FEM ANALYSIS OF A FLATBED SEMI-TRAILER CHASSIS STRUCTURE

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ABSTRACT *Chassis is the internal frame that supports a manmade object. Chassis is the bottom part of a vehicle, which is having a frame on which the body is mounted. An attempt is made in this paper to study the Static analysis on a flatbed semitrailer chassis.A Semi trailer is having wheels at the back but supported at the front by a towing vehicle. The 3d model of the chassis is created using SOLIDWORKS v2010 Software, and after that FE analysis is performed by creating a mesh of various size to obtain the stress and deformation by applying the boundary conditions in ANSYS. After that results are drawn from two different cases (kingpin, landing leg) and Von-misses stress and deformation induced in the chassis. Then the model is compared with the Analytical and FEA results of Von-misses stress, deformation due to some discrepancy between stress for landing leg case we advised to change the web thickness.*

Keywords: *Trailer, Chassis, Stress Analysis, Ansys, Solidworks, FEM*

I. INTRODUCTION

Transportation is used to carry freight, passengers, animals, but in India mostly 80% passengers use road to travel**.** Road freight contain around 63-65% of the total freight movement , rail freight contain around 27% of the total freight movement **,** sea freight consists of around 9% of the total freight market , air freight consists of around 1% of the total freight market

A trailer is generally a vehicle which is towed by a powered vehicle. It is basically used for the transport of goods and materials. There is no front axle in semi-trailer and tractor unit support most of it weight. But in semi-trailer it have landing gear legs which can be lowered to support its weight when it is uncoupled. Semi-trailers have wheels that can be dismounted and are relocatable to better distribute load to bearing wheel weight factors.

Flatbed semi-trailers are used to transport heavy cargo such as heavy machinery and construction materials..

The total volume of goods carried on heavy trucks is increasing. The main function of chassis is to support the weight of the vehicle components and transmit loads that result from various accelerations that are experienced in a harsh environment without failure and also without deformation.We have to consider many aspects when designing a chassis, such as loaded part, its material, its strength, stiffness and weight.

II. INTRODUCTION TO FINITE ELEMENT

Finite Element Analysis is a numerical technique for calculating the strength and behavior of structures. It is used to find deflection, stress, vibration, buckling and many other functions.It is also used to calculate small or large-scale deflection under loading or displacement. It can easly calculate elastic deformation, or "permanently bent out of shape" plastic deformation.

It is possible to evaluate a detailed and complex structure, in a computer, during the planning of the structure by using FE. The demonstration in the computer of the strength of the structure and the possibility of improving the design during planning can justify the cost of this analysis work

Finite Element Method divides a 3d model into very small “elements” and solves the resulting system of equations

FEA is used in industries to find modal, structural, harmonic, thermal and other analysis

III. NEED AND MOTIVATION

Majority of transportation (heavy) through semi-trailers. So most of the transporters are switching from trailers to semi-trailers and due to this Indian trailer market is growing at rapid rate.So we have High scope of customization in semi-trailers. Design is usually done at house and FEM analysis is out-sourced. FEM saves time and money. Research in the field of FEM is growing at a fast rate.

IV. OBJECTIVES

Study of transportation technology and its use now a days , Study Different type of trailer and its type and how they are Analyze actually by the FEM in trailer manufacturing companies. FEM Analysis of 2 axle flat bed trailer chassis frame and identify the critical stress points and then Comparison of FEM result with the theoretical results.

V. RESEARCH METHODOLOGY

By using Solidworks first 3d model is made and then it is converted and add in ANSYS for meshing.

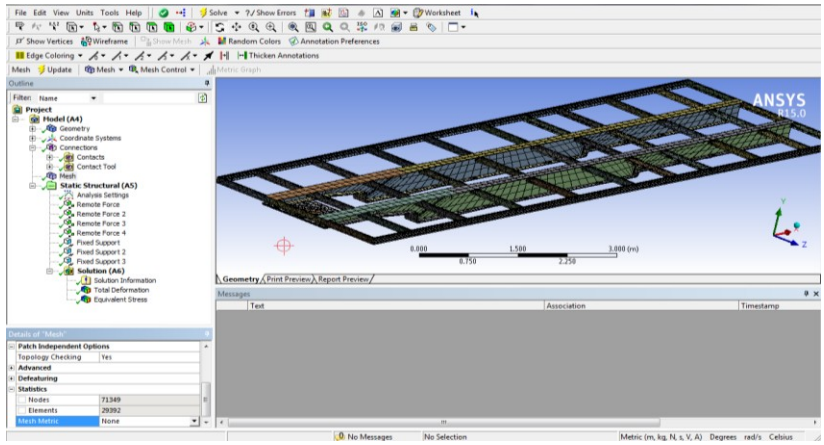


Fig 1: Chassis mesh

Boundary conditions applied to the chassis according to the use

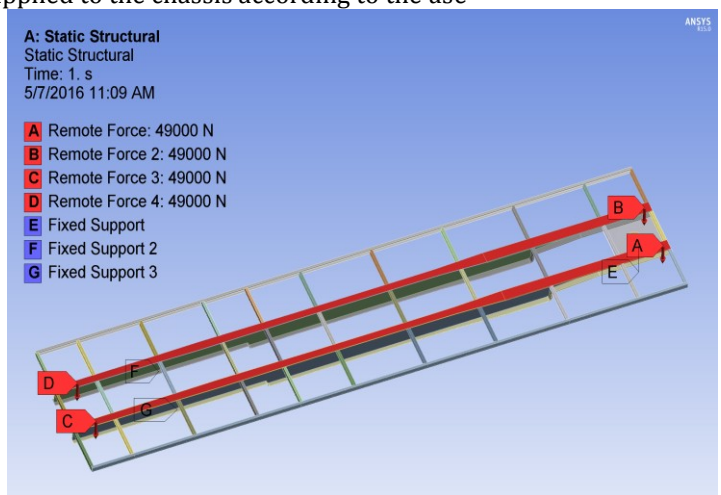


Fig 2: Boundry conditions on king pin and suspension center

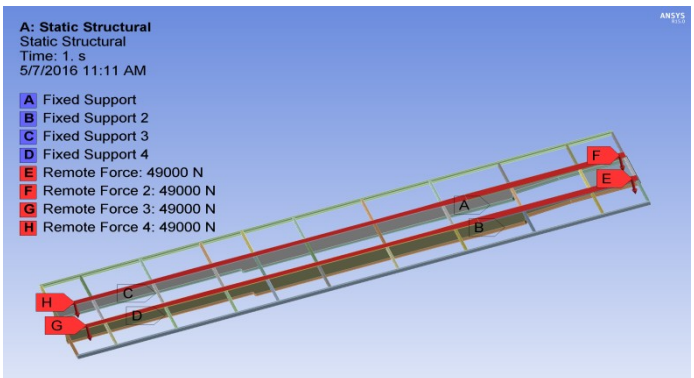


Fig 3: Boundry conditions on king pin and landing leg

VI. RESULTS AND ITS COMPARISON

Results are calculated by using the software and then it is validated by using the analytical approach by using equations and then both the reading is verified and if any change possible then it is corrected in the design of the chassis.

Below shown is result by ANSYS software

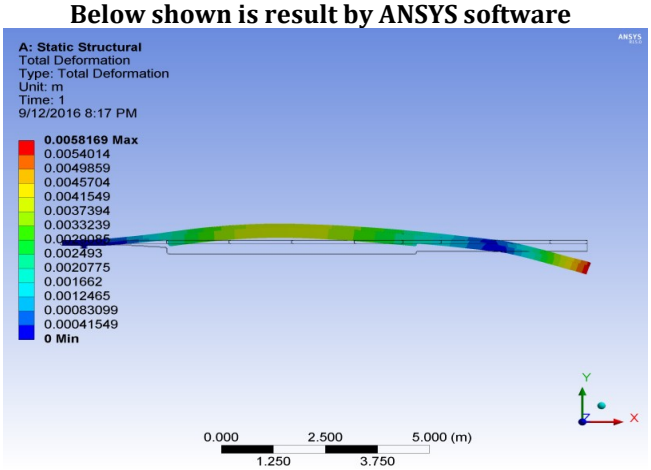


Fig 4: **king pin and suspension center deformation**

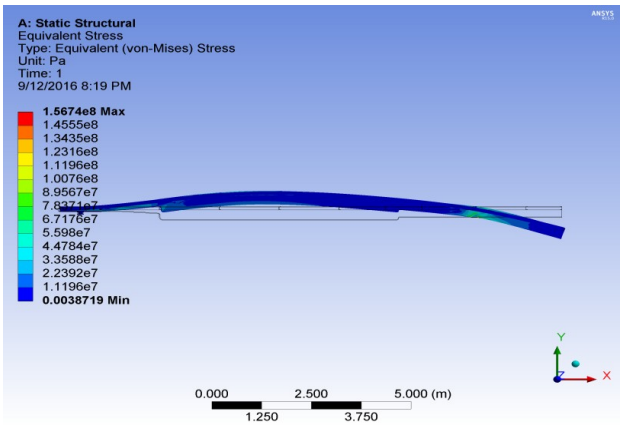


Fig 5: **king pin and suspension center stress**

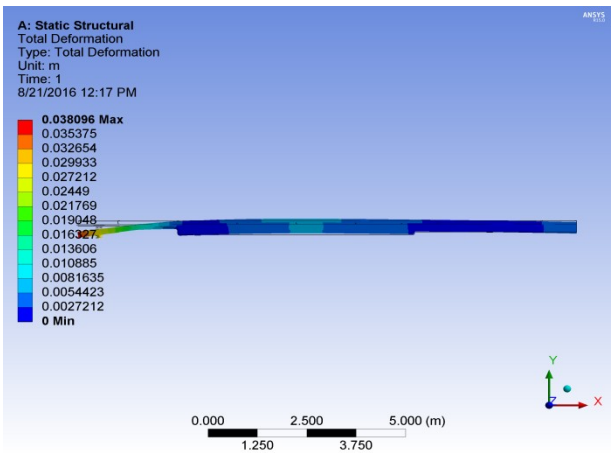


Fig 6: **Landing leg and suspension center deformation**

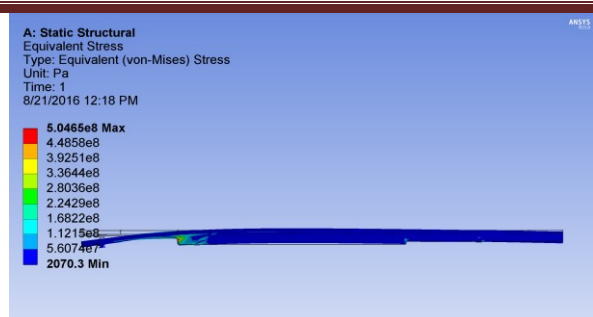
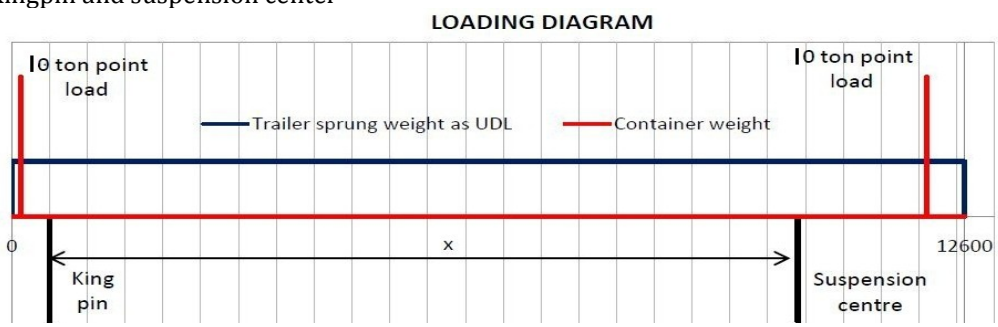


Fig 8: **Landing leg and suspension center stress**

Results by analytical approach

1. Kingpin and suspension center



Total weight of suspended mass is (W) = 22140 kg

B.M. Of all forces on the trailer About front end (forces acting downwards only)

Considering equilibrium of the system

$$-10000 \times 120 + Rc \times 500 - 2140 \times 6300 + Re \times 10396 - 10000 \times 12105 = 0$$

$$500 \times Rc + 103976 \times Re = 135732000$$

By solving above we get

Re = 12597.21 kg-mm Rc = 9542.789 kg-mm

At 500 mm (B)

-10000×11605 + 12597.21×9896 – 0.17×12100×12100 = -3832859.84 kg-mm

And so on…

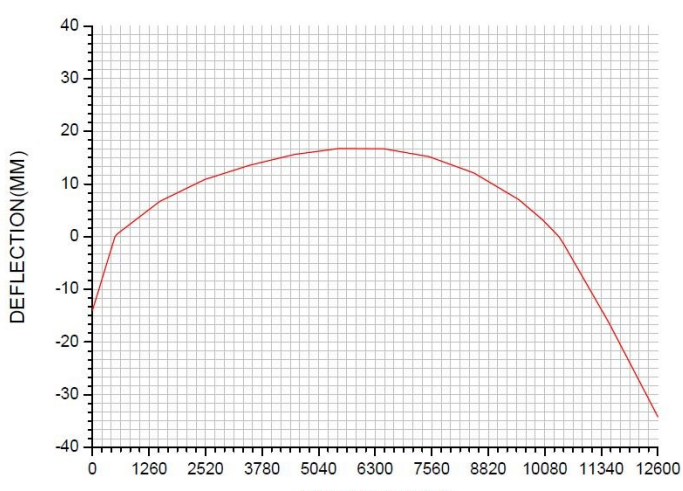
Vonmises stress

Formula of vonmises stress = $\sqrt{\sigma^2 + 3 \times \tau^2}$

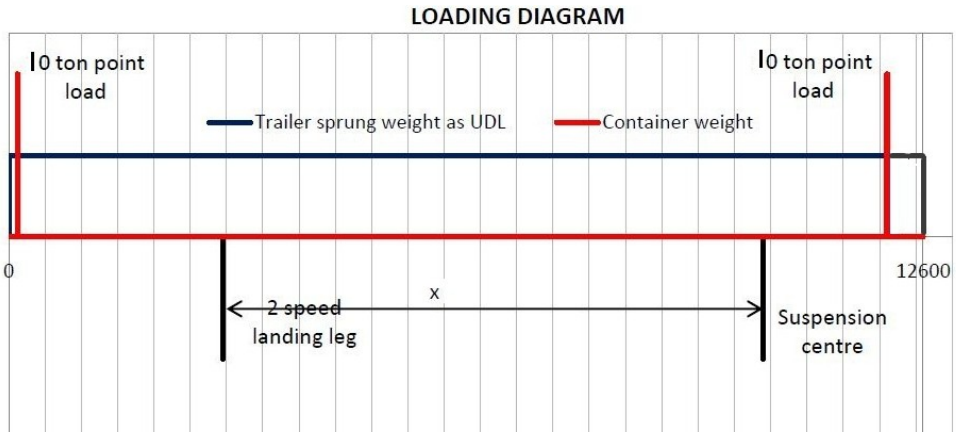
So vonmises stress value at distance of 500 mm from front = $\frac{M}{Z}$ = 38.49 N/mm^2

Vonmises stress value at distance of 10396 mm from front = $\frac{M}{Z}$ = 127.82 N/mm^2

Deflection



2. Landing leg mode calculations



vonmises stress

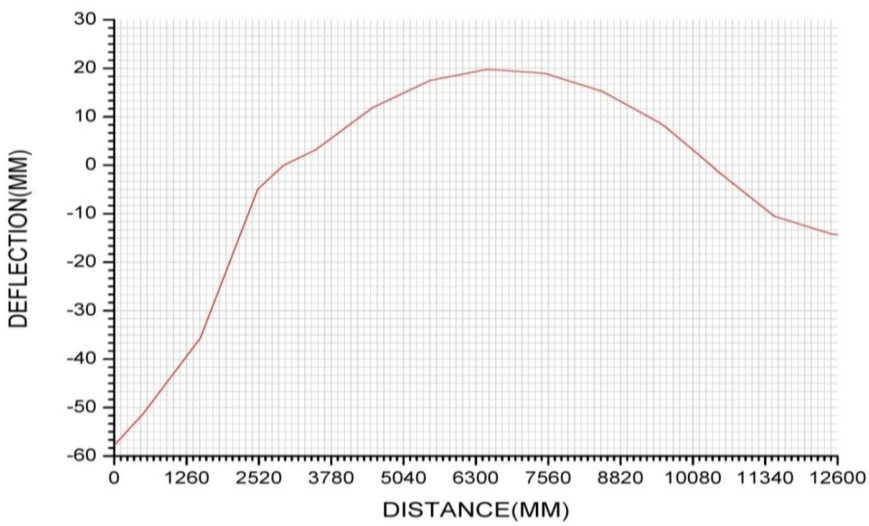
Formula of vonmises stress = $\sqrt{\sigma^2 + 3 \times \tau^2}$

Vonmises stress value at distance of 2950 mm from front = $\frac{M}{Z}$ = 80.8 N/mm^2

Vonmises stress value at distance of 4500 mm from front = $\frac{M}{Z}$ = 143.6 N/mm^2

Vonmises stress value at distance of 10396 mm from front = $\frac{M}{Z}$ = 127.82 N/mm^2

Deflection



For Case 1 Comparison between simulation and analytical

Stress, Deformation	Theoretical at top	Ansys	Material yield
stress	127.82 MPa	156.1 MPa	250 MPa
deformation	0 – 34 mm	0 – 6 mm	

For Case 2 comparison between simulation and analytical

Stress, Deformation	Theoretical at top	Ansys	Material yield
stress	143.7 MPa	500 MPa	250 MPa
deformation	0 – 57 mm	0 – 38 mm	

Conclusions & Scope of Future

In this study we presented the design and modeling of trailer chassis using FEA. Following are highlights of this study

1. Above FEA results Conformal matches with the analytical calculation so we can say that FEA is a good tool to reduce time-consuming theoretical Work.
2. Maximum stress occurs at the chassis mainframe lower portion where its width changes.
3. Maximum deformation occurs at back in kingpin case and at front in landing leg case.
4. The value of von-misses stresses comes from the analysis is far less than material yield stress so our design is safe for kingpin case but in case of landing leg stress value is more than yield stress value so it is recommended to increase the web thickness from 8 mm to 10 mm only for front portion up to 3000 mm.
5. Comparison with experimental results demonstrates the accuracy of the model

Following are the future research opportunities identified based on study undertaken here.

1. Model is analyzed by considering the static case only so dynamic case also play important role in this.
2. As weight of the model here is not considered but it may also be considered for cost-effective criteria.
3. Fatigue analysis may also be considered which is not taken in this.

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