# MODELING AND ANALYSIS OF AUTOMOBILE CHASSIS USING COMPOSITE MATERIALS

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**ABSTRACT:** In this analysis describes design and analysis of automobile chassis. Model of chassis is done in Pro-E software and is imported to ANSYS. The model is meshed. The material properties are defined in pre-processing. Initially static analysis has done on the chassis using different materials, and then the modal analysis was done to obtain the mode shapes of the chassis. Its principle function is to undamaged carry the maximum load for all designed operating conditions. An automobile chassis consists of a framework which supports a man-made object. It is same as an animal's skeleton. The chassis is a skeletal frame in which various automobile parts like engine, axle, tires, assemblies, steering, brakes etc. are affixed. Chassis is considered as a most important component of an automobile. It is the most vital element that provides strength and stability to the vehicle under different situation. It is provide strength and flexibility to it.

**Key Words**: Composite Material, Automobile Chassis, F.E.A ,Pro/E, ANSYS.

## 1. INTRODUCTION

An automobile chassis consists of framework which supports a man-made object vehicle is built on. It is like to an animal's skeleton. For an example of an automobile chassis is the inner part of an automobile, consisting of the frame on which the automobile body is mounted with the machinery and wheels. Automotive framework is a structure on which various automobile parts are bolted, like engine, axles, tires assemblies, steering, brakes and other automobile accessories etc. The automobile chassis is considered to be the most important parts of an automobile. Chassis is the most essential element of an automobile that provides strength and stability to the automobile under different situation. Automobile chassis afford strength and flexibility of the vehicle. The chassis to be backbone of an automobile, And chassis is the supporting frame the body of an engine, axle assemblies are affixed together. The Tie bars, that is necessary parts of the automotive frames, are that bind various automobile parts together.

## 2. THE SOME VARIOUS TYPES OF AUTOMOBILE CHASSIS IS FOLLOWING

a. Ladder Chassis

b. Backbone Chassis

c. Monocoque Chassis

## 3 MATERIALS USED FOR CHASSIS MANUFACTURING

Traditionally, the most common material selection for manufacturing vehicle chassis would be steel, in various forms. Some time, other materials have come into use, the majority of which have been covered here.

### 3.1 Steel

Steel is easy to get. Machinery to manipulate steel is easy to get. People who know how to work with steel are easy to get. Steel is easy - and it's also cheap. This is the main reason why 99% of the cars you find are made from steel

### 3.2 Titanium

Titanium has an association with space tech, and is regarded by many people as an "ultimate" material. It has a density roughly half that of steel.

### 3.3 Magnesium

Magnesium is the lightest metal that's likely to be used in a vehicle chassis, with a density about quarter that of steel. This weight advantage helps to compensate for the fact that its strength and rigidity is below even aluminium.

### 3.4 Fibreglass

Raw plastics do not have anywhere near enough stiffness to be used for structural components in cars. If strands of glass are added to the mixture, though, their properties improve remarkably.

### 3.5 Carbon Fibre

Carbon fiber is very similar to fibreglass, only with carbon strands rather than glass strands as the reinforcing medium - it's correct description would be Carbon Fiber Reinforced

Plastic (CFRP/CRP), though almost everyone refers to it as simply "carbon fiber".

## 4. MODELLING OF CHASSIS

Generally, during modling of an automobile chassis using the following method.

### 4.1 Modeling Of Chassis Using CAD System.

There are some good reasons for using a CAD system to support the mechanical design function:

- To increase in the productivity.
- To get better the quality of the mechanical design.
- To uniform design standards. To create a manufacturing data base.
- To remove inaccuracies due to hand-copying of drawings and irregularity between Drawings.

### 4.2 Using Pro/Engineer

Pro/ENGINEER is the industry of standard 3D mechanical design uniform. It is the world's leading CAD/CAM/CAE software, provide a wide range of integrated solutions to cover all form of product design and manufacturing.

**Advantages of Pro/Engineer**

- It is too fast and more in accuracy. If a design is finished. 2D and 3D views are ready to obtain.
- It has ability to incorporate changes in the design process is also possible.
- It is provides very accurate in representation of model specifying all other dimensions hidden geometry etc.
- It provides a better flexibility for change. For example if we like to change in dimensions of our model, all the related dimensions provide in design assembly, manufacturing etc. will be automatically changed.
- It give clear 3D models, which are easy to visual inspected and understand.

Pro/E provides simple assembly of the models or individual parts created it also less time required for the assembly to a large amount

**Parts To Model**

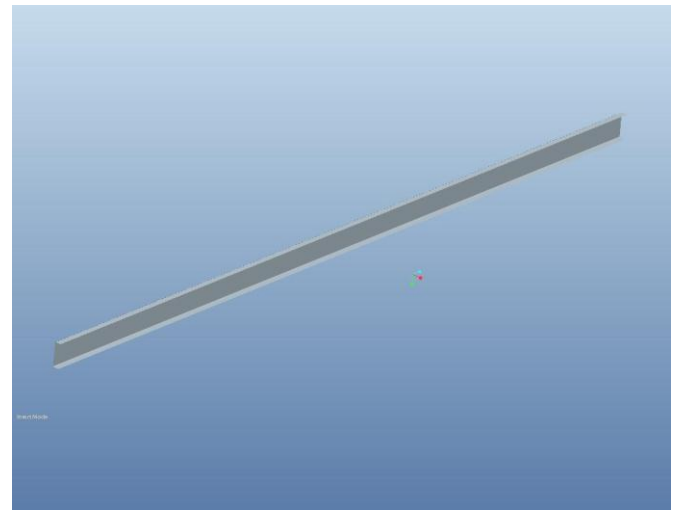| Part no | Description | QTY |
|---------|-------------|-----|
| 1 | Main Channel | 2 |
| 2 | End Channel | 1 |
| 3 | Hinge | 10 |
| 4 | Support Channel | 5 |

**Table No. 1**
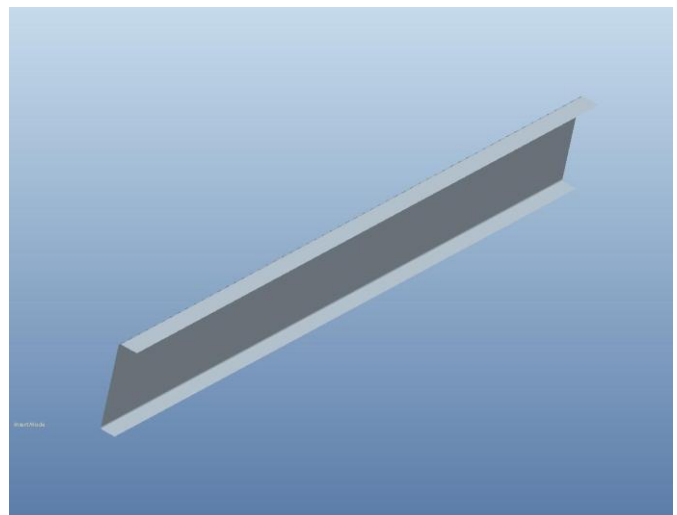
### 4.3 3D Drawings using pro-E



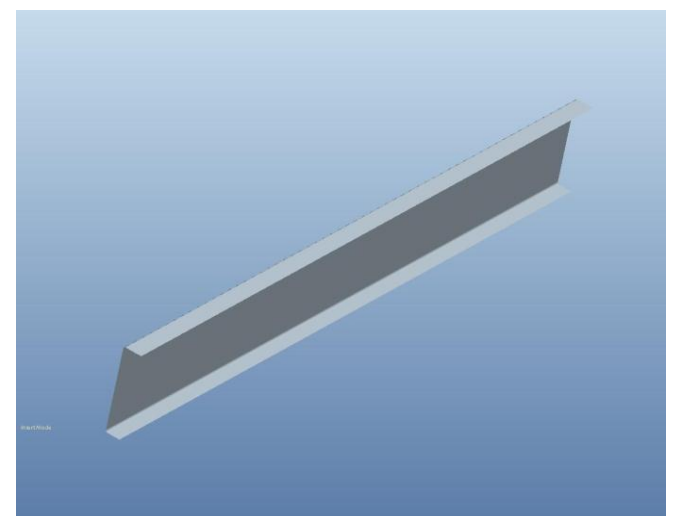Figure 1. MAIN CHANNEL
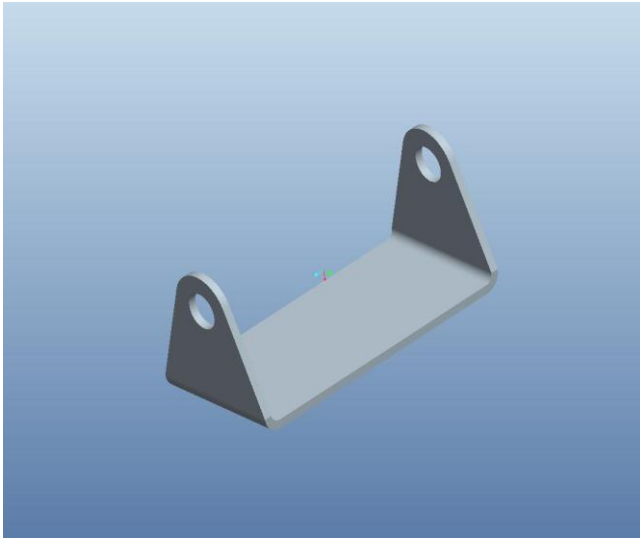


Figure 2 SUPPORT CHANNEL



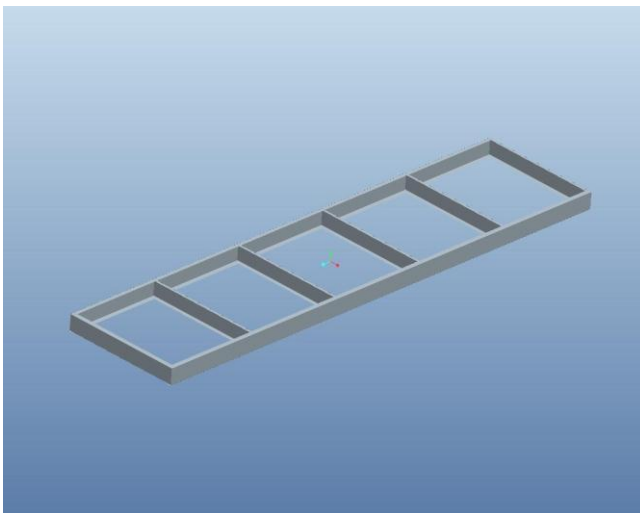Figure 3. SUPPORT CHANNEL

Figure 4.  HINGE



Figure 5.  ASSEMBLY

Require chassis has been design using pro-e and saved as ".asm ".

## 5.  FINITE ELEMENTS ANALYSIS

The main concept in Finite Element Analysis is that the structure or body may be divided into small elements of finite dimensions is called "Finite Elements". The original structure or the body is then considered as an assembly of these elements associated at a finite number of joints called is "Nodes point" or "Nodal". Simple functions are chosen to estimated the displacements of every finite element. Such assumed functions are called "shape functions". This will represent the displacement with in the element in terms of the displacement at the nodes of the element.

The finite element method (FEM) is a most important tool for which concerned in engineering design; it is now used regularly to solve the problems in the given below areas:

- Structural analysis

- Thermal analysis
- Vibrations and Dynamics analysis
- Buckling analysis
- Acoustics
- Fluid flow simulations
- Crash simulations
- Mold flow simulations

## 6.1  INTRODUCTION TO ANSYS

The ANSYS application is self contained common purpose finite element program developed and maintain by Swason.

ANSYS Finite Element Analysis software has ability to engineers Design to analyze the following tasks:

- Transfer CAD models of structures or, products, systems or build computer models components.

- Apply the operating loads and other design performed conditions.

- Study the physical activity response, such as temperature distributions, stress levels, and electromagnetic fields.

- Optimize a designing early in the development process to minimize production costs.

- Perform prototype testing in environments where it would be undesirable or impossible.

For users easy, simply access to program functions, documentation commands, and reference material, The ANSYS program have a compressive graphical user interface (GUI) .A perceptive menu system helps the users to operate through the ANSYS Program.

## 6.2  MODEL ANALYSIS

Modal analysis is the method to determine a structure and dynamic characteristics, are listed below,

- Resonant frequencies.

- Damping values and

- The associate with the pattern of structural deformation is called mode shapes.

### 6.2.1  Uses of Modal Analysis

To find out the mode shapes of a structure and natural frequencies, Modal analysis is needed. The natural frequencies and mode shapes are the essential parameters to design a structure for dynamic loading conditions.

## 7. RESULTS AND DISCUSSION

Model of chassis is done in Pro-E software and is imported to ANSYS. The model is meshed. The material properties are defined in pre-processing.  The list of material used and their properties are tabulated below in table 7.1.

| Sl. No | Properties | Units | Steel | Carbon Epoxy | E-Glass Epoxy | Rubber |
|--------|-----------|-------|-------|--------------|---------------|--------|
| 1 | Young's Modulus E11 | N/mm$^2$ | 2.068 e$^{11}$ | 1.34 e$^{11}$ | 50 e$^9$ | 4 |
| 2 | Density | kg/m$^3$ | 7830 | 1600 | 2000 | 2466 |
| 3 | Poisson Ratio | - | 0.3 | 0.3 | 0.3 | 0.49 |

Table No. 2  Material Properties

Initially static analysis was done on the chassis using different materials, and then the modal analysis was done to obtain the mode shapes of the chassis.

## 7.1 Deflection And Stress Calculations Of Main Channel

Consideration data

L = total length of channel=7000mm

W = load on both channels=10,000kg

(i.e) on one channel w=5000kg

### 7.1.1 Reaction

$$R = \frac{WL}{2} = \frac{5000 \times 7000}{2} \times 9.81$$

$$R = 1.71e^8$$

Applying load at a distance of mid (i.e) 3500mm

### 7.1.2 Bending Moment

$$M_{max} = \frac{WL^2}{8}$$

$$M_{max} = \frac{5000 \times (7000)^2 \times 9.81}{8}$$

$$M_{max} = 3.00431e^{11} \text{Nmm}$$

### 7.1.3 Moment of inertia

$$I = \frac{bd^3 - h^3(b-t)}{12}$$

$$I = \frac{70(220)^3 - (208)^3(70-6)}{12}$$

$$I = 14119136 \text{mm}^4$$

### 7.1.4 Deflection

$$Y = \frac{wl^3}{48EI}$$

For Alloy Steel,E = 206800Mpa

$$y = \frac{5000 \times (7000)^3}{48 \times 14119136 \times 206800}$$

$$y = 12.23 \text{mm}$$

For Carbon Epoxy,E = 181000Mpa

$$y = \frac{5000 \times (7000)^3}{48 \times 14119136 \times 181000}$$

$$y = 13.98 \text{mm}$$

For E-Glass epoxy,E = 38600Mpa

$$y = \frac{5000 \times (7000)^3}{48 \times 14119136 \times 38600}$$

$$y = 65.55 \text{mm}$$

### 7.1.5 Radius of gyration

$$\text{Radius of gyration} = \sqrt{\frac{bd^3 - h^3(b-t)}{12(bd - h(b-t))}}$$

$$= \sqrt{\frac{70(220)^3 - (208)^3(70-6)}{12(70 \times 220 - 208(70-6))}}$$

R.G = 82.23mm

$$\text{Area} = bd - h(b-t)$$

$$= 70 \times 220 - 208(70-6)$$

$$= 2088 \text{mm}^2$$

### 7.1.6 Modulus of section

$$Z = \frac{bd^3 - h^3(b-t)}{6d}$$

$$Z = \frac{70(220)^3 - 208^3(70-6)}{6 \times 220} = 128355.7818$$

$$\text{Shear force} = \frac{Wb}{L} = \frac{5000 \times 70}{7000} = 50 \times 9.81 = 490.5 \text{N}$$

$$\text{Shear stress} = \frac{\text{shear force}}{\text{area}} = \frac{490.5}{2088}$$

Shear stress = 0. 2349N/mm$^2$

Stress at critical point =

$$\frac{WL}{8Z} = \frac{5000 \times 7000}{8 \times 128355.7818} \times 9.81 = 334.373 \text{N/mm}^2$$

$$\text{Stress at the center } S = \frac{WL}{4Z} = \frac{5000 \times 7000}{4 \times 128355.7818} \times 9.81$$

$$= 668.746 \text{N/mm}^2$$

## 7.2 Structural And Modal Analysis Of Chassis Without Damping Material And Layers

The pro-E model is imported to ansys. The material taken as steel, youngs modulus, poisson ratio and density are given.

Finite element simulation of chassis designed.

- Complete the study about chassis design, analysis of the chassis, existing data and compotator modal.

- 3D finite models of a chassis to simulate static structural of FE analysis were developed

- FE meshed model is developed for obtain accurate results.

- The stress concentration areas were evaluated by the finite element analysis. From the analysis, it was obtained that the stress concentration areas be distributed at the rear of rail structure and horse collar portion of the chassis.
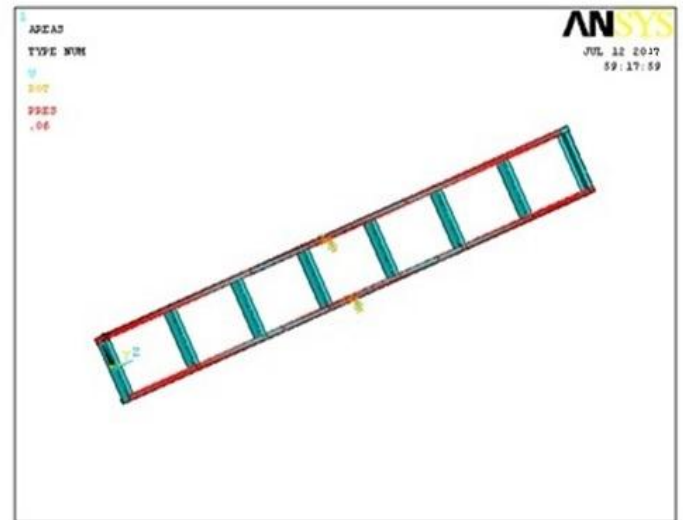
7.2.1 Static analysis on chassis for material



Figure 6  Imported Model



Figure 7  Meshed Model

Pressure – 0.06N/mm$^2$



Figure 8 Loads acting on the chassis

## 7.2.1.1 Results
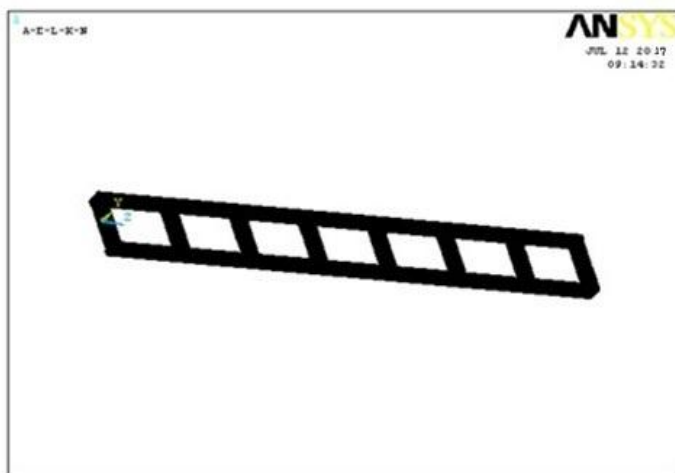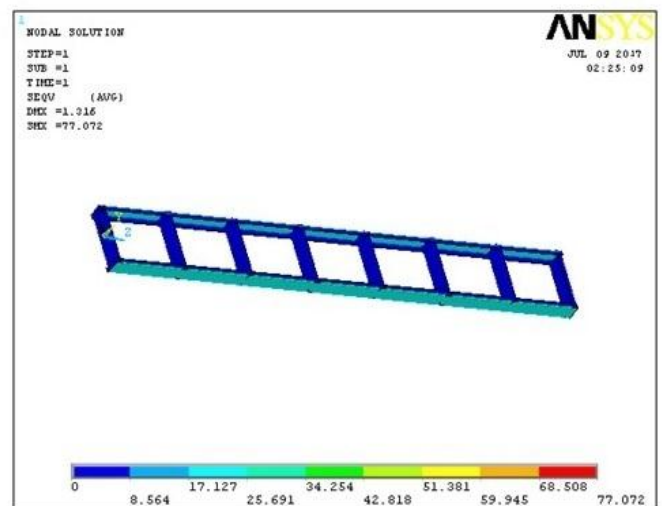


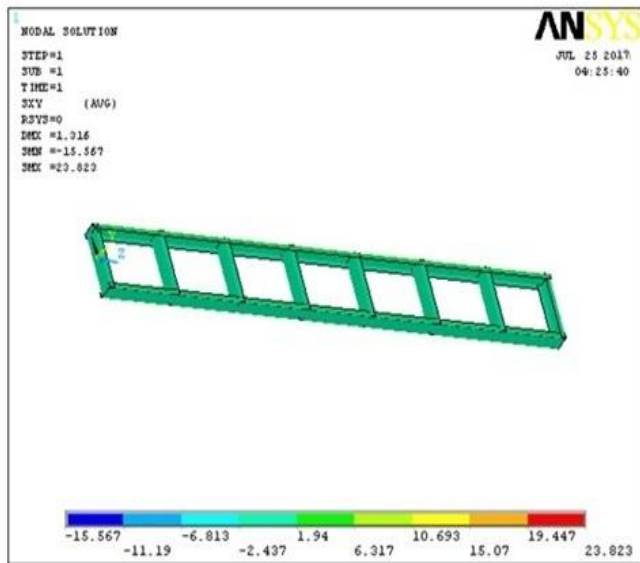Figure 9 DISPLACEMENT



Figure 10 STRESS

Figure 11 SHEAR STRESS IN XY

## 7.3    CONCLUSION

Chassis used in a heavy vehicle modeled using Pro/Engineer. Structural and modal analysis is done on the automobile chassis using ANSYS software. This analysis is done using three materials which is STEEL, CARBON EPOXY and E-GLASS EPOXY. Using different layers 3, 5 and 11 with and without damping material as RUBBER.

To observing the structural analysis results, the stress values of Carbon Epoxy and E –Glass Epoxy are less than their permissible stress values. So using this composite for chassis is safe. To using composites alternative of steel, the weight of the chassis reduces by 4 times than alternative using of steel because the density of steel is more than to the composites.

By using the layers for maintain same thickness of the chassis, and the displacement as well as stress values are reduced than using as single layer. So it will be better to take layers  as single layer

## 7.4    Future Scope

There is a high scope for further research in chassis simulation to solve vibration, frequency response and mode shape analysis related problems.

Useful future work would be to find out torsional stiffness of the chassis including the modeling infinite springs, suspension, and loading.

This chassis structure should be further analysed and improved on the overall performance especially on structural dynamic behaviour and quality auditing for better

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