STRESS ANALYSIS OF TRACTOR TROLLEY CHASSIS WITH EFFECT OF VARIOUS THICKNESS AND DESIGN OPTIMIZATION FOR WEIGHT REDUCTION

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ABSTRACT

This paper aims to perform the stress analysis of an actual Tractor trolley chassis structure consisting of C section beams design application of 6 tonne. The material of structure is Mild Steel with 248 MPa of yield strength. The scope of this study concern on structural design of the C section beams for information and data gathering, which will be used for further design improvement. Finite element modelling (FEM) and analysis are performed using a modelling software i.e. Pro-E Wildfire 5. Firstly, a 3-D model of Tractor trolley chassis based on design from workshop is created by using Pro-E. Stress and displacement contour are later constructed and the maximum deflection and stress are determined by performing stress analysis.

To reduce the expenses of the chassis of the trolley, the chassis structure design should be changed or the thickness should be decreased. Design optimization done by keeping the material and dimension constant and using sensitive analysis reduction in weight happen. As raw material required is less, cost of chassis ultimately reduces.

Keyword: - *Tractor trolley chassis, stress, Deflection, FEA, Sensitive analysis*.

1. INTRODUCTION:

Trolleys are widely used for transporting agriculture products, building construction goods and etc. The main requirements of trolley manufacturing are high performance, easy to maintain, longer working life and robust construction. In this work, tractor trolley which is used for the agriculture work and sometimes used for transporting building construction material is considered. These trolleys are divided into two types as two wheeler and four wheeler. The tractor trolleys are available in various capacities like 4 ton, 6 ton, 8 ton[1]

A chassis is one of the key components of the vehicle. A chassis consists of an internal framework that supports the container of tractor trolley in its construction and use. It is a dead vehicle which is connected to the tractor to carry the load. The trolley chassis main frame is supported at two points over the axle. The chassis is connected to wheel axle through semi helical leaf spring and to the tractor by coupling. Tractor Trolley Chassis should be rigid enough to withstand the shock, twist, and other stresses & its principle function is to carry the maximum load for static and dynamic condition safely. An important consideration in chassis design is to have adequate bending stiffness along with strength for better handling characteristics.

This paper is organised in the following manner. Section II Literature Review, in section III explains the theoretical concepts such as Tractor trolley, Tractor trolley chassis, Load acting on chassis, SFD and BMD of chassis, FE

analysis of trolley. In section IV proposed methodology is discussed. In section V of the paper we have included results and comparisons with the existing model. Section VI contains conclusion and future scope of the topic.

2. LITERATURE REVIEW

Many researchers had conducted analysis on chassis of various heavy vehicles. Abd Rahman et. al. investigated stress analysis on a heavy-duty truck chassis using finite element method. Mohd Azizi Muhammad Nora, Helmi Rashida in the Stress Analysis of a Low Loader Chassis wrote methodology for analysis of chassis and conclude by changing thickness of member F O S increded up to 3.5. Teo Han Fui, Roslan Abd. Rahman, Faculty of Mechanical Engineering, University Technology Malaysia, in December 2007, works on the Statics and Dynamics Structure analysis of a 4.5 ton truck chassis, he determined the dynamic characteristic, of the truck chassis, investigating the mounting locations of components on the truck chassis and observing the response of the truck chassis under static loading conditions. N. K. Ingole P.G. Student of Dept. of Mechanical Engineering, R.C.E.R.T Chandpur, Maharashtra, India he did the study on various cases for reduction of weight like that Variation in Cross -sectional areas of cross members. And etc.

3. TRACTOR TROLLEY, TRACTOR TROLLEY CHASSIS, SFD, BMD, DEFLECTION AND STRESS ANALYSIS:

In this section, we mainly discuss the tractor trolley, Trolley chassis, Shear force and bending moment Diagram and Stress analysis of trolley chassis.

3.1 Tractor trolley:

Trolleys are widely used for transporting agriculture goods, building construction material and etc. The main requirements of trolley manufacturing are high performance, easy to maintain, longer working life and robust construction. In this work, tractor trolley which is used for the agriculture work and sometimes used for transporting building construction material is considered.

Fig -1: Tractor trolley

3.1 Tractor trolley chassis:

Fig -2: Tractor trolley chassis

A chassis is one of the key components of the vehicle. It is a dead vehicle which is connected to the tractor to carry the load. The trolley chassis main frame is supported at two points over the axle. The chassis is connected to wheel axle. Tractor Trolley Chassis should be rigid enough to withstand the shock, twist, and other stresses & its principle functions is to carry the maximum load for static and dynamic condition safely.

3.3 Specification of 6 ton two wheeler Trolley:

Table 1: Specification of 6 ton two wheeler Trolley[3]

Specification of 6 ton two wheeler Trolley		
Physical dimension	Length	3962.4 mm
	Width	1900 mm
	Height	1700 mm
Loading condition	Play load	60 KN
	Unloaded weight	13 KN
	Total weight	73 KN

4. METHODOLOGY:

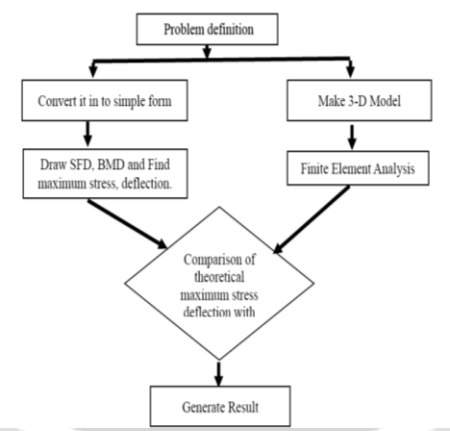


Fig -3: Methodology

Figure 3 shows methodology in this methodology we take a ladder type chassis. Finding the load and position of load on chassis. After that we assume chassis like simply supported beam carrying point load, UDL Load. Then calculate shear force and bending moment diagram. By using SFD and BMD we calculate maximum shear force and maximum bending moment along with position[4]. Then calculate maximum stress and deflection.

Simultaneously prepared 3-D model of chassis by using modeling software like Pro-E, CATIA etc. this model reprent the actual dimension of chassis. then by using the analysis software like ANSYS, Hypermesh etc. in analysis software we apply the load, giving the boundary condition and find the solution. After getting result of analysis software and analytical calculation we compare these two result. And generate accurate result. Then this result is useful for next development. for understanding the actual concept of chassis analysis we should study the following case study on the chassis analysis and design optimization for weight reduction[2].

4.1 Load calculation:

The geometry of the chassis is given. Model No. = 6 ton two wheeler. Side bar of the chassis are made from "C" Channels with 200 mm x 100 mm x 7 mm.
Length = 3048 mm
Material of the chassis is Mild Steel.
Capacity of Trolley = 6 ton = 6000 kg = 58860 N.
Capacity of Trolley with 25% = 73575 N.
Weight of the trolley itself = 1.3 ton = 1300 kg
= 12753 N
Total Gross weight = 73573 + 12753 = 88328 N
Chassis has two longitudinal members so load will be acted upon these two longitudinal members. Therefore, load acting on each member will be half of the total load acting on chassis.
Total load acting on the chassis = 8.8 ton = 8800 kg = 8800 x 9.81= 86328 N
Load acting on one longitudinal member = $x = \frac{86238}{2}$ = 43.164 KN/M
Intensity of Uniformly Distributed Load over the chassis is = $\frac{43.164}{3.048}$ = 14.1614 KN/M.

Member of chassis are made from "C" Channels with 200mm x 100 mm x 7 mm
For finding the stress on the chassis we consider following case
1) By considering the dimension of chassis member is 200 x 100 x 7 mm
2) By considering the dimension of chassis member is 200 x 76 x 6.2 mm (MC 200)
3) By considering the dimension of chassis member is 175 x 76 x 6.2 mm (MC 175)

4.2 FE Analysis of Chassis
1) Case 1 by considering the dimension of chassis member is 200 x 100 x 7 mm
i) Modelling
3-D modelling was done using Pro-E software.

Fig -4: 3-D Model of C section Chassis (case 1)

ii) Meshing

The model has been meshed as shown in Figure 5. The number of nodes are 21426 and element 21434.

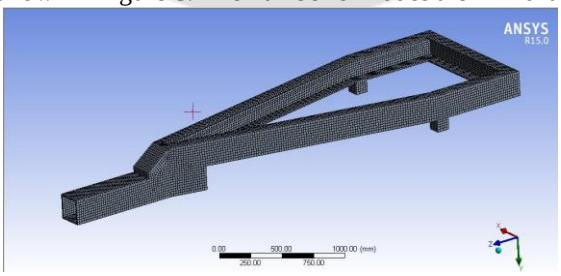


Fig -5: Meshing of trolley chassis (case 1)

iii) Loading

Figure shows the force that has been acted downward to the structure model. The load is distributed uniformly along contact surface area of the chassis. The load is derived from the weight of application loading.

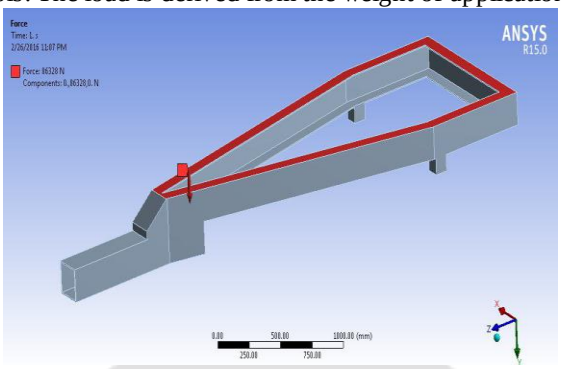


Fig -6: Loading distribution on trolley chassis (case 1)

iv) Result and discussion

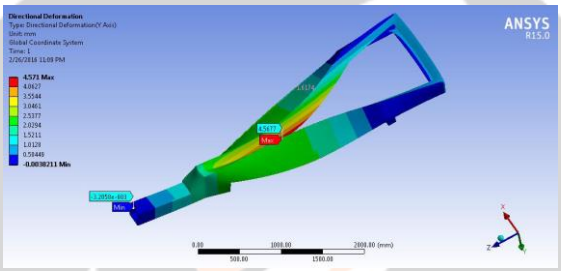


Fig -7: Deflection of trolley chassis (case 1)

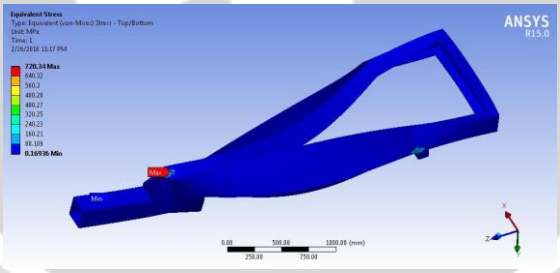
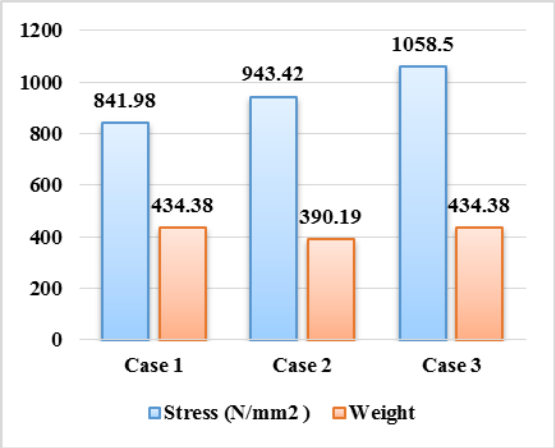


Fig -8: Von Misses stress on trolley chassis (case 1)

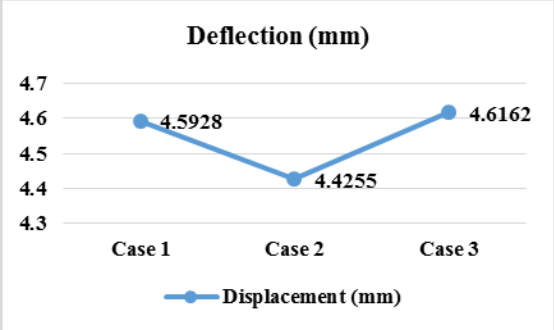
5. RESULTS AND COMPARISONS:

Table 2: Comparison of results of cases

FE Analysis			
Sr. no	**Displacement (mm)**	**Stress (N/mm2)**	**Weight**
Case 1	4.5928	841.98	434.38
Case 2	4.4255	943.42	390.19
Case 3	4.6162	1058.5	434.38



Graph 1: Stress and weight for chassis



Graph 1: Deflection of chassis

6. CONCLUSION AND FUTURE SCOPE:

Stress analysis using finite element method was successfully carried out to determine high stress value, maximum deflection and its location on a tractor trolley chassis structure. The results of analysis shows that the location maximum deflection and maximum stress is not equal to theoretical maximum location of simple beam under Uniform loading distribution. Because of we assume simply supported straight beam with uniform cross section.

- As compare to case 1 with 2 by changing the dimension weight is reduces up to 11.325 % but stress increases by 10.75 %.
- As compare to case 1 with 1 weight remain constant but 20.45 %

From graph 5.1 and 5.2 it is clear that we reduces the dimension value of stress increase but weight reduces. As we see there in no such effect on the deflection.

7. REFERENCES

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