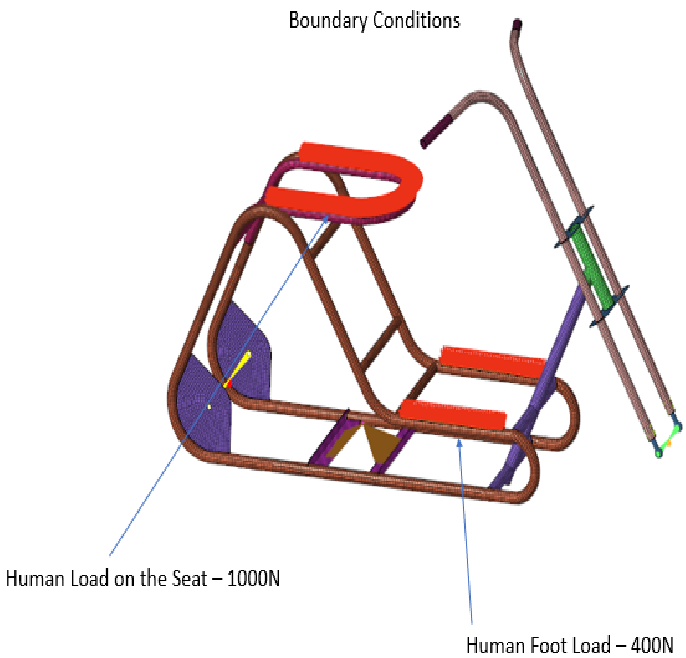
Figure 12. Mode 10

Table 1. Summary of frequency

Generalised Subcase	Mode	Frequency	Eigen value	Stiffness	Mass
1	1	2.492338E+01	2.452300E+04	2.452300E+04	1.000000E+00
1	2	4.510711E+01	8.032480E+04	8.032480E+04	1.000000E+00
1	3	5.138768E+01	1.042504E+05	1.042504E+05	1.000000E+00
1	4	5.762886E+01	1.311112E+05	1.311112E+05	1.000000E+00
1	5	5.852904E+01	1.352392E+05	1.352392E+05	1.000000E+00
1	6	6.499871E+01	1.667897E+05	1.667897E+05	1.000000E+00
1	7	6.967246E+01	1.916382E+05	1.916382E+05	1.000000E+00
1	8	9.374133E+01	3.469141E+05	3.469141E+05	1.000000E+00
1	9	9.591192E+01	3.631658E+05	3.631658E+05	1.000000E+00
1	10	1.233630E+02	6.007992E+05	6.007992E+05	1.000000E+00
1	11	1.472213E+02	8.556600E+05	8.556600E+05	1.000000E+00
1	12	1.566058E+02	9.682231E+05	9.682231E+05	1.000000E+00
1	13	1.712884E+02	1.158286E+06	1.158286E+06	1.000000E+00
1	14	1.845779E+02	1.344990E+06	1.344990E+06	1.000000E+00
1	15	1.890092E+02	1.410345E+06	1.410345E+06	1.000000E+00

4.4.2 Structural Analysis

For structural analysis the inputs loads given is 4000N (Figure 12 and 13).



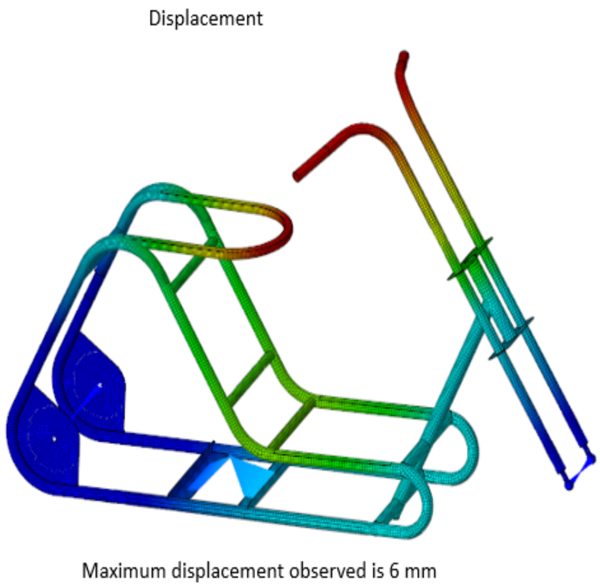


Figure 13. Structural Analysis

The results obtained in static analysis:

Table 2. Static Analysis Results

Stress	Displacement	Allowable stress
27.7 MPA	6MM	230MPA

4.5 Fabricated model

The Figure 14 shows the model.

Figure 14. Fabricated model

6. Conclusion

1) Chassis is designed and developed considering the boundary conditions.
2) The allowable stress for MS steel is around 230MPA and maximum stress obtained in the analysis is 27.7MPA which proves that the design is safe.
3) As steel is used for fabrication it increased the manufacturability of pipes when welding is in process due its strength.
4) At various loading conditions the chassis is analysed giving a expected output.

7. Scope for Future Work

1.The designed chassis can be used to manufacture the electric vehicle.

2. For further work the chassis can be modified based on the components used for the production of electric moped.

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Biographies

Bandari Sateesh working as Professor in the Department of Mechanical Engineering in Vignan's Institute of Information Technology.

Ch. Teja Sri, M. Naga Gowtham Kumar, B.V.S.A Madhuri, G. Komali Harika are the students who has completed Under-graduation in B.Tech, Mechanical Engineering from Vignan's Institute of Information Technology, Duvvada, Visakhapatnam from 2018 to 2022.