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Design and Analysis of Electric Bike Chassis

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Abstract - *This project presents the Structural and Dynamic Investigation of Electric Motorcycle Chassis followed by it's fabrication. The purpose is to analysis the chassis motorcycles and the structure, to ensure the mode shape in motorcycles chassis structure. The study of dynamic properties of motorcycles chassis is great way to determine the natural frequencies of the structure and its mode shapes. The main objectives of this experiment are to design a new model motorcycles chassis and to find the modal properties of the structure and compare them between experimental modal analysis and finite element analysis. The modal properties are included the natural frequency and mode shapes of the each modes. Besides, this experiment will be comparing the results of Finite element analysis (FEA) in order to get the precise and accurate modal properties of each mode. The dynamic behavior analysis is important for frame structure design. From the experiment, the result shows the percentage difference between both Finite Element Analysis .*

***Key Words*: Chassis, FEA, Design, Frame, Motorcycle.**

1. INTRODUCTION

As we know that the fossil fuels are getting limited and extent as the days pass by. Therefore now the world is shifting more towards renewable sources of energy which do not get extent and even do not cause any pollution. Electricity is one of the main source of energy which is emerging with immense growth. Along with that Electric vehicles are also emerging in the market with increased range capacity and overcoming all the features that they lacked from an ordinary petrol vehicle. Growing fossil fuel consumption has made automobile manufacturers to focus on innovative design to improve overall fuel efficiency of the vehicle. Thus ne technology is being implemented in few hybrid electrical applications. Even they are proving to be more economic than the one's already in the market. But the drawback of these electric vehicles seem to be range and charging points. Hence we decided to do some effort in this domain. Thus this project will be focused on the design and fabrication of chassis of the new vehicle that used alternative power source(electricity) as it's main energy.

A chassis is a motorcycle's core structure. It supports the engine, provides a location for the steering and rear suspension, and supports the rider and any passenger or luggage. Also attached to the frame are the motor and battery. At the front of the frame is found the steering head tube that holds the pivoting front fork, while at the rear there is a pivot point for the swing arm suspension motion. Some motorcycles include the engine as a load-bearing stressed member; while some other bikes do not use a single frame, but instead have a front and a rear subframe attached to the engine

In the early days, motorcycles were little more than motorised bicycles, and consequently frames were tubular steel. While the use of steel tubing is still common, in modern times other materials, such as titanium, aluminium, magnesium, and carbon-fibre, along with composites of these materials, are now used. As different motorcycles have varying design parameters (such as cost, complexity, weight distribution, stiffness, power output and speed), there is no single ideal frame design, and designers must make an informed decision of the optimum choice. Spine nd backbone, single cradle, half duple cradle, full cradle are some of the types of the chassis

Design is one of the main processes in producing the new vehicle. This will help to make a new vehicle that follows the criteria needed by the designer and the customer. The sections will carry certain components of a electric vehicles bolted to it. Designs are also made under various considerations various aparametrs are checked using various simulations .

1.1 PROBLEM STATEMENT

The energy storage and usage demand is increasing day by day. Hence the usage of electric vehicle is increasing. Chassis is the backbone of any vehicle. Therefore proper design and fabrication of Electric Bike chassis is required.

1.2 Objective

1. To study the design and analysis of electric bike chassis .

2. To carry modeling and simulation of the chassis.

3. To perform manufacturing of electric bike chassis.

4. To validate experimental results for displacement and stress analysis.

1.3 METHODOLOGY

We have started the work of our project with literature review. After referring several papers, we got the idea of what our destination exactly is .After this we started design of our idea. Calculation of various design parameters of different parts in the prototype was done. And a model was designed.

2. Assumptions for Analysis

- The element must not have a zero volume.
- Elements may be numbered either as shown in Figure: SOLID187 Geometry or may have node L below the I, J, K plane.
- An edge with a removed midside node implies that the displacement varies linearly, rather than parabolically, along that edge. See Quadratic Elements (Midside Nodes) in the Modeling and Meshing Guide for information about using midside nodes.
- When mixed formulation is used (KEYOPT(6) = 1 or 2), no midside nodes can be missed.
- If you use the mixed formulation (KEYOPT(6) = 1 or 2), the damped eigensolver is not supported. You must use the sparse solver (default).

Stress stiffening is always included in geometrically nonlinear analyses (NLGEOM,ON). Pre-stress effects can be activated by the PSTRES command

Image 1: Isometric view

Table: Loads in Directions

Load Cases	2G Loading	Von Mises Stress (MPa)	FOS (YS: 460MPa)
LC1	Z Direction	43	10.70
LC2	Y Direction	205	2.24
LC3	X Direction	246	1.87

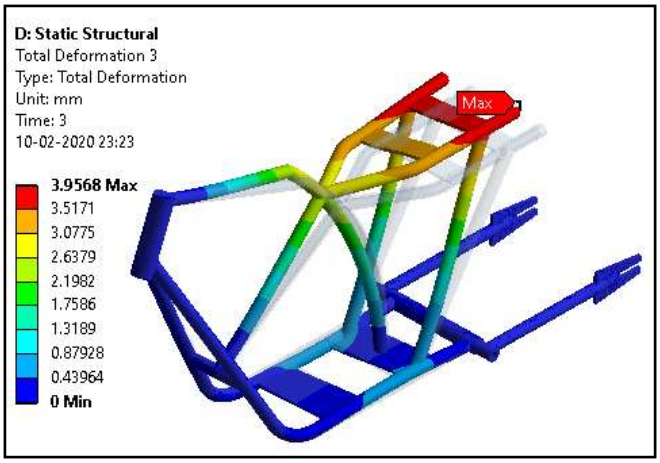


Figure: Static structural deformation

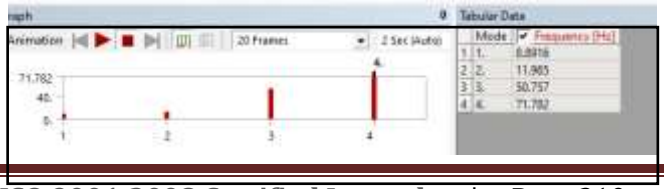
Dynamic Analysis (Modal Analysis):

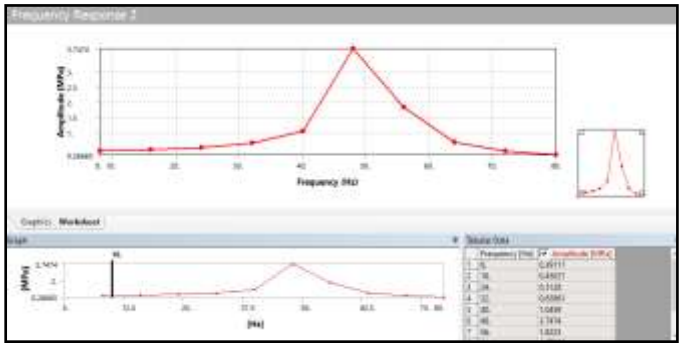
The goal of modal analysis in structural mechanics is to determine the natural mode shapes and frequencies of an object or structure during free vibration. It is common to use the finite element method (FEM) to perform this analysis because, like other calculations using the FEM, the object being analyzed can have arbitrary shape and the results of the calculations are acceptable. The types of equations which arise from modal analysis are those seen in eigen systems. The physical interpretation of the eigenvalues and eigenvectors which come from solving the system are that they represent the frequencies and corresponding mode shapes. Sometimes, the only desired modes are the lowest frequencies because they can be the most prominent modes at which the object will vibrate, dominating all the higher frequency modes.

The force frequency of the electric motor running at max 3000RPM is as below:

Force frequency: Critical order * RPM/60 * 1.2(20% higher for safer side)

Force frequency: 1 * 3000/60*1.2 = 60Hz





Based on harmonic analysis the amplitude for 50Hz the von misses stress is less than material YS for 2G excitation force and hence current design meets limits.

Design changes made to meets static analysis limits as below.

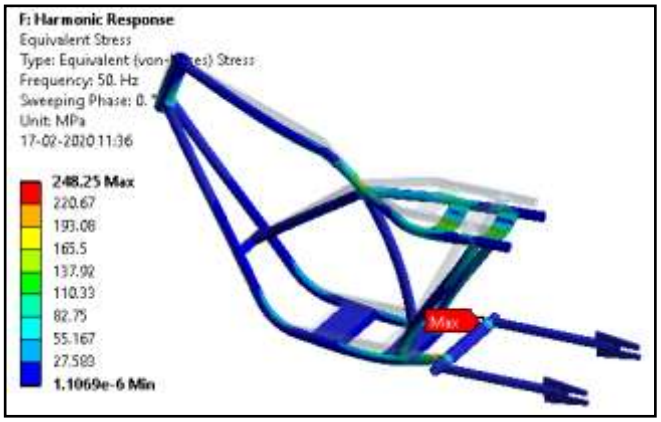


Fig –Harmonic response

3. CONCLUSION

A frame design was adopted to provided not only better strength and rigidity but also better component mountings. A FEA model was created and analysis of the frame was carried out with various load cases. It was clear from the analysis that the displacement during worst load cases was well within limits. The essential components like the battery pack and the motor are safe from the critical forces acting on the frame.

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