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Design and Analysis of Single Main Frame Electric Bike Chassis

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Abstract - *The aim of this investigation is to analyse the single main frame electric bike chassis using material AISI 1018- LOW CARBON STEEL. Usually electric bikes have a double membrane chassis but we are using a single main frame with a battery cage.A chassis serves as the basic foundation on which all the parts of a vehicle rests. In an automobile, the chassis acts as a skeleton on which the engine, transmission, driveshaft, differential, gearbox and suspension are mounted. In the Electric wheeler scenario, Battery, Motor, Controllers, etc., are some of the major components. Its principle function is to safely carry the maximum load for all designed operating conditions.*

Key Words: Electric bike, chassis, battery, Motor, Low carbon steel.

1.INTRODUCTION

The chassis should be structurally sound in every way and support the body panels over the expected life of the vehicle and beyond. In the Electric bike scenario Battery, Motor, Controllers are some of the major components.

The battery and motor generally sits inside the frame, the rear swing arm is attached by a pivot bolt (allowing the suspension to move) and the front forks are attached to the front of the frame. The frame can also help to protect the more sensitive parts of the motorcycle in a crash.

E-bike chassis design works around three major aspects of the motorcycle, the rider, battery package and suspension. The suspension mounting points are fixed in space and are determined by the geometry of the suspension. The battery package is a large component in the vehicle with a fixed size, and needs to be located as close to the rear of the vehicle as possible for proper weight distribution.

1.1 MAJOR PARTS OF CHASSIS:

- Primary frame
- Secondary frame
- Supporting frame
- Steering frame
- Battery cage
- Motor mount

1.1.1 Primary frame:

Primary frame is the base part of a chassis. All other major parts are attached, welded or mounted on the primary frame. So it is necessary to have a strong design and suitable selection of material.

1.1.2 Secondary frame:

It is welded with the primary frame and it supports the mounting of the seat and some other accessories like body mounts, wire supports, etc. The secondary frame has to withstand the load made by the driver and pavilion. So the material must withstand high load and it also has to support weldability with the material of primary frame and other mounts and supports.

1.1.3 Supporting frame:

It is used in some chassis designs only, which is mainly used to improve the support of the secondary frame. It provides improved support for the secondary member. The secondary frame has to accept the load of the driver and pavilion by considering this constraint the secondary frame is installed.

1.1.4 Steering Head:

Steering head is the part which is welded at the front end of the primary frame which supports the front steering system assembly. The assembly of the steering system must be perfect to its nomenclature.

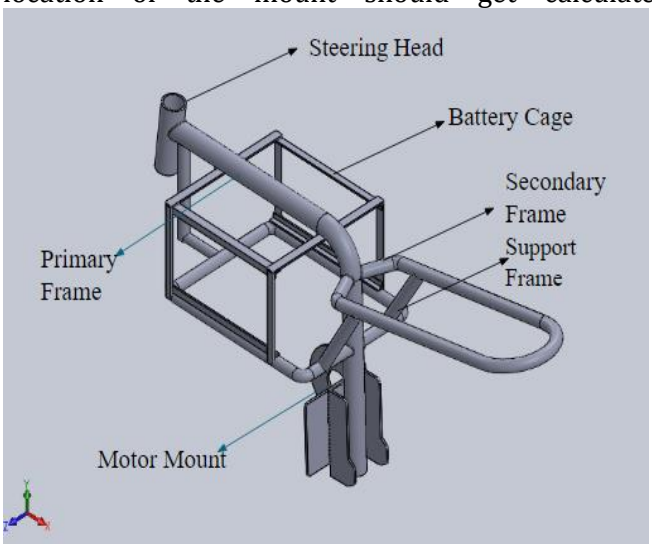
1.1.5 Battery cage:

The major part and the power source of an E-Bike is Battery. The position and location of the battery have to be calculated by considering Centre of Gravity and other constraints. By considering the dimension and weight of the battery the battery cage or holder or mount is designed.

1.1. 6 Motor Mount:

The motor mounting is welded on the primary frame of the chassis under certain conditions. The load

acting on the motor will get transferred to the mounting, so the selection of material, position and location of the mount should get calculated

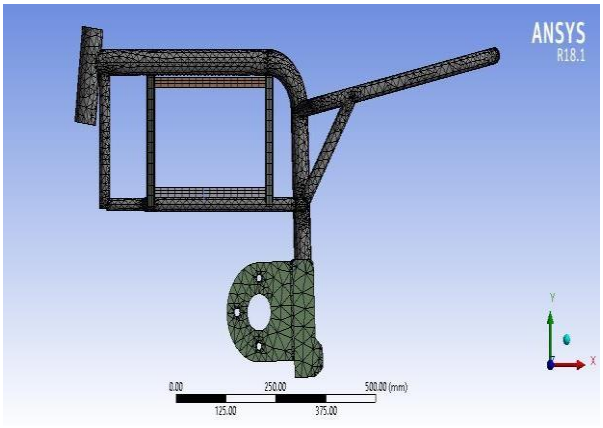


2.RESULT AND DISCUSSION:

Meshing is an integral part of the engineering simulation process where complex geometries are divided into simple elements that can be used as discrete local approximations of the larger domain. The mesh influences the accuracy, convergence and speed of the simulation.

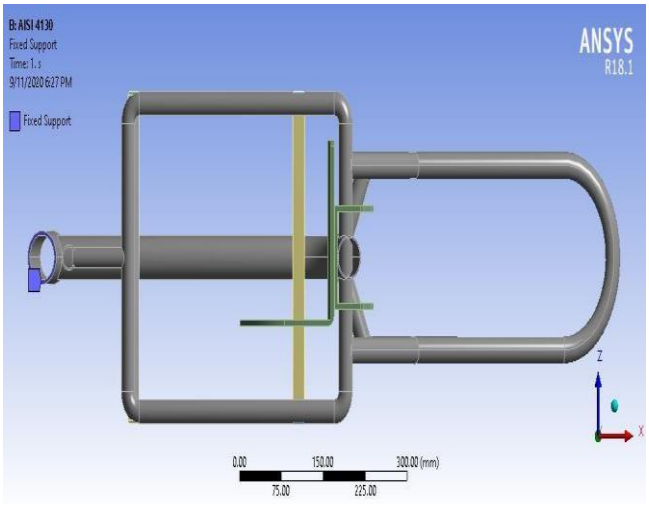
Mainmenu → Project → Model → Connections → Mesh.

One of the purposes of meshing is to actually make the problem solvable using Finite Element. By meshing, you break up the domain into pieces, each piece representing an element.



2.1 Fixed support:

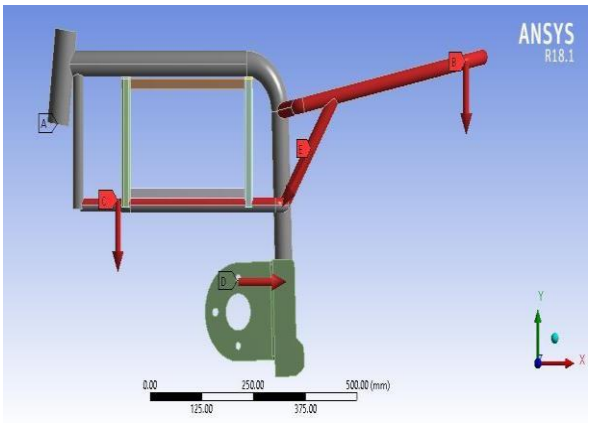
The support of the chassis is fixed at the bottom of the Steering head as shown in figure. This point acts as a fixed position for the whole design. Fixed supports can resist vertical and horizontal forces as well as a moment. Since they restrain both rotation and translation, they are also known as rigid supports. This means that a structure only needs one fixed support in order to be stable.



2.2 Loads acting on the chassis:

Details of load applied on the design of single main frame e-bike chassis are given below.

The above figure shows the Load or Force applied on the different parts of the chassis design. The value of load or force and direction of force applied are the same for all the three materials which are used for analysis. Totally four loads were applied on the chassis. The details were listed below.



Load acting on Secondary frame (Force 1):

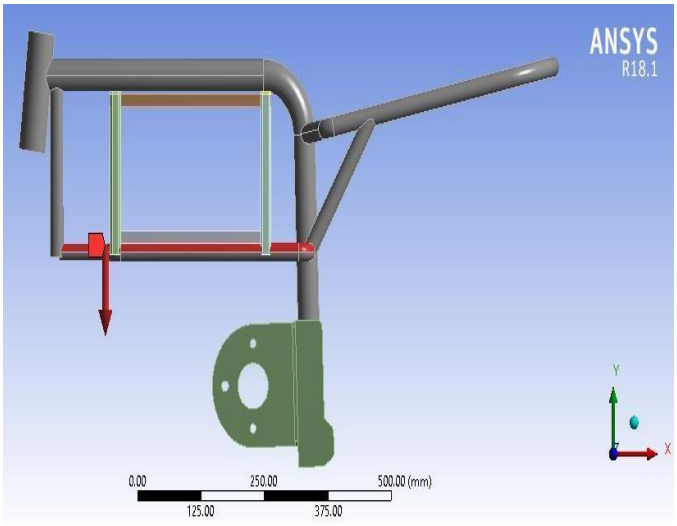
Sl. No.	Times	X-axis [N]	Y-axis [N]	Z-axis [N]
1.	0	0	0	0
2.	1	0	-1200	0

The mass of the passenger is considered here as the load acting on the secondary frame. We have considered about 120Kg (approximately 1200N) of mass acting on the secondary frame. The value of force is given in the negative because of the direction of load acting on the chassis.

2.3Load acting on Battery cage (Force 2):

Sl. No.	Times	X-axis [N]	Y-axis [N]	Z-axis [N]
1.	0	0	0	0
2.	1	0	-500	0

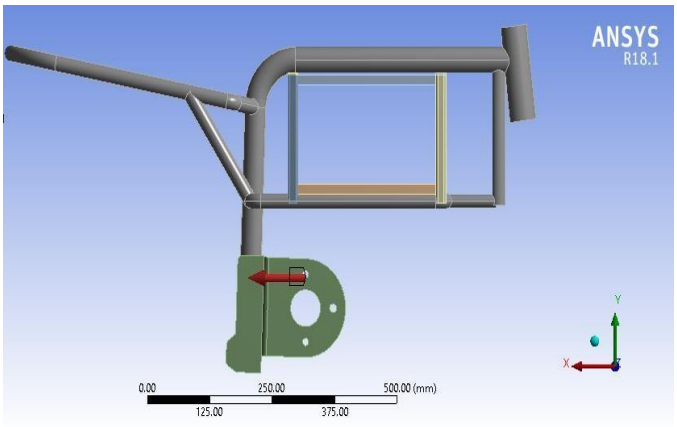
The mass of the battery pack is considered here as the load acting on the Battery cage. We have considered about 50Kg (approximately 500N) of mass acting on the Battery cage. The value of force is given in the negative because of direction of load acting on the chassis.



2.4Load acting on Motor mount (Force 3):

Sl. No.	Times	X-axis [N]	Y-axis [N]	Z-axis [N]
1.	0	0	0	0
2.	1	100	0	0

The force made by the motor is considered here as a load which is acting on the Motor mount. When the motor is mounted on the plate and the rear wheel sprocket (Driven sprocket) is connected to the motor sprocket (Driving sprocket). We consider the mode of drive as chain drive.



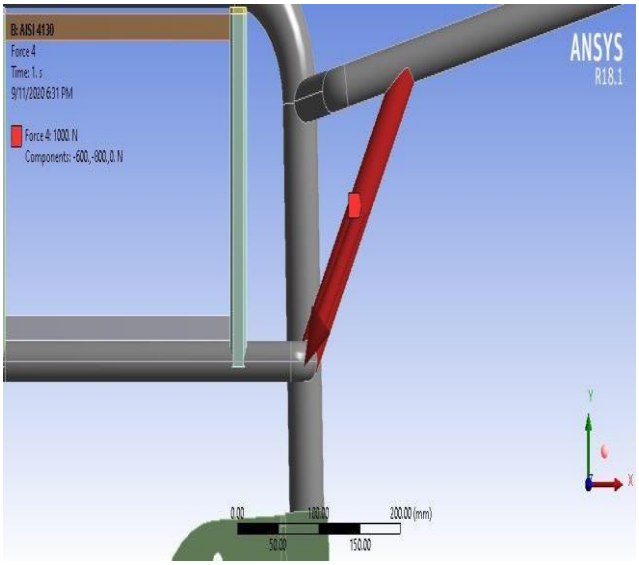
2.5Load acting on Supporting frame (Force 4):

Sl. No.	Times	X-axis [N]	Y-axis [N]	Z-axis [N]
1.	0	0	0	0
2.	1	-600	-800	0

The force applied on the Secondary frame distributes the force to the Support frames to minimize the stress acting on the secondary frame. So the force distribution is done as shown in the table.

The support frame position is inclined approximately sixty degrees from the plane of X-axis. So the force is applied in two directions (X-axis

and Yaxis) to get the proper direction of force to act on the frame.



2.6Solution:

The design of Single main frame E-Bike chassis is subjected under various loads and processes to ensure the strength and durability of the design made for various materials mentioned in the last chapter.

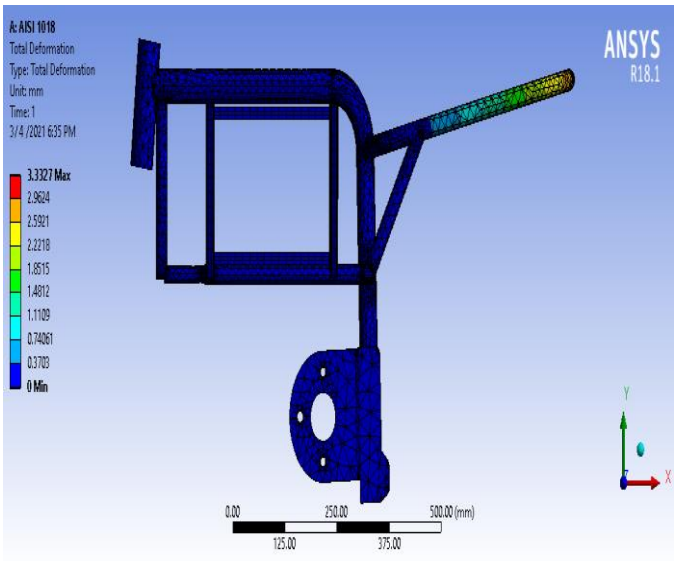
2.7 List of results generated:

- Total Deformation (mm),
- Equivalent Elastic Strain (mm/mm),
- Maximum Shear Elastic Strain (mm/mm),
- Equivalent Stress (MPa),
- Maximum Shear Stress (MPa).

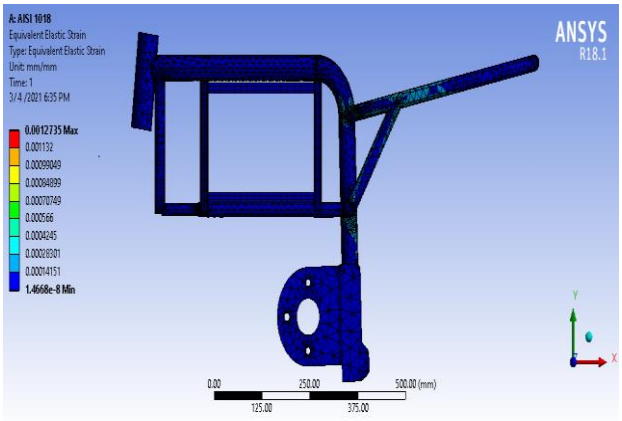
AISI 1018 - Low carbon steel:

Sl. No.	Solution	Minimum value	Maximum value
1.	Total Deformation **(mm)**	0	3.3327
2.	Equivalent Elastic Strain	1.47E-08	1.27E-03
3.	Maximum Shear Strain	1.09E-08	1.58E-03
4.	Equivalent Elastic Stress **(MPa)**	1.52E-03	216.93
5.	Maximum Shear Stress **(MPa)**	8.67E-04	125.24

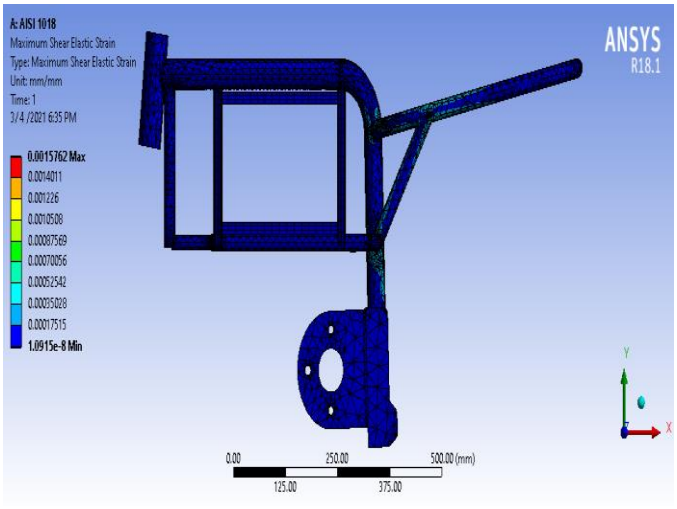
Total deformation:



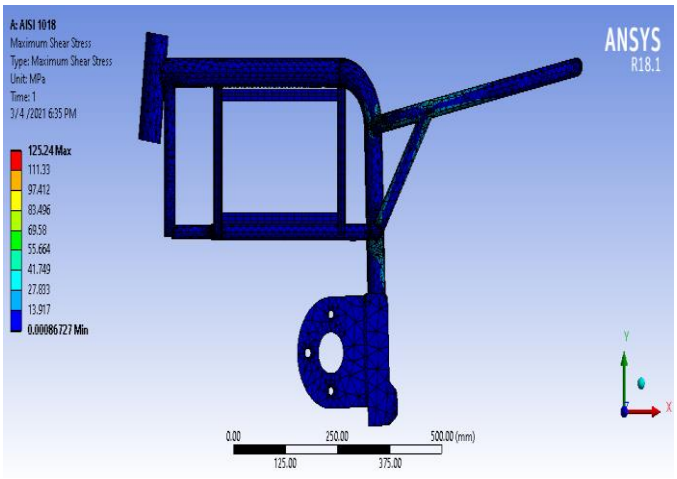
Equivalent Elastic Strain:



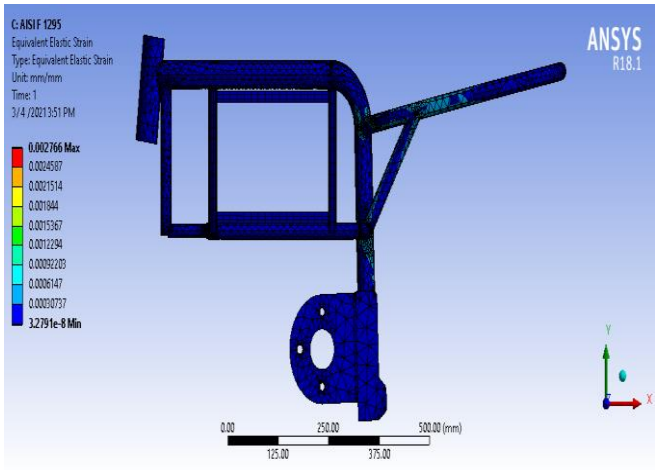
Maximum Shear Elastic Strain:



Maximum Shear Stress:



Equivalent Elastic Strain:



3. CONCLUSIONS

The Design and Analysis of Single Main Frame Electric Bike Chassis was done successfully by using ANSYS WORKBENCH software. From the ANSYS WORKBENCH Total Deformation, Equivalent Shear stress, Maximum Shear Stress, Equivalent Shear Strain, Maximum Shear Strain are obtained. The material AISI-1018 LOW CARBON STEEL gives positive results. So, it is safe to use.

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