DESIGN AND ANALYSIS OF MOTOR BIKE FRAME

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ABSTRACT

Frame is very important part of bikes, as all the important accessories are mounted on the frame. The frame need to be very strong, stiff and light in weight, which is obtained by combining different materials and optimizing its shapes. The strength of frame construction is correct design of a frame because it is the most important part that ensures safe riding. This project deals with the design of bike frame. The modeling of bike frame is done in solid works and analysis of frame is done using the ansys work bench software. This project gives us the stress, strain, displacement values of particular bike frame on load condition.

1. INTRODUCTION

Each week Ride Apart looks back at key milestones in motorcycle history from technical innovations to significant model introductions to racing successes and, of course, some of the disastrous things we'd rather forget. This week we look at the origins of the motorcycle frame and some of the developments it has undergone in more than 100 years.

It's a fact that in the early 1900s, motorcycle manufacturers were in effect nothing more than bicycle makers who found a way to strap an engine to a bicycle frame. This was a bit of a hit and miss affair, as riders ran the risk of the engine often shaking itself loose and falling out of the frame on the move. However, providing you didn't go faster than 20 mph, which was probably very unlikely as most engines at that time (both cars and bikes) were not that powerful or that fast, you were for all intents and purposes riding the first motorized bicycle that we know today as the motorcycle.

The bicycle frame design that was used back then is more or less the same set up we have today on bicycles with tubes connected to three critical points – the head stock where the steering is mounted, a crank bearing case where the pedals are located and a tube carrying the saddle.

To make a bicycle into a motorcycle, many of the early manufacturers simply bolted or clipped an engine onto the frame. There was no clutch or gearbox and the rider continued to use the existing bicycle pedals to both start and add additional momentum once they were on the move.

Despite the fact you now had an engine mounted on your bicycle frame, the brakes remained the same too and were notorious for being next to useless even on a conventional bicycle let alone on a bicycle fitted with a motor.

As engines became more powerful, motorcycle manufacturers began to see some limitations to using a conventional bicycle frame. Most notable was the fact that the tubes at the critical weld points suffered stress cracks causing the frames to break and collapse if the engines didn't fall out.

Figure:1 Bike With Frame.

Prior to the First World War, motorcycle development and engineering moved at a rapid pace and manufacturers started to use purpose built frames that could handle bigger capacity, more powerful engines.

To keep this simple, as there have been multiple versions of motorcycle frames over the years, all motorcycle frames are made from welded aluminum, steel or alloy and in some cases carbon fiber.

The sole purpose of a motorcycle frame is to act as base, which all of the components (gas tank, engine, suspension, handlebars etc) can be bolted to. Usually the engine sits inside the frame, the swing arm is attached using a pivot bolt (allowing the suspension to move) and the front forks are attached to the front of the frame via the steering head.

Figure: 2 Mono Cop Chassis

2. LITERATURE SURVEY

Design and Analysis of bike Frame with Different Materials Akash Rathore1, Amit Sharma2, Amol Dwivedi3, Jatinder Singh Sidhu4, Nikhil Tikle5, Manoj Sharma6, Vishal Wankhade , using non convectional material as bike frame and analysis optimization of bike frame.

Material and Design Optimization for an Aluminum Bike Frame A Major Qualifying ProjectSubmitted to the FacultyOf theWORCESTER POLYTECHNIC INSTITUTEIn Partial Fulfillment of the Requirements for theDegree of Bachelor of ScienceBy Forrest Dwyer, Adrian
Shaw, Richard Tombarelli . The team collaborated with a local bike company, in the process of developing a new 6061-T6 aluminum mountain bike, to investigate the fatigue behavior of the new frame and optimize the material/heat treatment and frame design.

3.PROBLEM STATEMENT

3.0 problem background:

The main objective of the project is to study the stress, strain, and deformation of bike frame on given load condition by using different materials such as Carbon steel, Aluminium Alloy, High Strength Carbon Fibre, Titanium Alloy, Aluminium silicon Magnesium Alloy,Aluminium Metal Matrix, first the part is designed in solid works software and then analysis on the mode is performed on ansys work bench software.

3.1 Problem Statement

With the abusive conditions of mountain riding or uneven surface riding, riders require frames that can withstand significant forces, and have high fatigue lives. Aluminum is the material of choice for most bicycle companies when it comes to mountain riding frames, with other common materials being steel, titanium and composites. Aluminum has a favorable strength to weight ratio, and a lower cost compared to other materials used for bike frame. However, when compared to these other materials, aluminum is more susceptible to fatigue failure at lower cycle counts and has a finite fatigue life, and compare to stress , strain and deformation composite material such as aluminum metal matrix show good result and strength with low weight ratio.

MATERIAL FOR BIKE FRAME

- Steel
- Aluminium
- Carbon fibber
- Titanium
- Composite

4. DESIGNING OF AMOTOR BIKE FRAMEBY USING SOLID WORKS

4.1 Introduction To Solidworks :

Solidworks mechanical design automation software is a feature-based, parametric solid modeling design tool which advantage of the easy to learn windows TMgraphical user interface. We can create fully associate 3-D solid models with or without while utilizing automatic or user defined relations to capture design intent.

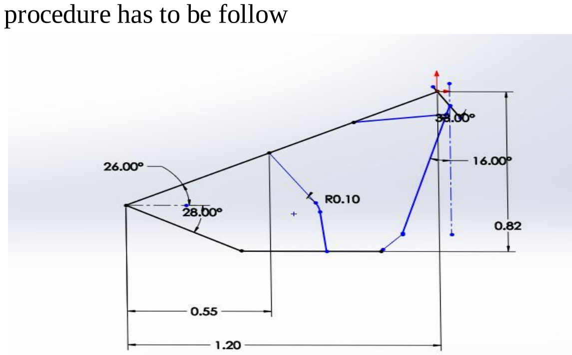
Parameters refer to constraints whose values determine the shape or geometry of the model or assembly. Parameters can be either numeric parameters, such as line lengths or circle diameters, or geometric parameters, such as tangent, parallel, concentric, horizontal or vertical, etc. Numeric parameters can be associated with each other through the use of relations, which allow them to capture design intent

A Solid Works model consists of parts, assemblies, and drawings.

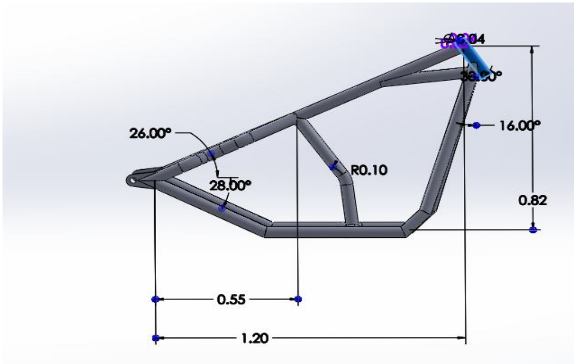
- Typically, we begin with a sketch, create a base feature, and then add more features to the model. (One can also begin with an imported surface or solid geometry).
- We are free to refine our design by adding, changing, or reordering features..

4.2 Design procedure of Motor Bike Frame

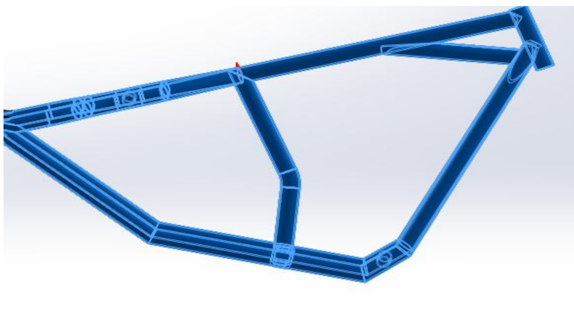
For designing the Motor Bike Frame the following procedure has to be follow

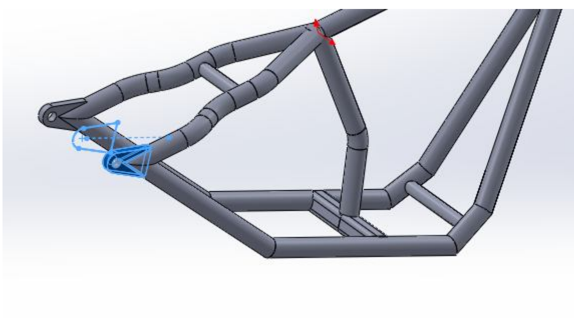


2d sketch of a Motor Bike Frame

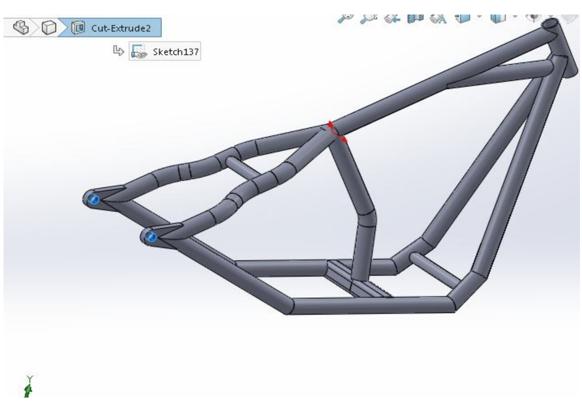


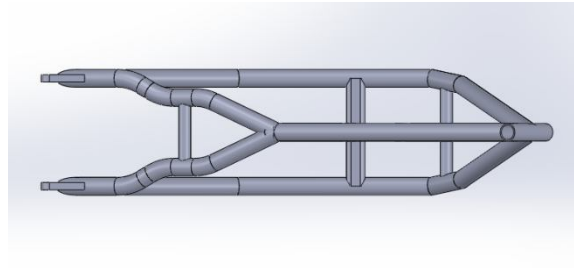
Sketch and Sweep



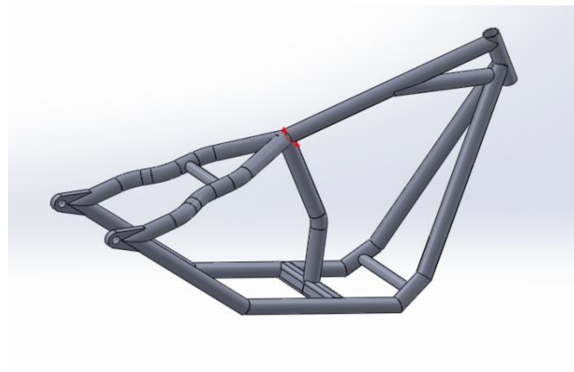


Draw sketch and mirror and cut extrude the part.





Top View



Bike chassis final 3d model.

5. ANALYSIS DEFINATION &STEPS:

The steps needed to perform an analysis depend on the study type. You complete a study by performing the following steps:

- Create a study defining its analysis type and options.
- If needed, define parameters of your study. A parameter can be a model dimension, material property, force value, or any other input.
- Define material properties.
- Specify restraints and loads.
- The program automatically creates a mixed mesh when different geometries (solid, shell, structural members etc.) exist in the model.
- Define component contact and contact sets.
- Mesh the model to divide the model into many small pieces called elements. Fatigue

and optimization studies use the meshes in referenced studies.

- Run the study.
- View results.

5.1 Analysis on motor bike Frame by using ansys 14.5 work bench software

The analysis of connecting rod models are carried out using ANSYS software usingFiniteElement Method. Firstly the model files prepare in the SOLIDWORKS SOFTWARE.

Then are exported to ANSYS software as an IGES files as shown in figure

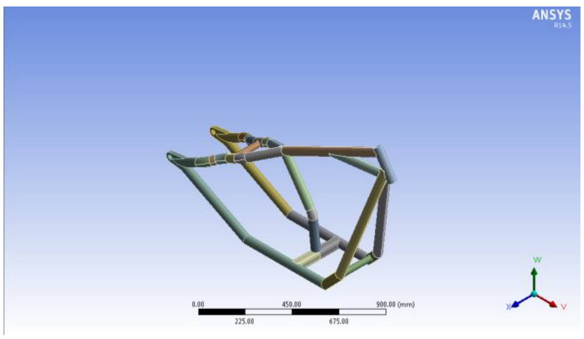


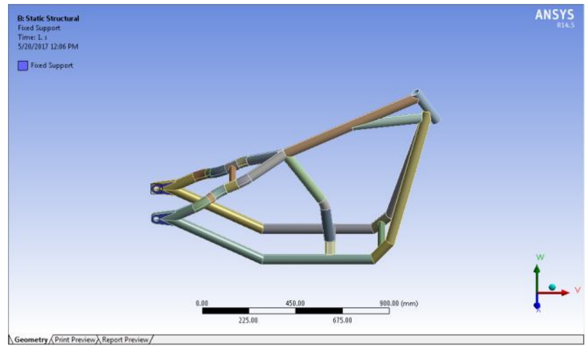
Figure5.1 structural analysis

5.2 Materials and their properties

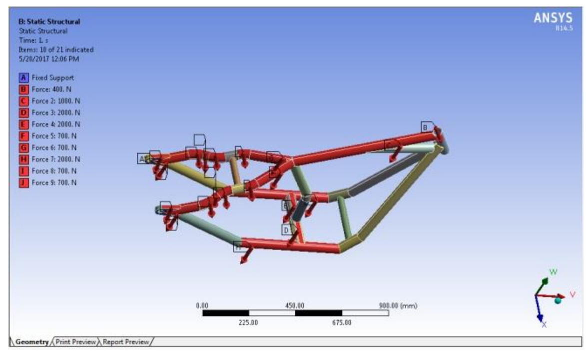
Material	Density(kg/m3)	Young modulus(pa)	Poison ratio	Shear modulus(pa)	Bulk modulus(pa)
Carbon steel	7860	2.1E+11	0.30	8.0769E+11	1.75E+11
Aluminum alloy	2770	7.1E+10	0.33	2.6692E+10	6.9608E+10
H.S.C.F	1600	1E+11	0.1	4.5455E+10	4.166E+10
Titanium alloy	4620	9.6E+10	0.36	3.529E+10	1.1429E+11
Aluminum silicon magnesium alloy	2700	6.9E+10	0.33	2.594E+10	6.7647E+10
Aluminum metal matrix	2800	9.8E+10	0.33	3.6842E+10	9.6078E+10

5.3 Load & fixed support

- **Fixed support**

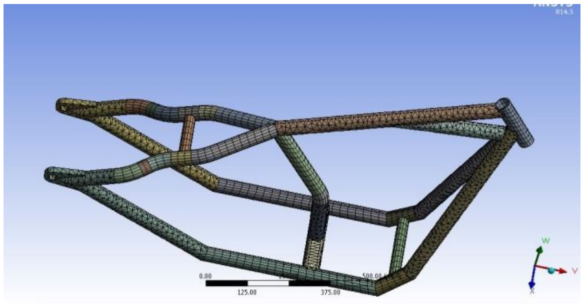


- **Load**



5.4 Meshing

Meshing is probably the most important part in any of the computer simulations, because it can show drastic changes in results you get. Meshing means you create a mesh of some grid-points called 'nodes'. It's done with a variety of tools & options available in the software. The results are calculated bysolving the relevant governing equations numerically at each of the nodes of themesh. The governing equations are almost always partial differential equations, and Finite element method is used to find solutions to such equations. The pattern and relative positioning of the nodes also affect the solution, the computational efficiency & time.



Mesh Type: Tetrahedral

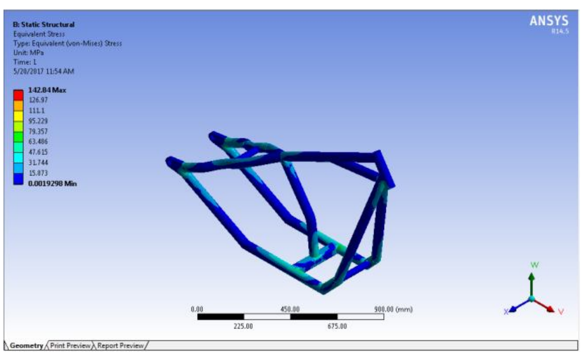
No. of nodes: 16190

No. of elements: 8821

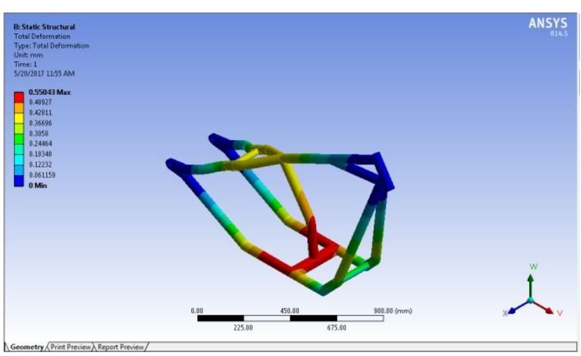
6. STRUCTRUALANALYSISRESULTS

6.1 Material: Carbon Steel

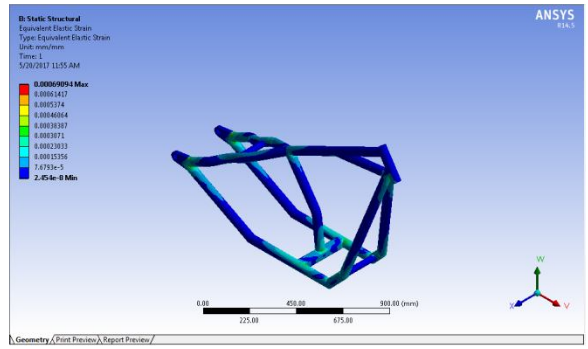
Maximum Stress



Total Deformation

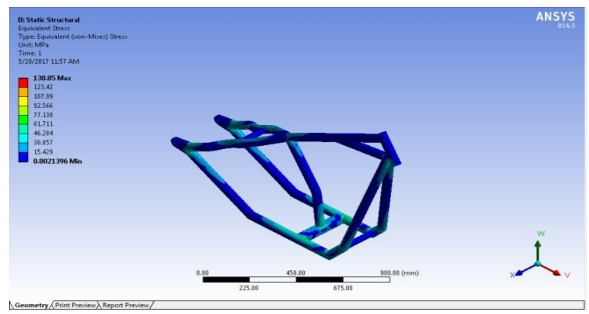


Maximum Strain

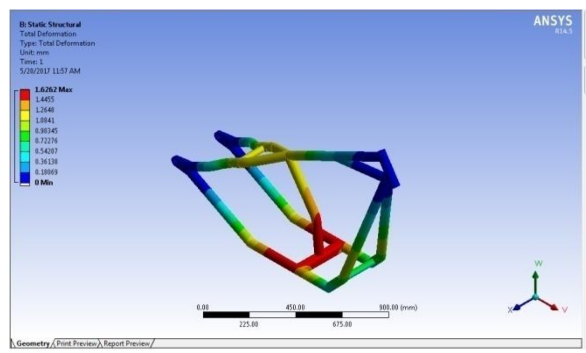


6.2 Material: Aluminium Alloy

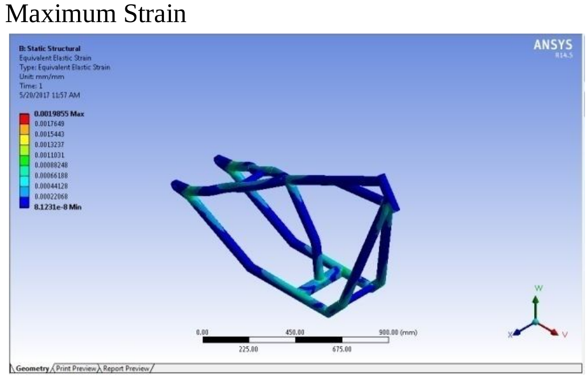
Maximum Stress



Total Deformation

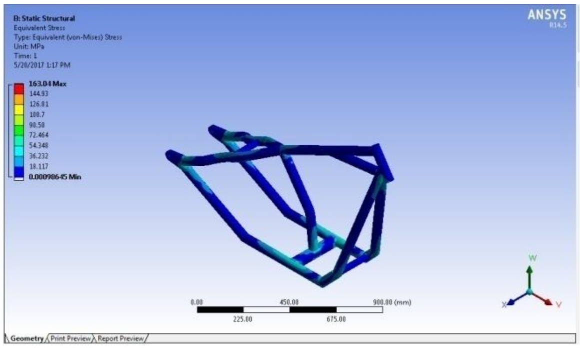


Maximum Strain

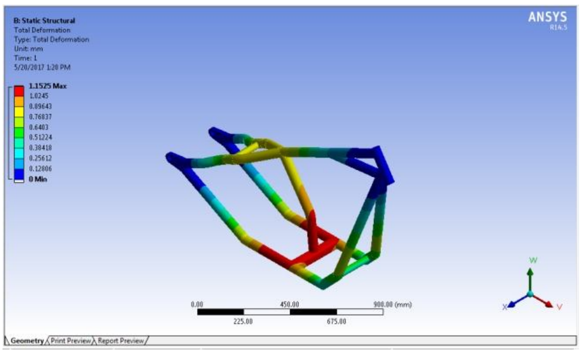


6.3 Material: HSCF(High strength carbon fiber)

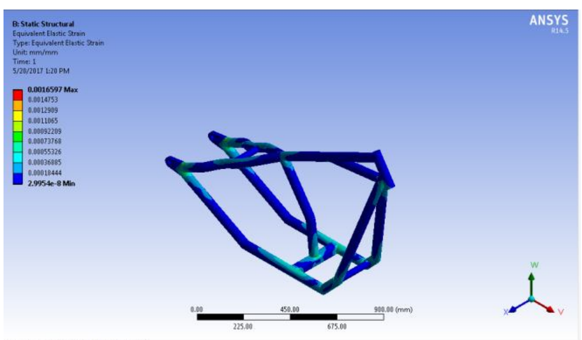
Maximum Stress



Total Deformation

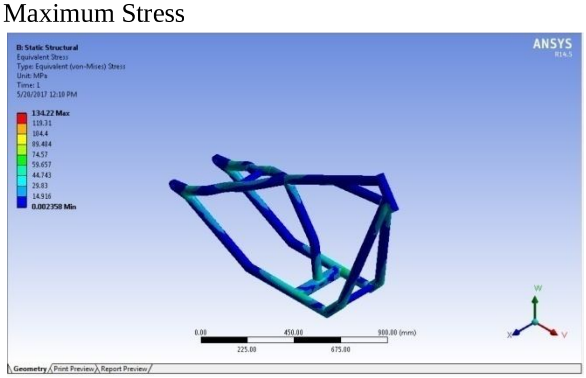


Maximum Strain

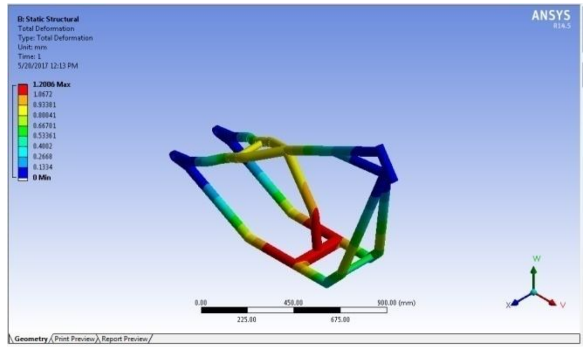


6.4 Material: Titanium Alloy

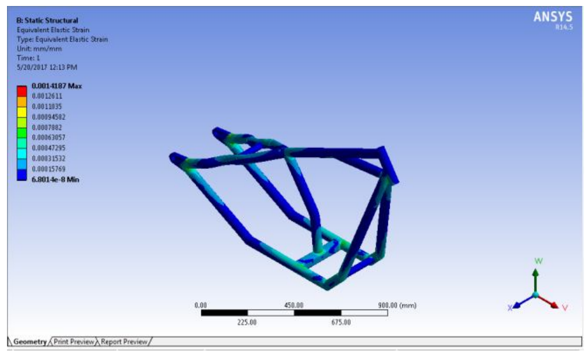
Maximum Stress



Total Deformation

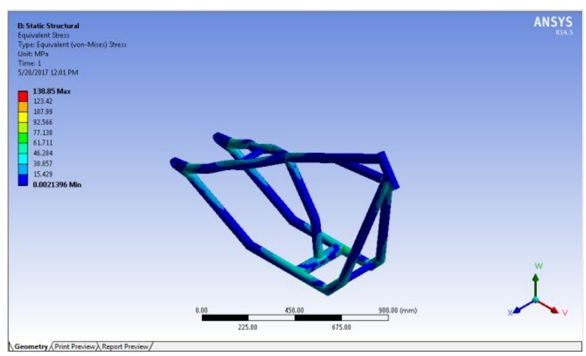


Maximum Strain

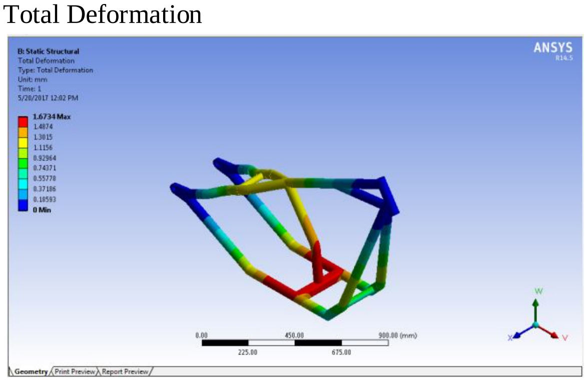


6.5 Material: Aluminium silicon magnesium alloy

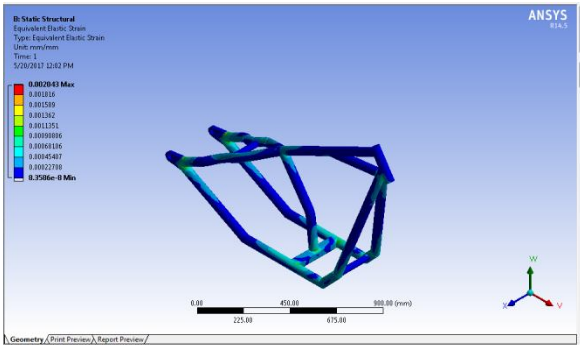
Maximum Stress



Total Deformation

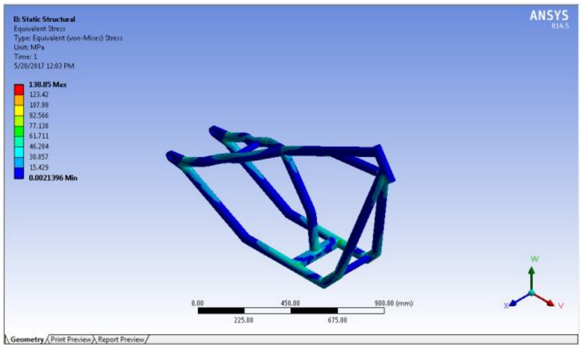


Maximum Strain

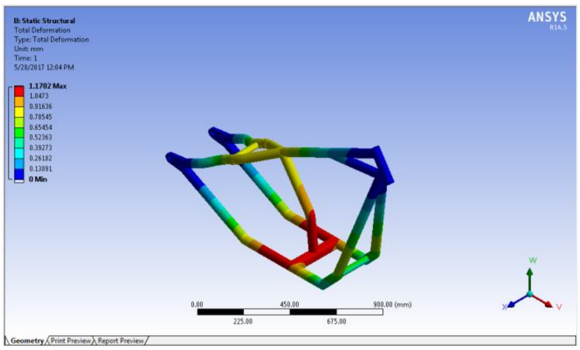


6.6 Material: Aluminium Metal Matrix(KS1275)

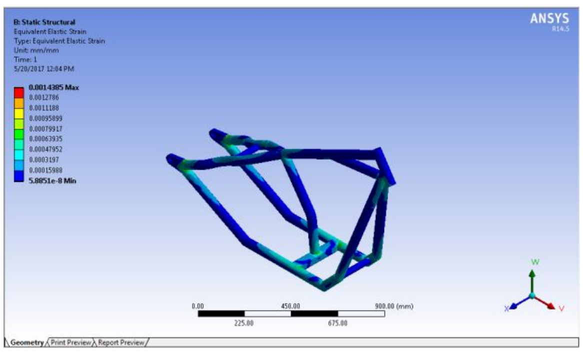
Maxium Stress



Total Deformation



Maximum Strain



7. RESULT TABLE

Results:

Material	Stress(mpa)	Deformation(mm)	strain
Carbon steel	142.84	0.55043	0.00069094
Aluminum alloy	138.85	1.6262	0.0019855
H.S.C.F	163.04	1.1525	0.0016597
Titanium alloy	134.22	1.2006	0.0014187
Al Si Mg alloy	138.85	1.6734	0.002043
Al metal Matrix	138.85	1.1782	0.0014385

For comparisons of the results obtained From the static analysis result tables it is concluded that Aluminium Metal Matrix (KS1275) showing least stress and least deformation & strain value on same static load condition.

From the Modal analysis result tables it is concluded that Aluminium metal Matrix (KS1275) shows Less deformation results for given frequency. Hence for Structural Analysis Aluminium metal matrix (KS1275) (Composite) it is best suitable material for Motor bike frame.

8. CONCLUSION

- Designing and analysis of bike frame is done by using solid works 2016 software
- In this project we designed bike frame by using various commands in solid works 2016 software.
- After designing of bike save the solid work file to IGES (neutral file) and transfer it to ansys work bench geometry
- Here static analysis has done on bike frame; analysis is carried out on by using ansys work bench software on given load conditions.

- Three Different materials in which two general material alloy i.e.; carbon steel , aluminum alloy and one composite material aluminum metal matrix (ks1275) are used
- Stress, strain and displacement values as result for given load condition for each material are noted and tabulated for compare.
- All the three materials showing nearly same stress values, but aluminum metal matrix is showing least deformation values compare to all other materials.
- Thus from table we conclude that aluminum metal matrix which is light weight also best material for motor bike chassis or frame compare to other two general materials.

9. REFERENCES

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