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Computational & Analytical Design Study of Eicher truck (E-2 plus) Chassis frame

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ABSTRACT

The automobile's chassis is a critical component. The chassis acts as a support structure for the body and other components of the car. Additionally, it must be sufficiently robust to handle pressures such as shock, twisting, vibration, and others. Having sufficient bending stiffness for improved handling characteristics is just as vital as strength when designing a chassis. Strength and rigidity are hence two crucial factors in the chassis' design. This paper details the work done to analyse the vehicle chassis' static structural integrity. The use of finite element techniques makes it simple to analyse structural systems like the chassis. So it is necessary to create a suitable finite element model of the chassis. PRO-E is used to model the chassis, and FEA is done on the modeled chassis using the ANSYS Workbench.

Keywords: chassis frame; Stress analysis; Finite element method; Truck chassis; structural analysis

1. Introduction

The lower body of a vehicle, including the tyres, engine, frame, driveline, and suspension, is commonly referred to as the chassis. The frame is one and provides necessary support to the vehicle components that are mounted on it. Furthermore, the frame must be strong enough to withstand shock, twist, vibrations, and other stresses. The chassis frame is made up of side members that are connected by a series of cross members. The Finite Element Method (FEM) can be used to locate the crucial stage with the highest stress. One of the factors that may contribute to fatigue failure is this critical point. The magnitude of the stress could be used to predict the truck chassis' life span. The accuracy of truck chassis life prediction is dependent on the result of its stress analysis

Nomenclature

Front Overhang
Rear Overhang
Wheel Base
Turning Radius
Overall Length

Table 1 - Properties of ST 52

S.No	Physical Properties	Value
1	Density (g/cc)	7.87
2	Hardness (Brinell)	207
3	Hardness (Rockwell B)	94
4	Hardness (Rockwell C)	17
5	Ultimate tensile strength (N/mm2)	602
6	Yield strength (N/mm2)	522
7	Elongation at break (%)	32.6
8	Modulus of elasticity(KN/mm2)	210
9	Bulk modulus(KN/mm2)	140
10	Poisson's ratio	0.3
11	Shear modulus(KN/mm2)	80

1.2Analytical Calculation for Chassis Frame

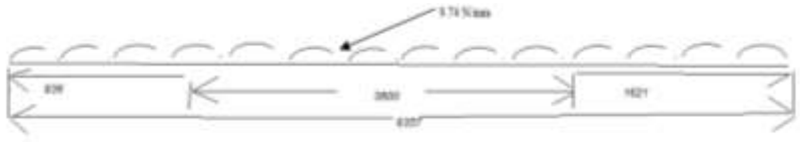


Fig. 1 frame of Chassis as a simply supported beam

Where

E = 2.10 x 105 N / mm2

Poisson Ratio = 0.31 Radius of Gyration

R = 210/2 =105 mm (1)

Capacity of Truck = 8 ton = 8500 kg = 8500*9.81=83385 N

Capacity of Truck with 1.25% = 104231 N

Weight of the body and engine = 2 ton = 2000 kg = 19620 N (2)

Total load acting on chassis = Capacity of the Chassis + Weight of body and engine = 104231 + 19620 = 123851 N (3)

Chassis has two beams.

So

Load acting on each beam is half of the Total load acting on the chassis.

Load acting on the single frame = 123851/ 2 (4)

= 61925.5 N / Beam

1.3 Calculation for Reaction

The chassis is simply clamped together with a shock absorber and a leaf spring. As an outcome, Chassis is a Simply Supported Beam with a uniformly distributed load. The total load acting on the entire span of the beam is 61925.5 N. The beam's length is 6357 mm.

Uniformly Distributed Load is 61925.5 / 6357 =9.74 N/mm (5)

Now taking the reaction around the Support A

$$RC = \frac{\mathbf{wl(l-2c)}}{\mathbf{2b}}$$

= 9.74 x 6357x (6357-2 x 1621) /2x3800 = 25377.82 N (6)

$$RD = \frac{\mathbf{wl(l-2a)}}{\mathbf{2b}}$$

= 9.74 x 6357 x (6357-2 x 936)/ 2x3800 = 36539.17 N (7)

1.4 Calculation of Shear Force & Bending Moment

Shear Force

V1 = wa (8)

= 936 x 9.74 = 9116.64 N

V2 = Rc – V1 (9)

= 25377.82 – 9116.64 = 16261.18 N

V3 = Rd – V4 (10)

= 36539.17 – 15788.54= 20750.63 N

V4 = wc (11)

= 9.74 x 1621 = 15788.54 N

1.5 Bending Moment Equation

$$M1 = -\frac{wa^2}{2}$$

= (9.74 x 876096)/2= - 4266587.52 N-mm (12)

$$M2 = \frac{wc^2}{2}$$

= (9.74 x 2627641)/2 − = - 12796611.67 N-mm (13)

$$M3 = RC \{ (\frac{Rc}{2w} - a\}$$

= 9307641.176 N-mm

1.6 Stress Calculation

Mmax = 12796611.67 N-mm (14)

Moment of Inertia around The X – X Axis

Ixx = $(bh^3 - b_1h_1^3)/12$ = (76x 2103) - (70 x 1983) 12 = 13372380 mm4 (15)

Section of Modules around The X – X Axi

Zxx = $(bh^3 - b_1h_1^3)/6h$ = (76x 2103) - (70 x 1983) 6 x 210 = 127356 mm3 (16)

1.7 Stress Produced in the Beam is as under

$\sigma = \frac{Mmax}{Z}$ = 95.44 N / mm2 (17)

1.8 Deflection of the Beam

Moment of inertia of side bars

$Ib_1 = 13372381\ mm^4$ (18)

$Ib2 = 13372381\ mm^4$ (19)

Moment of inertia of cross bar

$Ib3 = 10023948\ mm^4$

1.9 Total Mass Moment of Inertia

= [(13372381x 2) + (10023948x 6)] = 86888520 mm^4

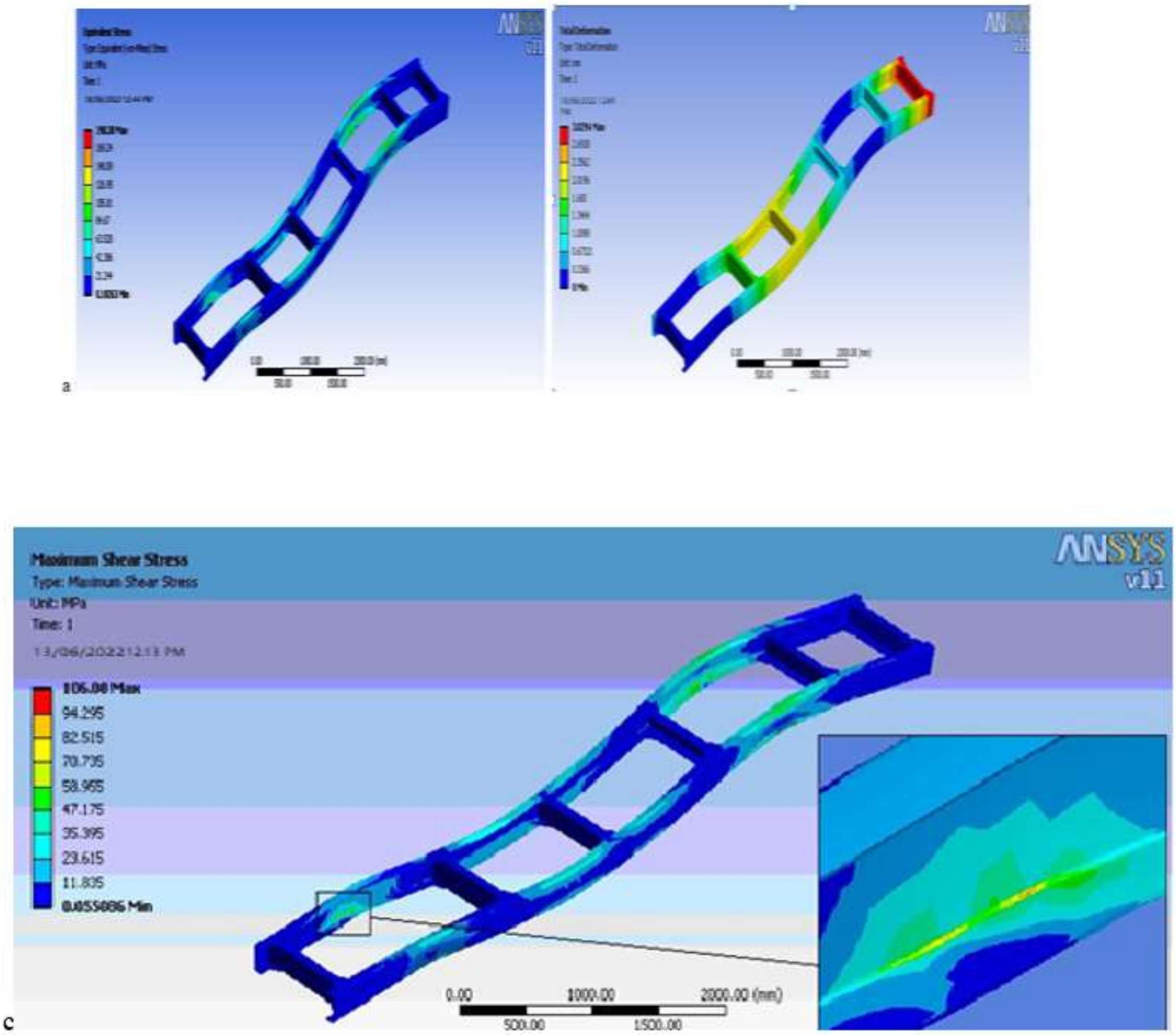
1.10 Deflection of Chassis

$$=\frac{wx(b-x)}{24EI}\{x(b-x) + b2\text{-}2(c2+a2) - \frac{2}{b}(c2x+a2\{b\text{-}x)\} \quad (20)$$

= 2.89 mm that is within safe limit according deflection span ratio.

Computational Analysis

a



c

Fig. 1 (a) stress in the chassis, (b) deformation (c) shear stress

Conclusion

According to FE analysis, the highest stress that occurred was 106.07 MPa. The maximum shear stress is calculated as 95.44 Mpa. The FE analysis result is 10% higher than the analytical calculated results. The numerical simulation result has a maximum displacement of 3.0293 mm. The numerical simulation result is 5.92 percent greater than the analytical calculation result of 2.89 mm. The difference is due to model simplification and numerical calculation uncertainly

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