International Journal of Advanced Technology in Engineering and Science
Vol. No.4, Issue No. 07, July 2016
www.ijates.com
ijates
ISSN 2348 - 7550

DESIGN AND DEVELOPMENT OF MINI TRACTOR TROLLEY CHASSIS USING FEA METHOD

[1] Pankaj Badhe, [2]V.L.Firake

[1]P.G. Scholar J.T.M. C.O.E. Faizpur , N.M.U. (India)

[2] Assistant Professor Scholar J.T.M. C.O.E. Faizpur N.M.U. (India)

ABSTRACT

The automobile is divided into two parts body and chassis. The chassis is basic structure of a vehicle. It contains all the engine parts and power systems but the frame is the main portion of chassis. Its principle function is to safely carry the maximum load for all designed operating conditions. This paper describes modeling and analysis of existing 'C' section Mini Tractor Trolley chassis. In the present work, the dimensions of an existing 'C' section Mini Tractor Trolley chassis is taken for modeling and analysis. Weight reduction is now the main issue in automobile industries.

This paper aims to redesign a modified chassis for tractor trolley. By keeping the material and dimension similar and using 'I' cross section area instead of 'C' resulted in more safer stresses than 'C' and 36% reduction in weight. As raw material required is less, cost of chassis ultimately reduces.

Key Words: Optimize, Mathematical Model, Design Chassis, FEA.

I INTRODUCTION

In modern world ON-Road vehicles have changed drastically based on the design and other functional aspects. Market demands the faster and higher transportation in a short span. In order to meet this market demand, vehicle manufacturers are designing heavy load carrying vehicles. These heavy load carrying vehicles gives an advantage of faster, heavy transportation in a short span. On the other side the safety of the heavy load carrying vehicle has to be ensured. Based on the historical data Chassis/body is responsible for only 7% of the failure types. However, failures of chassis are catastrophic with serious consequences. In some cases, a consequence of these in-service failures results in the recall of all affected vehicles with heavy costs and bad publicity. Every vehicle has a body, which has to carry both the loads and its own weight.

Vehicle body consists of two parts; chassis and bodywork or superstructure. The conventional chassis frame, which is made of pressed steel members, can be considered structurally as grillages. The chassis frame includes cross-members located at critical stress points along the side members. To provide a rigid, box-like structure, the cross-members secure the two main rails in a parallel position. The cross-members are usually attached to the side members by connection plates. The joint is riveted or bolted in trucks and is welded in trailers. Chassis is the backbone of any vehicle. If any failure occurs in chassis it will leads to the collapse of a whole vehicle system. Also chassis is not a component that can be replaced easily. If any failure occurs at chassis, either have to replace the chassis totally or require the cost and effort similar to the new vehicle assembly.

II LITERATURE REVIEW

CicekKaraogluandN.SefaKuralay (2002) 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.

Mohamad Tarmizi Bin (2008) Mechanical Engineering department Universiti Malaysia Pahang he use 3D model for finite element analysis issues regarding the experimental analysis of car chassis is addressed. The modeling 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.

Manpreetsinghbajwaet.al. (2013)reported on the effect of static load and give an analysis (excluding damping and inertia effects) of the chassis of TATA super ace using ANSYS workbench and its verification using solid mechanics. The chassis of TATA super ace is of ladder frame type which has two side members or longitudinal members of C- cross section and five transverse members called as cross members of box cross section.

Karaoglu and Kuralay 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.

Fermeretal investigated the fatigue life of Volvo S80 Bi-Fuel using MSC/Fatigue Conle and Chu did research about fatigue analysis and the local stress –strain approach in complex vehicular structures .Structural optimization of automotive components applied to durability problems has been investigated byFerreira et al.

Swami K.I. et.al.(2014)related his work to perform towards the static structural analysis of the truck chassis. Structural systems like the chassis can be easily analyzed using the finite element techniques. Thus proper finite element model of the chassis has been developed. The chassis is modeled in ANSYS. Analysis is done using the same software.

III DEVELOPMENT OF MATHEMATICAL MODEL

Chassis design for heavy vehicle applications starts based on the loads primarily acting on it. In heavytransportation vehicles the vertical load due to pay load is a primary. In order to overcome this vertical load the chassis has to resist the bending moment acting on it. As per the basic equations of pure bending,

Bending Stress calculation:

Figure: 1 'I' Section channel

By flexural formula,

$$\sigma_b = \frac{M y_{max}}{I_{min}}$$

Where,

σ_b = bending Stress

y_{max} = Distance from neutral axis

I_{min} = Min moment of inertia

Moment of inertia @X-axis,

$$= \frac{BD^3}{12} - \frac{bd^3}{12}$$

Moment of inertia @Y-axis,

$$= \frac{BD^3}{12} - \frac{bd^3}{12}$$

By using Parallel axis theorem,

$$I_{yy} = I_{yy1} + I_{yy2} + I_{yy3}$$

Deflection of Chassis:

ijates
ISSN 2348 - 7550

$$\delta = \frac{5}{384} X \frac{\omega L^4}{EI}$$

IV SPECIFICATION OF EXISTING MINI TRACTOR TROLLEY CHASSIS

The total capacity of the trolley is 50 KN but the self weight of trolley and the other accessories is 37 KN. So here the gross weight come over is 87 KN is considered the existing chassis consists of 'C' section having cross section area 150mm x 75mm x 5.8mm and the material used for manufacturing is structural steel.The specifications of tractor trolley is shown in table 1 which is collected from industry itself.

Table: 1 Specification of Tractor Trolley.

General	Overall Length	Box 3900mm
		Chassis :- 1800mm
Overall	width	1370 mm
Load	Payload Capacity	5000 kg
	Unloaded Weight including weight of chassis	2220 kg
	Gross Weight considering factor of safety 1.2	8664kg

Table:2 Material Properties of Structural Steel used for chassis.

Young's Modulus	200 x E9 pa
Poisson's Ratio	0.3
Density	7.85e-006 kg/mm³
Tensile Yield Strength	250. Mpa

V STRUCTURAL ANALYSIS OF CHASSIS

In the present study, market available tractor trolley Chassis is selected and its dimension is noted. The Possible loads acting and the place of loads are noted. According to the dimensions, tractor trolley Chassis is modeled using CATIA software. It is then imported to design modeler software ANSYS**.**

Mathematical calculations of existing trolley chassis

Channel Specification=150X75X5.7mm

Weight of Channel/feet=5.12 kg (std. data)

∴ Total length of channel used for manufacturing of chassis is

∴ 1800X4=7200mm (Length)

∴1370X4=5480mm (Width)

∴ Total Length=12680mm

≅42 feet

∴ Raw material Weight for chassis= 42X5.121=218.4 kg

≅ 220kg

Net weight of chassis=220kg

Trolley box weight= 2000kg (Data from Manufacturer)

∴ Total Net Weight =2220kg

Load Carrying Capacity=5000kg

Gross weight of tractor trolley & chassis = 7220kg

Considering factor of safety=1.2

∴Total gross weight=8664kg

∴ The Total weight acts on 2 beam so,

Net load on , 1 beam = 8664/2 kg

Net UDL on beam ie.$\frac{\text{Total Load}}{\text{Length of Beam}}$

$$= \frac{8664 X 9.81}{42/_{3.289}}$$

=6656 N/m

≅6660 N/m

Bending Stress (σ_b)

$$\sigma_b = \frac{1021.4 X 10^3 X 75}{0.896 X 10^6}$$

$$= \frac{1021.4 X 75}{89.6}$$

= 85.49 N/mm^2

Deflection of Chassis:

$$\delta = \frac{5}{384} X \frac{\omega L^4}{EI}$$

$$= \frac{5}{384} X \frac{6660 X (1.3)^4 X 10^{12}}{200 X 10^3 X 0.0896 X 10^6}$$

International Journal of Advanced Technology in Engineering and Science
Vol. No.4, Issue No. 07, July 2016
www.ijates.com
ijates
ISSN 2348 - 7550

= 1.38 mm

Mathematical calculations of trolley chassis using I section of 150x75x5.8

∴Net mass /feet=4.5kg

∴ Total weight=31.28x4.5

=140.76kg

∴ The net weight acting on chassis=Design load + Trolley box Weight + self-Weight

=5000+2000+140.76

=7140.76 Kg

≅7140 kg

Considering FOS=1.2

Hence Design Load=8568 kg

UDL acting on Beam

Total weight/Total length=8568/9.51

=9009.00 N/m

As per design uniformly distributed load acting on beam=9009.6/2

=4504.5 N/m

Calculation of bending stress

$$\sigma_b = \frac{M*y}{I}$$

$$=\frac{695.88*150*10^3}{2.1*10^6*2}$$

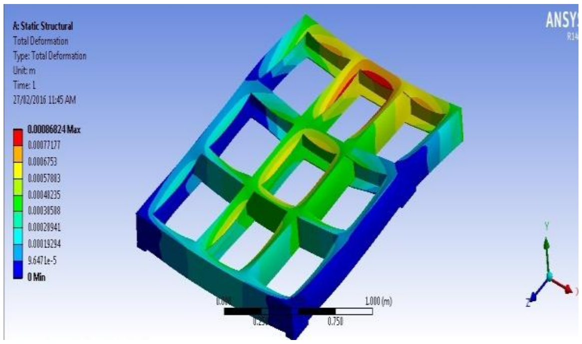
$\sigma_b = 24.85\ N/mm^2$

Deflection of Beam(δ)=$\frac{5}{384}$x$\frac{WL^4}{EI}$

$$=\frac{5}{384}x\frac{4.504*1300^4}{200*10^3*2.565*10^6}$$

δ=0.322 mm

Analysis of Existing 'C' Cross Section Chassis Using Ansys Tool



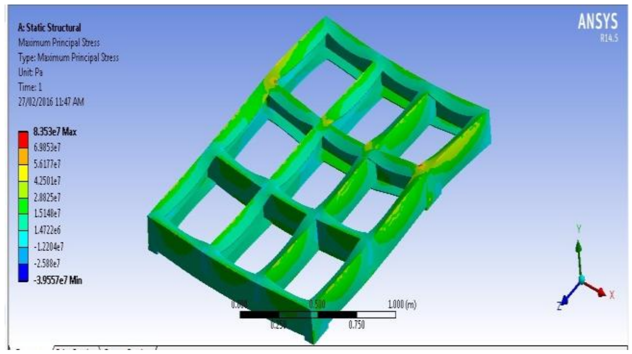
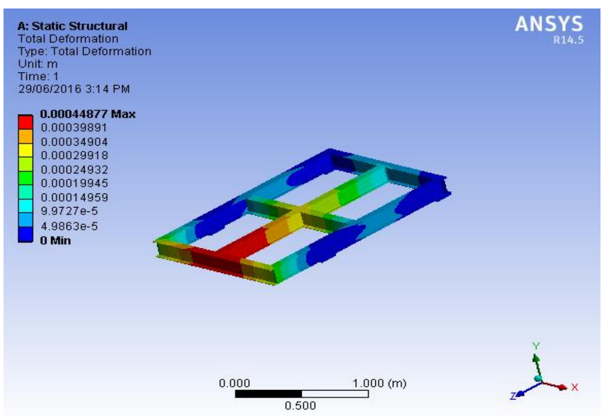


Figure: 2 Total Deformation **Figure:3 Von–mises stress**

Analysis of Modified 'I' Cross Section Chassis Using Ansys Tool



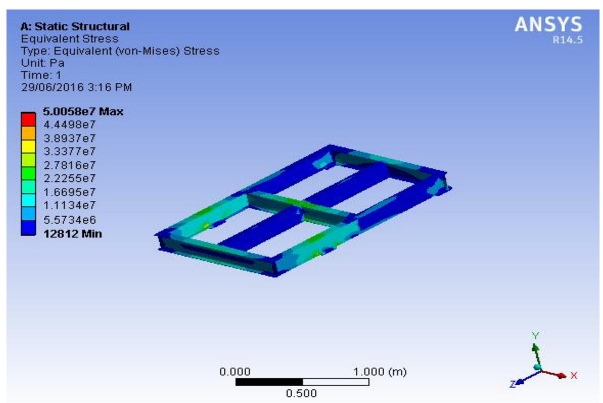


Figure:4 Total Deformation **Figure:5 Von–mises stress**

CONCLUDING REMARKS

i. The color contour shows the variation in stress and deformation. Red color shows maximum values 50 N/mm^{2}and 0.4487 mm for stress (σ) and deformation (δ)respectively, accordingly the value decreases with change in color up to minimum value showed by color blue.

ii. The static structural analysis is done and by the observing the results there is less stress induced in some areas of Chassis.

iii. The maximum stress induces 50 N/mm^{2}is less than that of yield stress (Sy) 250N/mm^{2}so a chance for modification is there in a chassis.

So, the deflection induced in this channel is less than existing channel and stresses induced is within limit so, this can be taken as optimize section.

Table:3 Comparison of Existing 'C' Section and Modified 'I' Section Mini Tractor trolley chassis.

SR NO.	FACTORS	EXISTING 'C' SECTION	SUGGESTED 'I' SECTION (150x75x5.8)
1	Equivalent (Von-Mises) Stress	$83.5 N/mm^2$	$50\ N/mm^2$
2	Total Deformation	0.868 mm	0.4487 mm
3	Factor Of Safety	1.2	1.2
4	Mass	220 kg	140 kg
5	Weight Reduction	36 %	

VI CONCLUSION

1. The newly designed 'I' section Chassis reduces 36 % of weight reductionas compared to the existing 'C' section Chassis.More safer stresses are obtained in new suggested design.
2. Increase in Factor of Safety obtained in new suggested design.
3. Reduction in weight shows that raw material required for manufacturing of the Chassis is reduced.
4. As raw material required is reduced, reduction in cost is achieved.

REFERENCES

[1]. CicekKaraoglu, N. SefaKuralay "Stress analysis of a truck chassis with riveted joints" Elsevier Science B.V Finite Elements in Analysis and Design 38 (2002) 1115–1130.

[2]. Hemant B.Patil1, Sharad D. Kachave "Effects Of Web And Flange Thickness On Bending Stiffness Of Chassis" International Journal Of Advance Research In Science And Engineering http://www.ijarse.com IJARSE, Vol. No.2, Issue No.7, July, 2013 ISSN-2319-8354(E).

[3]. JadavChetan S., PanchalKhushbu C., Patel Fajalhusen "A Review of the Fatigue Analysis of an Automobile Frames" International Journal of Advanced Computer Research (ISSN (print): 2249-7277 ISSN (online): 2277-7970) Volume-2 Number-4 Issue-6 December-2012.

[4]. J. Gadus, "Optimization of frameworks by means of FEM use" Slovak Agricultural University, Nitra, Slovak Republic.

[5]. Harish V. Katore, Prof Santosh B. Jaju, "Redesigning Of Tractor Trolley Axle Using Ansys" International Journal of Engineering, Science and Technology(IJEST) ISSN:0975-5462 Volume No 3, 6 June 2011

[6]. MohdAzizi Muhammad Nora,,HelmiRashida, Wan MohdFaizul Wan Mahyuddin "Stress Analysis of a Low Loader Chassis" Elsevier Ltd. Sci Verse Science Direct Procedia Engineering 41 (2012) 995 – 1001.

[7]. MohdNasirTamin, Journal Mekanikal, No.26, 76 – 85.[2] Statics and Dynamics Structural Analysis Of A 4.5 Ton Truck Chassis, Teo Han Fui, RoslanAbd. Rahman*,Journal Mekanikal, December 2007, No. 24, 56 – 67

[8]. N.K.Ingole, D.V. Bhope "Stress analysis of tractor trailer chassis for self weight reduction" International Journal of Engineering Science and Technology (IJEST), ISSN: 0975-5462 Vol. 3 No. 9 September 2011.

[9]. Patel Vijay kumar V, Prof. R. I. Patel "Structural Analysis of Automotive Chassis Frame and Design Modification for Weight Reduction" International Journal of Engineering Research & Technology (IJERT), ISSN: 2278-0181, Vol. 1 Issue 3, May – 2012.