Design and Analysis E-Bike Chassis at Different Load Conditions

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ABSTRACT

The chassis serves as a skeleton upon which parts like gearbox and engine are mounted. The two-wheeler chassis consists of a frame, suspension, wheels, and brakes. The chassis is what truly sets the overall style of the two-wheeler. Commonly used material for two-wheeler chassis is steel which is heavy or more accurately in density. In this paper, deals with design of two-wheeler chassis frame and its weight optimization. Various loading conditions like static and modal analysis were carried out on the chassis and the design is optimized by reducing the weight of the chassis by using alternate loads while maintaining the strength. 3D modelling done in CATIA parametric software and analysis done in ANSYS.

Keywords:

1. INTRODUCTION

A motorcycle frame 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 fuel tank 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 sub frame attached to the engine. A vehicle frame, also known as its chassis, is the main supporting structure of a motor vehicle, to which all other components are attached, comparable to the skeleton of an organism.

Functions

The main functions of a frame in motor vehicles are:

- To support the vehicle's mechanical components and body.
- To deal with static and dynamic loads, without undue deflection or distortion.

Motorcycles chassis

What forms an especially important aspect of a motorcycle frame’s cost and its capability is the material that it is made of. Traditionally, and even today, for budget-oriented motorcycles,

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frames are made of steel tubes, and are bent or welded together to suit a specific chassis requirement. While steel is cost-effective, reasonably strong, and very suitable for motorcycles with low to moderate performance requirements, modern motorcycles require their chassis to be stiffer, more lightweight and look better than what traditional steel tubes could offer. Modern motorcycles, thus, make use of materials such as aluminium and alloys to achieve the target.

Fig. 1: Chassis frame

2. LITERATURE REVIEW

C. H. Neeraja a C. R. Sireesha and D. Jawaharlal [1] have modelled a suspension frame used in two-wheeler. Modelling is done in Pro/Engineer. They have done structural and modal analysis on suspension frame using four materials Steel, Aluminium Alloy A360, Magnesium and carbon fiber reinforced polymer to validate our design. By observing the results, for all the materials the stress values are less than their respective permissible yield stress values. So, the design was safe, by conclusion. By comparing the results for four materials, stress obtained is same and displacement is less for carbon fiber reinforced polymer than other three materials. So, for design considered, CFRP is better material for suspension frame. Cicek Karaoglu and N. Sefa Kuralay [2] did the finite element analysis of a truck chassis. The analysis showed that increasing the side member thickness can reduce stresses on the joint areas, but it is important to realize that the overall weight of the chassis frame increases. Using local plates only in the joint area can also increase side member thickness. Therefore, excessive weight of the chassis frame is prevented. In November 2008 Mohamad Tarmizi Bin Arbain uses 3D model for finite element analysis issues regarding the experimental analysis of car chassis is addressed. The modelling approach is investigated extensively using both of computational and compared it to experimental modal analysis. A comparison of the modal parameters from both experiment and simulation shows the validity of the proposed approach. Then perform the computational stress analysis with linear material type analysis to find the stress concentration point in the car chassis. Kuralay [3] investigated stress analysis of a truck chassis with riveted joints using FEM. Numerical results showed that stresses on the side member can be reduced by increasing the side member thickness locally.

3. CAD

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Computer-aided design (CAD), also known as computer-aided design and drafting (CADD), is the use of computer technology for the process of design and design-documentation. Computer Aided Drafting describes the process of drafting with a computer. CADD software, or environments, provide the user with input-tools for the purpose of streamlining design processes, drafting, documentation, and manufacturing processes. CADD output is often in the form of electronic files for print or machining operations. The development of CADD-based software is in direct correlation with the processes it seeks to economize; industry-based software (construction, manufacturing, etc.) typically uses vector-based (linear) environments whereas graphic-based software utilizes raster-based (pixelated) environments.

CATIA is an acronym for Computer Aided Three-dimensional Interactive Application. It is one of the leading 3D software used by organizations in multiple industries ranging from aerospace, automobile to consumer products.

CATIA provides the capability to visualize designs in 3D. When it was introduced, this concept was innovative.

3D model

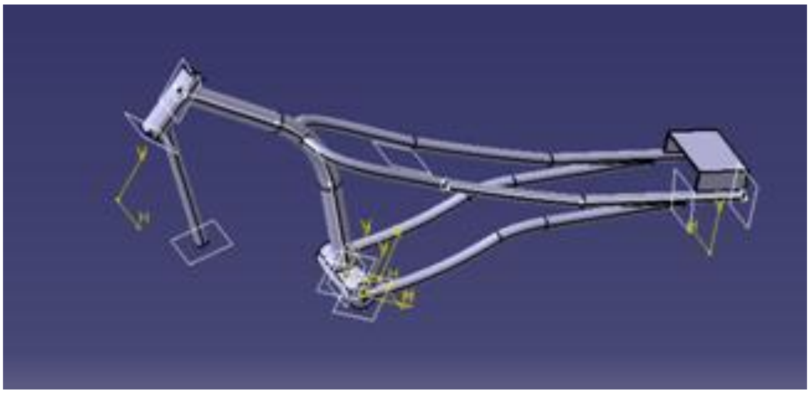

Fig. 2: 3D model of chassis

4. STATIC ANALYSIS OF CHASSIS

Structural analysis is probably the most common application of the finite element method as it implies bridges and buildings, naval, aeronautical, and mechanical structures such as ship hulls, aircraft bodies, and machine housings, as well as mechanical components such as pistons, machine parts, and tools. **Static Analysis -** Used to determine displacements, stresses, etc. under static loading conditions. ANSYS can compute both linear and nonlinear static analyses. Nonlinearities can include plasticity, stress stiffening, large deflection, large strain, hyper elasticity, contact surfaces, and creep.

Load Calculations

The following calculations are made considering that 2g force acts,

At single person

Approximated bike weight = 100 kg+75 (the weight of the bike + driver)

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Force = 9.81*175

= 1716.75 N

At two persons

Approximated bike weight = 100 kg+150 (the weight of the bike + 2 persons weight)

Force = 9.81*250

= 2452. 5 N

At three persons

Approximated bike weight = 100 kg+225 (the weight of the bike + 3 persons weight)

Force = 9.81*325

= 3188. 25 N

5. RESULTS AND DISCUSSION

Imported model

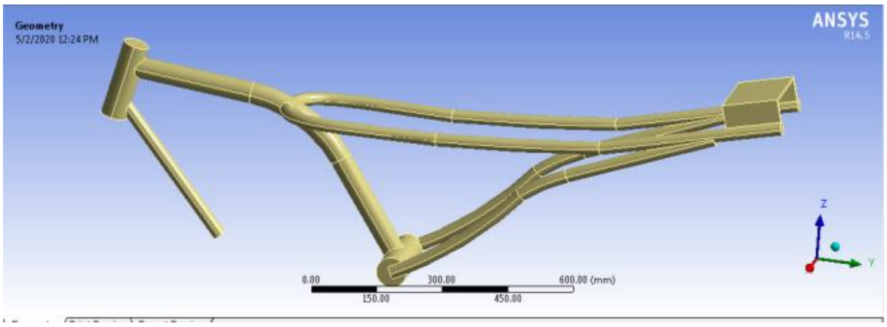

Fig. 3: Imported model form modelling software.

Meshed model

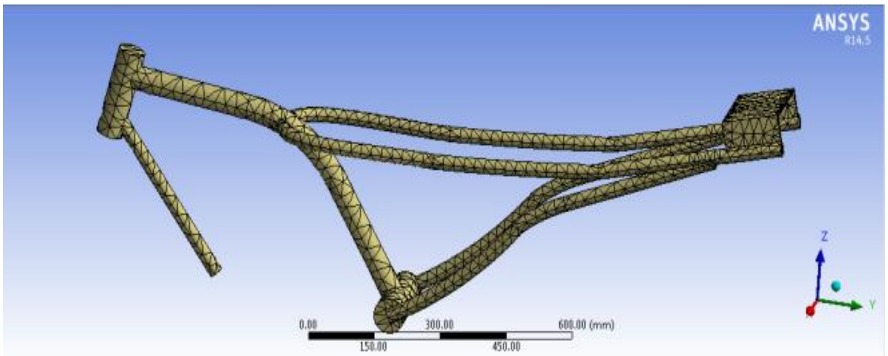

Fig. 4: Meshing model.

According above figure shows divided by elements through fine meshing

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Solution A6>insert>total deformation>right click on total deformation>select evaluate all result

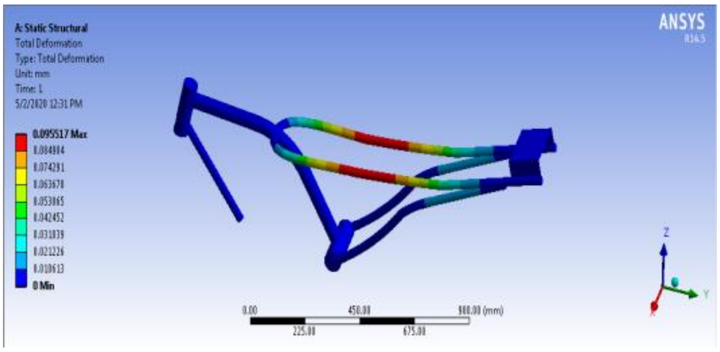
Insert>stress>equivalent (von misses)>right click on equivalent >select evaluate all results

Insert>strain>equivalent (von misses)>right click on equivalent >select evaluate all results

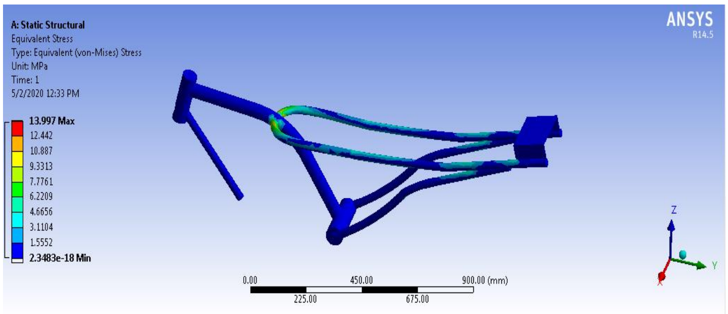
Results and discussion

At load-single person (1716.75N)

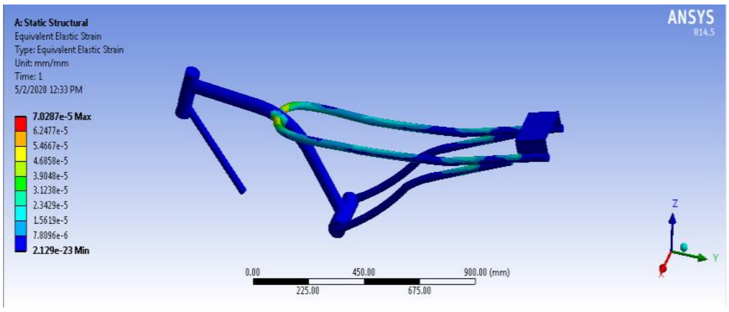
Total deformation



Stress



Strain



MODAL ANALYSIS OF BIKE CHASSIS FRAME

Total deformation 1

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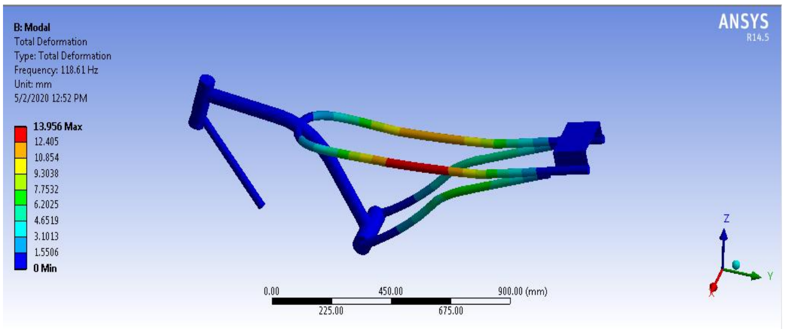
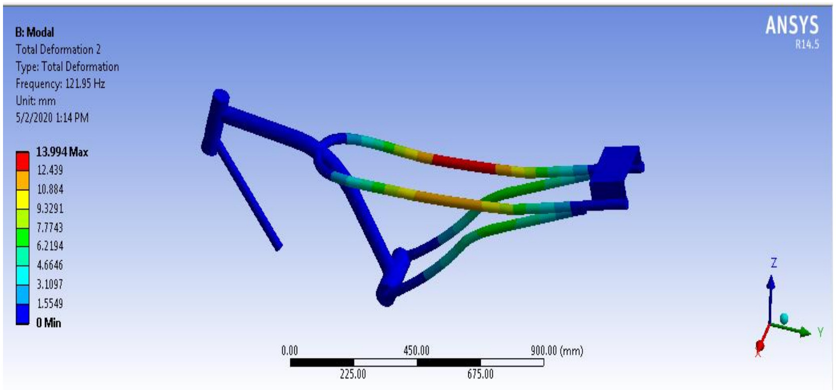


Total deformation 2



Total deformation 3

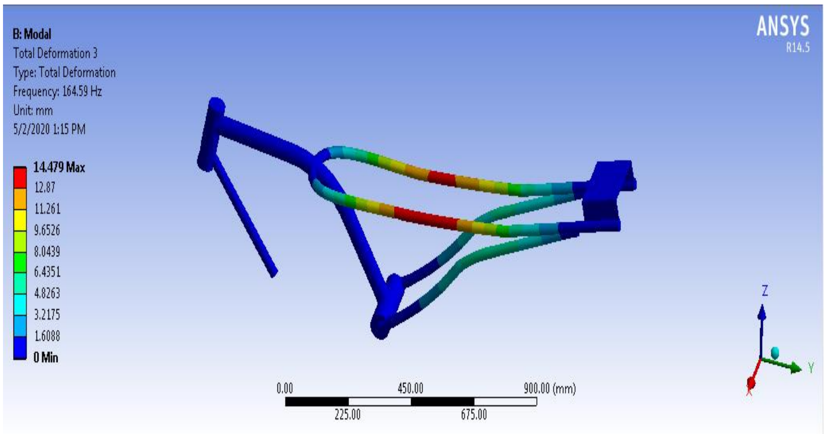


Table : Static Results tables

Number of persons Loads (N)	Total deformation (mm)	Stress (N/mm^2)	Strain
1 person (1716.75N)	0.095517	13.997	7.0287e-5
2persons (2452.5N)	0.13645	19.966	0.00070041

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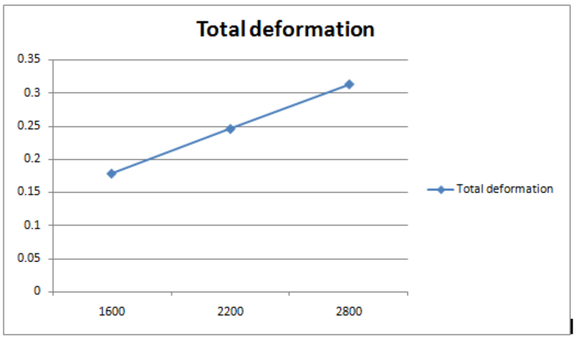
3 persons (3188.25N)	0.17739	25.994	0.00013053

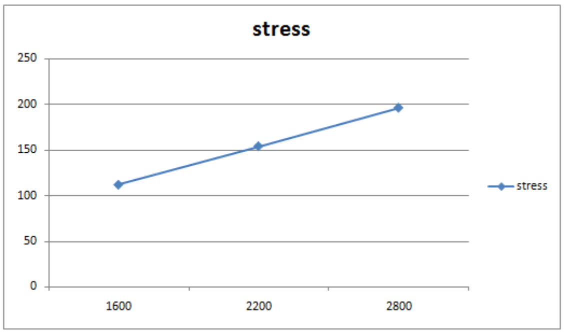
Table : Modal analysis results

Number of persons Loads (N)	Total deformation1	Frequency (Hz)	Total deformation2	Frequency (Hz)	Total deformation3	Frequency (Hz)
1 person (1716.75N)	13.956	118.61	13.994	121.95	14.479	164.59
2persons (2452.5N)	13.954	118.64	13.992	121.98	14.478	164.62
3 persons (3188.25N)	13.952	118.67	13.99	122.01	14.477	164.65

Static analysis Graphs



Stress



6. CONCLUSION

Two-wheeler chassis frame was modeled using CREO software. The two-wheeler chassis model was imported to ANSYS software to perform structural analysis (i.e. static and modal

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analysis). The analysis was done on the two-wheeler chassis frame for different Loads (1600, 2200 and 2800N).

By observing the static analysis results, the stress values decrease at load 1600N (one person +bike weight) and deformation decreases at same load.

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