STATIC AND DYNAMIC ANALYSIS ON TATRA CHASSIS

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ABSTRACT

This paper deals with the analysis of chassis frame for improving its payload by adding stiffner and c channel at maximum stress region of chassis frame. The FEM analysis has been carried out with various alternatives. The results illuminate the new creative ways for optimum frame design which makes it more sustainable for structural concerns. This paper analyzed the backbone frame for both dynamic and static load condition with the stress deflection bending moment on the tatra chassis frame. The finite element analysis over ansys is performed by considering the load cases and boundary conditions for the stress analysis of the chassis. The tatra chassis is being modeled in catia v5 and then it is being imported in the finite element analysis software-Ansys. At present the payload of the tatra is 10.4 tones in this project we enhance the capacity of vehicle to 14 tones from existing chassis as per the requirement. This has been carried out with limited modifications by adding stiffeners and c channel. The necessary design changes required to enhance the load carrying capacity of the vehicle has been recommended successfully.

Keywords: Static Analysis, Dynamic Analysis, Finite Element Analysis, ANSYS, Tetra Chasis

1.0 INTRODUCTION

TATRA is mainly used in terrain conditions fitted with EURO II Engine. It can able to operate under extremely high and cold ambient temperatures, high humidity and industry environments. The Chassis of this vehicle is very rigid against torsion and bending. The chassis has high resistance to shocks and vibrations. Therefore, it protects super structures from torsion, stresses, and allows driving fast on rough roads.

This vehicle is a Left hand drive. The specialty of this vehicle is 8×8 drives, all of the eight are lockable differentials. It contains independent suspension with swinging semi-axles for every eight wheels. The leaf spring and telescopic shock absorber supports the front axle. The leaf spring alone supports the rear axle. The tyres have manually controlled central tire inflation system (CTIS) operable on the move. It is a Longer Wheel Base special Chassis. This Chassis has four axles and all the axles are of driven type. Separate axle differential provided for each axle**.**

The TATRA backbone frame consists of tubes bolted together with axle final drive housing and cross members. The backbone frame is connected through the cross member with welded steel frame. The backbone frame also protects driveline shaft from transmission to the wheels and differentials that are placed inside, against duct, moisture and outer mechanical damages

1.1 Frame

TATRA backbone frame consists of tubes bolted together with axle final drive housings and cross members. The backbone frame is connected through the cross members with welded steel frame. This solid structure is exceptionally rigid against torsion and bending.

The backbone frame also protects driveline shafts from transmission to the wheels and differentials that are placed inside, against dust, moisture and outer mechanical damages. Chassis structure gives extremely high torsion resistance protecting super structures from torsion, stresses and together with independent wheel, suspension improves mobility in rough terrain.

1.2 Engine

Engine Type	- 8 Cylinder, Turbocharged, Air cooled engine.
Engine output	- 300 KW at 1800 r.p.m.
No. of Speed	- 10 speed manual synchromesh transmission.
Engine Capacity	- 12667 cc
Maximum torque	- 1830N-m at 1200 r.p.m

1.3 Chassis

The chassis of an automobile consists of following components suitably mounted:

- Engine and the radiator.
- Transmission system, consisting of the clutch, gear box, propeller shaft and the rear axle.
- Suspension system.
- Road wheels.
- Steering system.
- Brakes.
- Fuel tank.

All the components listed above are mounted in either of the two ways, viz., the conventional construction, in which a separate frame is used and the frameless or unitary construction in which no separate frame is employed. Out of these, the conventional type of construction is being used presently only for heavy vehicles whereas for car the same has been replaced by the frameless type accept of course by small manufacturers, who still find it economical to use frame.

2.0 PHASES OF DESIGN

The complete design process, from start to finish, is highly iterative in nature and is as outlined in the flow diagram shown below. The process begins with recognition of a need and a decision to do something about it. After much iteration, the process ends with the presentation of the plans for satisfying the need. The design of products and services is accomplished in this traditional way. Fig. 2b shows a flow diagram of iterative phases.

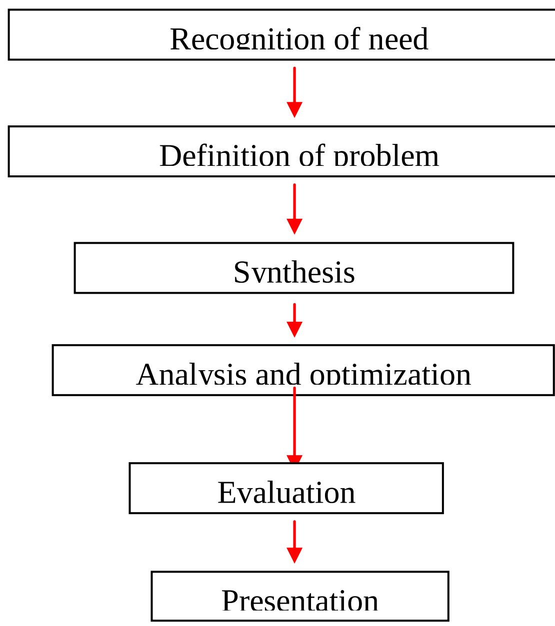


Fig. 1. Phases of design

3.0 FINITE ELEMENT ANALYSIS

The finite element analysis is a numerical analysis technique to obtain the solution of partial differential equations. The mathematical procedures such as Galerkin's weighted residual method and Raleigh-Ritz methods are used to obtain the finite element formulation of the partial differential equation. The geometrical domain describing the engineering field problem is divided into sub domains, referred to as finite elements, and the variation of the primary variable in the finite element is described using piece-wise continuous functions within each element.

4.0 GEOMETRIC MODELING OF CHASSIS

The Chassis Model of TATRA is created using CATIA V5 R16.

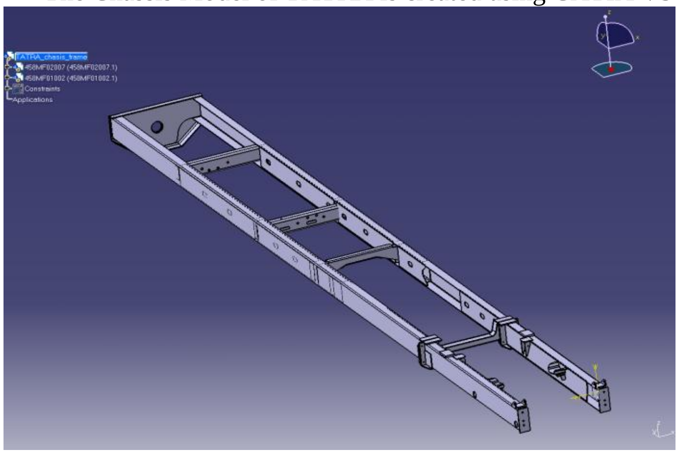


Fig.2

4.1 Material properties of chassis

No.	Material	Yield Strength (σ_y)	Ultimate Tensile Strength (σ_u)	Young's Modulus (E)	Poisson's Ratio (ν)
1	High strength Structural Steel	410 N/mm^2	540 N/mm^2	2, 00,000 N/mm^2	0.3

Table 1

4.2 Specifications of the chassis

No	Description	Dimension (mm)
1	Length of Chassis	10208
2	Width of Chassis	1000

Table 2

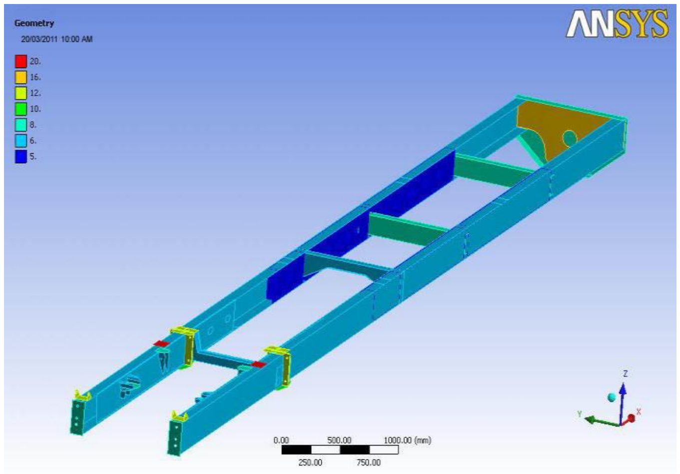


Fig 3: Ansys model with various thickness

The thickness is entered for all individual parts. It is varying from 5mm to 20mm.

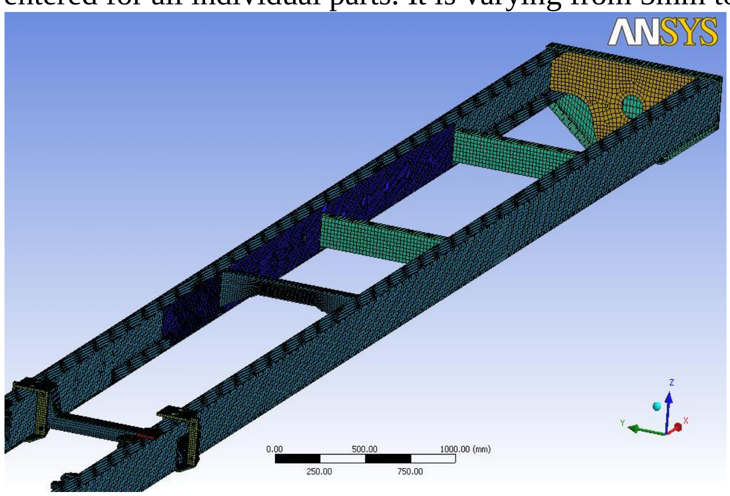


Fig 4: Finite element model of rear chassis

4.3 Boundary conditions on the chassis

S. No	Loads	Description
1.	Electronic component and Antenna Load	35000 N
2.	Cabin load	1949.7 N
3.	Engine load	3789.3 N
4.	Dynamic load	2g load applied in Z direction in centre of gravity

Table 3

5.0 ANALYSIS OF TATRA CHASSIS

- Static analysis
- Dynamic analysis
- Static analysis of the chassis:

A static analysis calculates the effects of ***steady*** loading conditions on a structure, while ignoring inertia and damping effects, such as those caused by time-varying loads. Static analysis determines the displacements, stresses, strains, and forces in structures or components caused by loads that do not induce significant inertia and damping effects.

6.0 RESULTS AND DISCUSSIONS

Before Modification

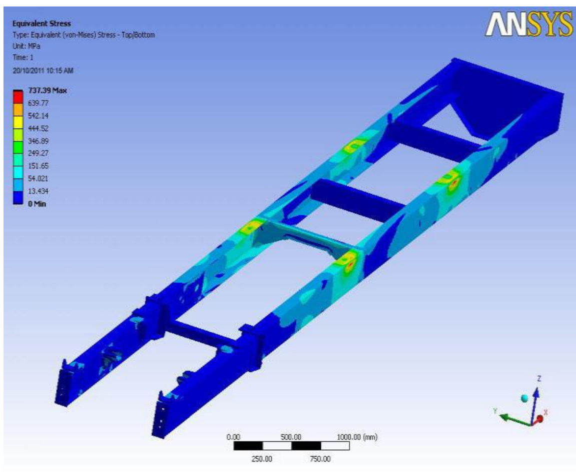


Fig 5:Stress in the Chassis

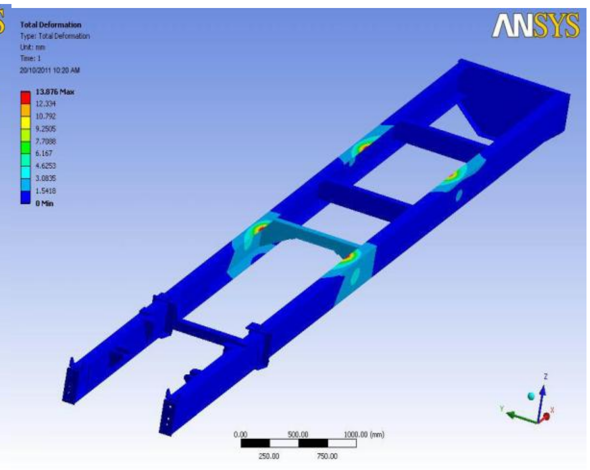


Fig 6 : Total deformation in the chassis

Max. Stress = 737.3 Mpa. / Location = just under the loading point

The above shown result plot represents the stress in the chassis.

Max. Deflection = 13.8 mm / Location = just under the loading point

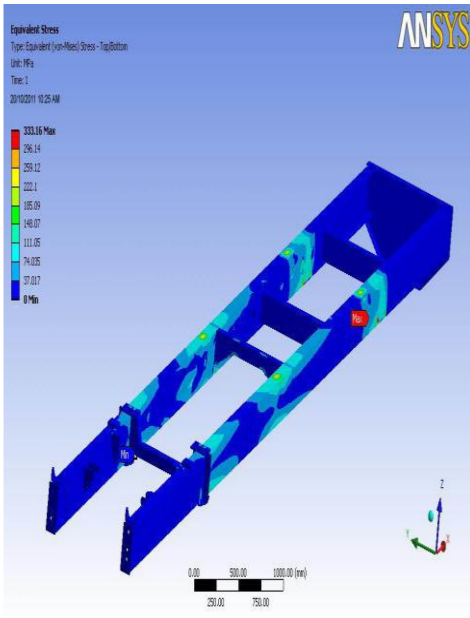
The above shown result plot represents the total deformation in the chassis

From the above stress and deformation contour, stress induced in the frame is 737.3 Mpa and deformation is 13.8mm. It is more than the yield strength of the material. So it is necessary to increase the strength of the chassis frame incorporating suitable design changes.

After Modification

The strength of the chassis was increased to the safety level by adding stiffeners. Six no of stiffeners was introduced in the maximum stress induced areas which is coming in the center of the rear chassis frame. The various result plots for different thickness are shown below.

For Stiffener thickness of 4 mm:4mm thickness stiffeners was introduced in the chassis frame and static analysis was carried out and the stress and deflection contours are shown below,



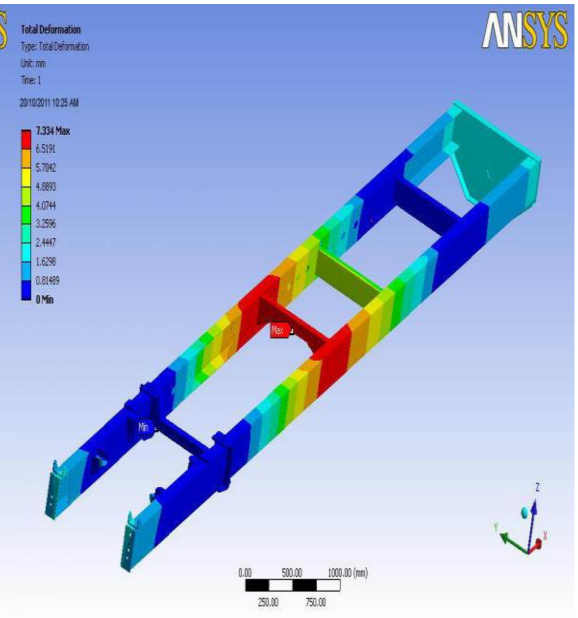


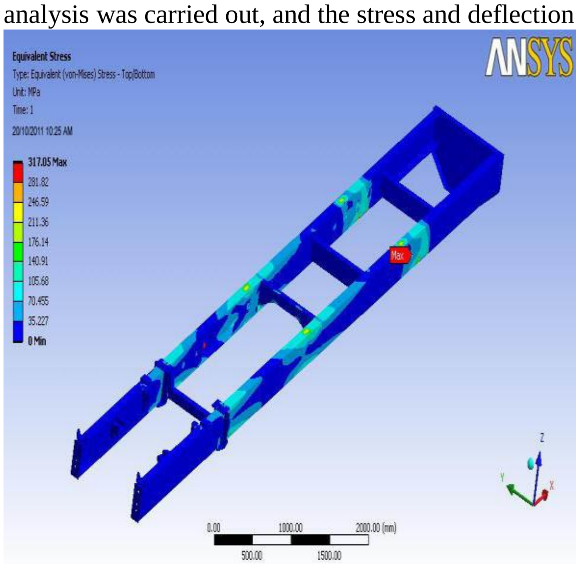
Fig 7 Stress induced in the chassis Fig 8 Deflection induced in the chassis

Max. Stress = 333.16 Mpa. / Location = just under the loading point
Stress induced in the chassis when the stiffener is 4 mm
Max. Deflection = 7.3 mm / Location = Center portion of rear chassis
Deflection developed in the chassis when the stiffener is 4 mm

From the above stress and deformation contour, stress induced in the frame is 333.16 Mpa and deformation is 7.3mm. It is is less then the acceptable value. But factor of safety is 1.27. So it is necessary to increase the stiffness thickness of the chassis frame to reduce the stress level.

For stiffener thickness of 5 mm

Instead of 4mm thickness stiffeners 5mm stiffener was introduced in the chassis frame, static analysis was carried out, and the stress and deflection contours are shown below,



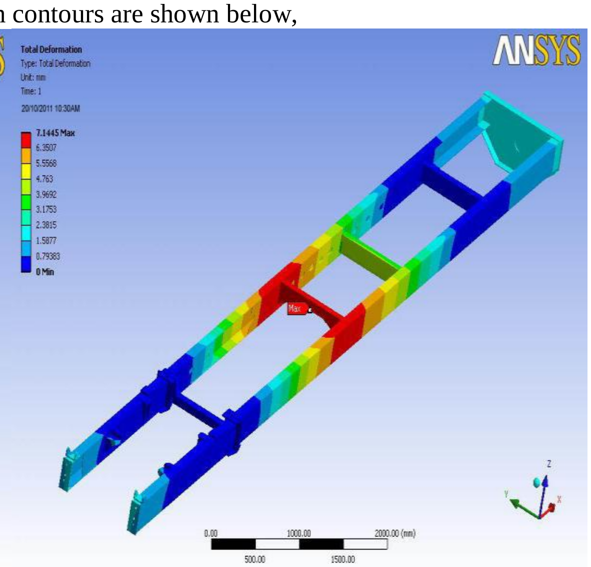


Fig 9 Stress induced in the chassis Fig10Deflection induced in the chassis

Max. Stress = 317 Mpa. / Location = just under the loading point

Stress induced in the chassis when the stiffener is 5 mm.

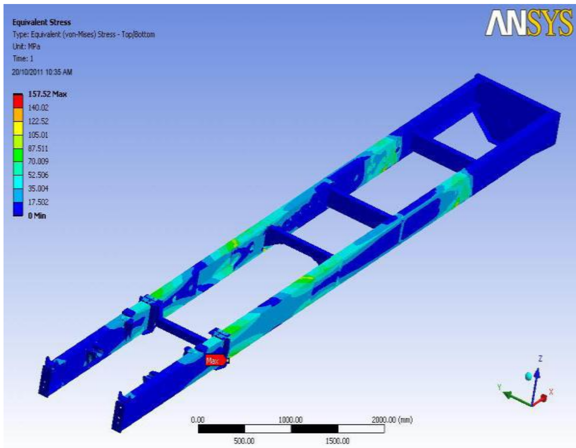
Max. Deflection = 7.14 mm / Location = Center portion of rear chassis

Deformation developed in the chassis when the stiffener is 5 mm.

From the above stress and deformation contour, stress induced in the frame is 317 Mpa and deformation is 7.14mm. It is less then the acceptable value. But factor of safety is 1.29. So it is necessary to reinforce the “C” channel with stiffness thickness of the chassis frame to reduce the stress level.

Static Analysis Of Reinforced “C” Channel With Stiffener

Two reinforced “C” channel was introduced under the loading point and the analysis is carried for this condition.



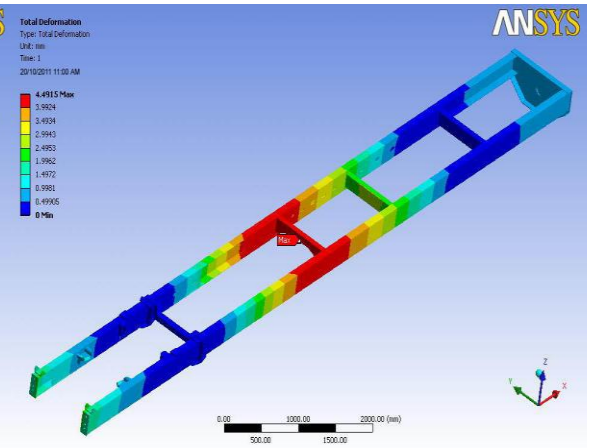


Fig 11Stress induced in the chassis Fig 12: Deflection induced in the chassis

Max. Stress = 157.5 Mpa. / Location = near the supporting point

Max. Deflection = 4.9 mm / Location = Center portion of rear chassis

Factor o Safety

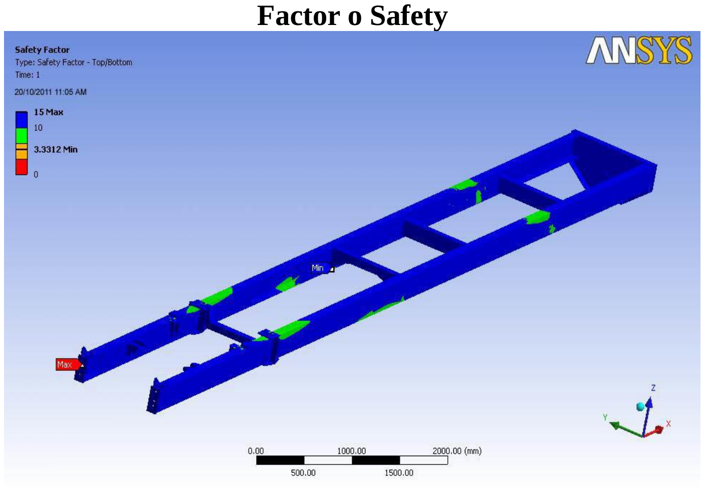
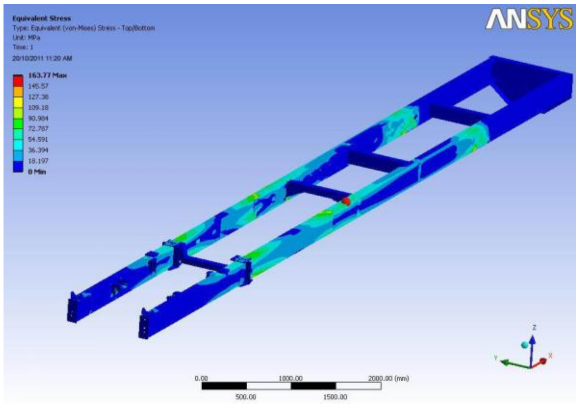


Fig 13: Factor of safety

Dynamic analysis of the chassis

The analysis inertia force is considered to act on z direction and other loading conditions are kept same. Analysis has been carried out in this and plot has shown below.



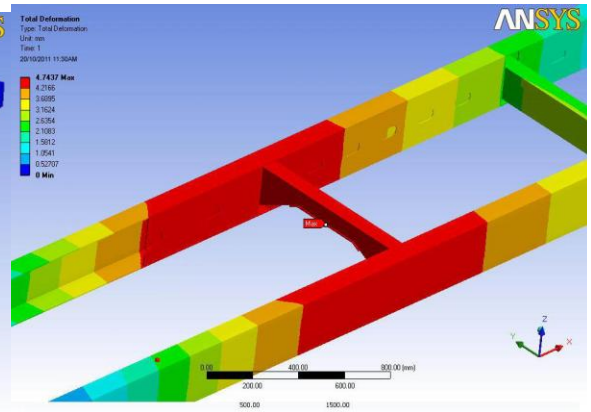


Fig 17: Stress induced in the chassis

Fig 18: Total deformation in the chassis

Max. Stress = 163.7 Mpa. / Location = near the supporting point
Max. Deflection = 4.7 mm / Location = Center portion of rear chassis

Factor Of Safety

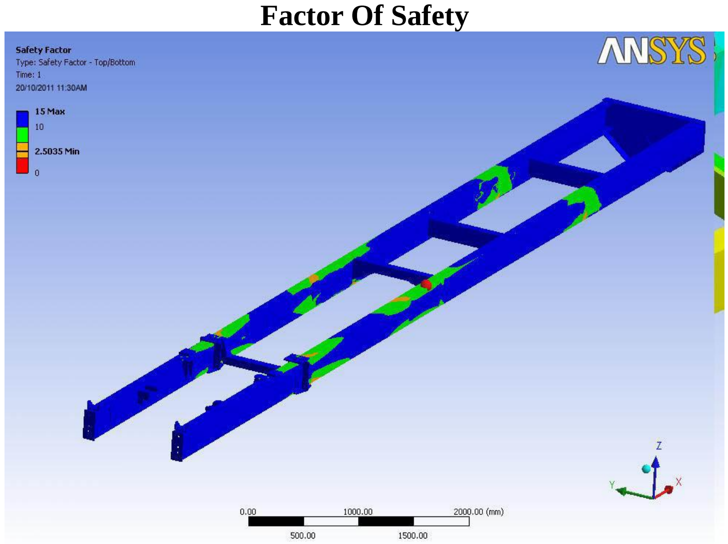


Fig 19:Factor of safety

Static stress Analysis result due to electronic components and Antenna, Engine, Cabin load is shown in Fig .

Dynamic load Stress Analysis result due to Electronic components and Antenna, Engine, Cabin load and inertia load is shown in Fig .

The maximum stress occurs where near the fixed support shown in Fig . The magnitude of maximum stress level is found to be 163.77 N/mm2 which is well within the acceptable criteria.

7.0 CONCLUSIONS

The existing TATRA chassis was analyzed by the finite element analysis for installation of the Antenna and Electronic components and the stress levels are found to be 737.3 N/mm2.After modifications, the TATRA Chassis with suitable reinforcement, increase in thickness, addition of stiffeners, the finite element analysis was carried out, and the stress levels of chassis are found as 173.38 N/mm2, which is less than yield stress 410 N/mm2.

From the above Results, it can be concluded that the modified TATRA chassis is capable to carry the loads beyond the previous payload upto 14 tonnes.

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