International Journal of Ignited Minds (IJIMIINDS)

Optimization of Load Carrying Capability of Tipper Truck Cargo Body Using Non-Linear Structural Analysis

Mr. Bhaskar C V[a], Mr. Rangaswamy H[b], Mr. Imran Ali M R[c]

[a]*PG Scholar, Department of mechanical engineering, S.I.E.T, Tumkur, India.*

[b]*Asst Prof, Department of mechanical engineering, S.I.E.T, Tumkur, India.*

[c]*Asst Prof, Department of mechanical engineering, H.M.S.I.T, Tumkur, India.*

ABSTRACT

The truck industry is a significant lifeline of the country's economic activity. There is considerable scope to improve the design of their products. In order to save unloading costs tipper trucks are becoming very popular now a day. These bodies are also known as dump bodies. These are useful in a simple way to unload the material. Loading & unloading capacity of truck significantly influences the cost to the vendor. These tipper trucks are used to carry heavy loads especially countries like India where loads are always exceeds the actual load carrying capacity of the vehicle. There is a considerable scope to improve the tipper truck in terms of loads and design optimization. These vehicles should be designed in such a way that it has to carry over load than the design load. Hence, a design study is made in this analysis to check the maximum load carrying capacity of the vehicle keeping minimum factor of safety of the tipper (FOS=2). With this concept maximum load carrying capacity of tipper dump body is modeled and analyzed. The current study analyses the structural behavior of the body for actual loads and maximum loads that a tipper can bare without failure using Finite Element Modeling (FEM). A non-linear analysis is performed to estimate this max loading capacity. The results obtained from FEM are studied and conclusions are derived from this study and suitable loads are suggested.

Keywords - *FOS, FEM, Tipper truck, design optimization, Stress.*

1. INTRODUCTION

The main intention of tipper truck body are handling and carrying the large quantities of materials. Tipper truck body is main part of tipper truck which can be made by different materials like steel, aluminum, carbon epoxy, etc. based on the application like load carrying capacity of the vehicle and purpose of use. We have different variety of tipper truck, it can be used in transport of sand, gravels, ore etc. In tipper truck cargo design, various factor affect based on the field of application. Tipper truck cargo must have strength, less weight, high load carrying capacity, easy to manufacture which in turn save the material, if payload capacity is more we can save time, money and fuel, finally fuel efficiency can be increased. Sankararao Vinjavarapu, Unnam Koteswararao, V. Lakshmi Narayana [1] analyzed The Design Optimization of Tipper Truck Body. N.Nagendra Kumar, B. Jithendra and Malaga. Anil Kumar [2] studied the Optimization of Weight and Stress Reduction of Dump for Automotive Vehicles. Deepesh Garg and Dr. R S Bindu [3] scrutinized the Design Optimization of Truck Body Floor for Heavy Loading. Sitaramanjaneyulu.k, P.Vijaya kumar Raju [4] presented the Modeling and Analysis of Heavy Truck at Variable Loads.

2. RESULTS AND DISCUSSIONS

2.1 Geometry

While designing any vehicle or vehicle body center of gravity plays an important role in balancing the vehicle, especially in turnings or cornering. To have this balance, the center of gravity of the body should be as low as low and near to the center of the vehicle. If this is not possible sufficient possible step need to be taken to minimize the effect of unbalance forces. Geometry of tipper truck body is modeled & is given below.

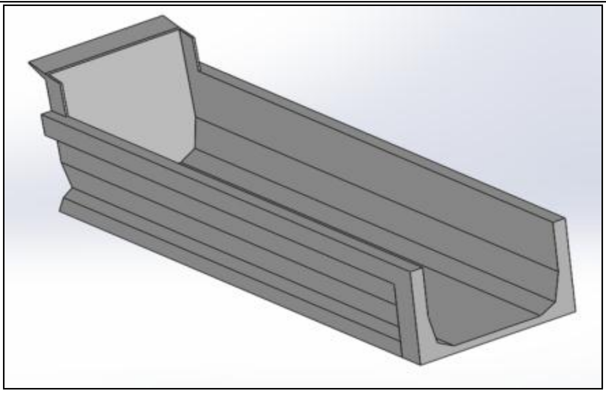

Fig 2.1: Geometry of Body

2.2 Finite Element model

Geometry was imported to ANSYS and the critical regions are identified and these regions are divided to have fine and good quality of the hexahedral mesh. Below shows the meshing of the tipper dump body with hex mesh.

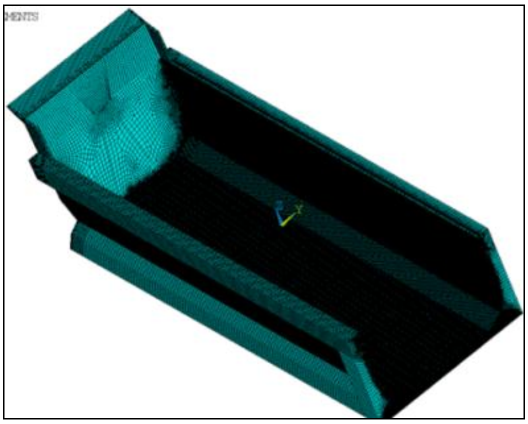

Fig 2.2.1: FE Model

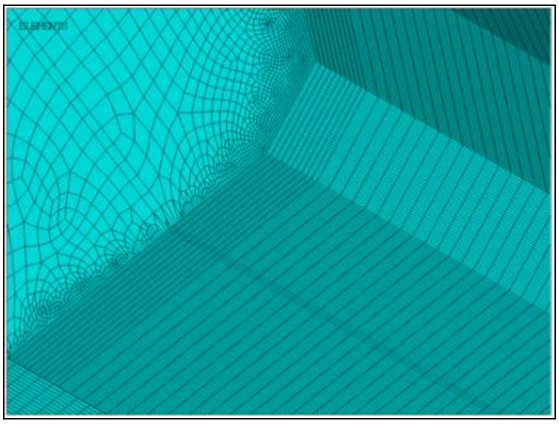

Fig 2.2.2: Zoom in view of Mesh

2.3 Constraints

All the heavy vehicles are mounted on the chassis which is the actual load carriers. These chassis interns mounted on the primary and secondary suspensions. Primary and secondary suspensions will take the load and sudden shock, hence avoiding direct damage to the vehicle. In our analysis, we have not considered the primary and secondary suspensions but the location where the tipper body mounted to the chassis is considered for the constraining purpose i.e. the bottom rectangular channels.

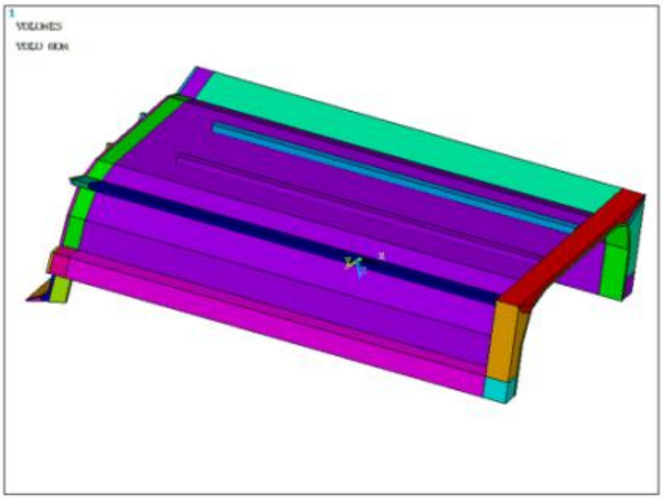

Fig 2.3: Snap showing the Constrained Region.

2.4 Loads

The tipper loads are calculated by the loads that carried by the tipper body hence it will face static forces from the material it carry. The details load distribution is shown in the below figure. The tipper side frame will have different load as compared to the bottom surface, it is due to the effect of gravity that is acting on the body. The load that is acting on the body is assumed to be uniform pressure obtained from the maximum load and is calculated using standard calculation [2].

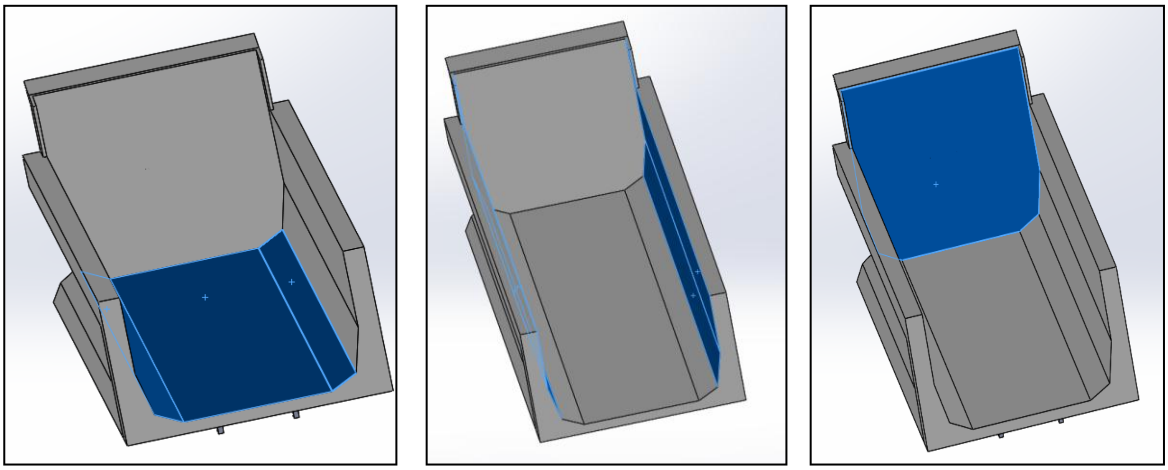

Fig 2.4: Distribution of load for side, end and bottom frame.

Full design load is applied on the bottom sheet, 10% of design load is applied on the side frame and 15% of total design load is applied on the end frame as shown in the fig 2.4.

2.5 Load case-1 "self- weight"

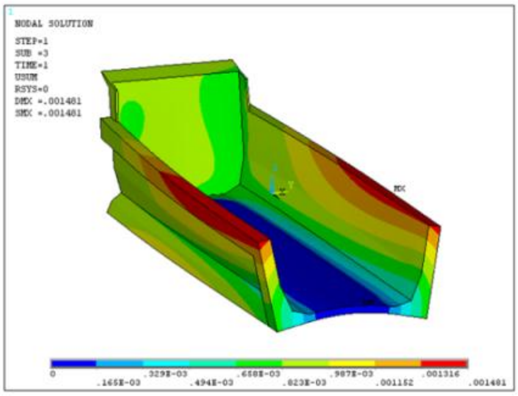

Fig 2.5.1: Deformation plot

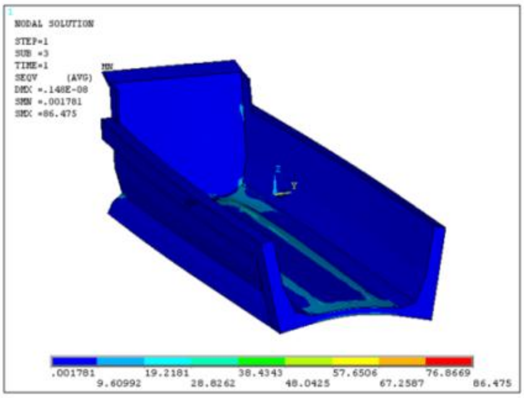

Fig 2.5.2: von-Mises stress plot

2.6 Load case-2: "Design load" (18 tons)

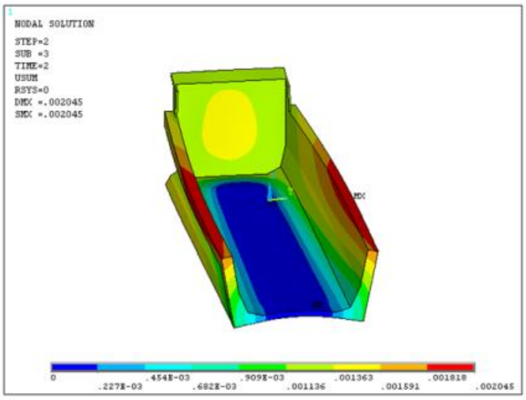

Fig 2.6.1: Deformation plot

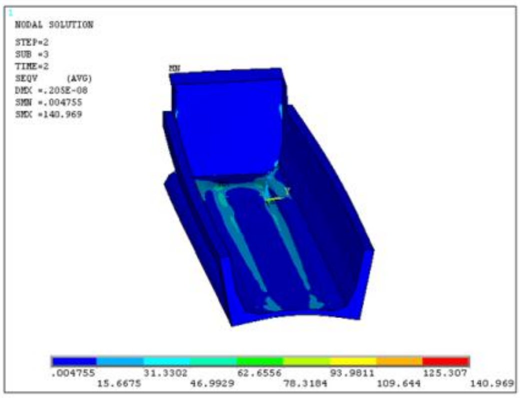

Fig 2.6.2: von-Mises stress plot

2.7 Load case-3 : "Design load" (26 tons)

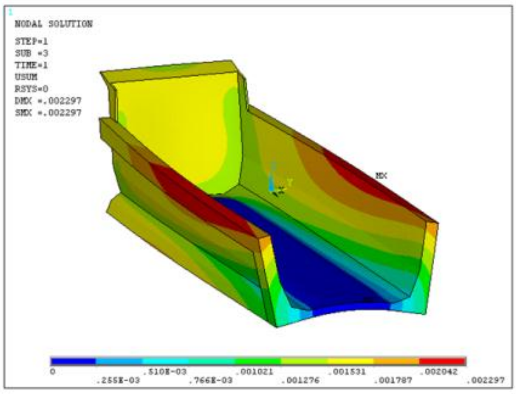

Fig 2.7.1: Deformation plot

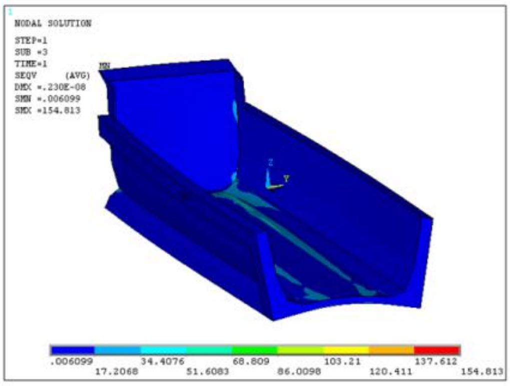

Fig 2.7.2: von-Mises stress plot

2.8 Load case-4: "Design load" (30tons)

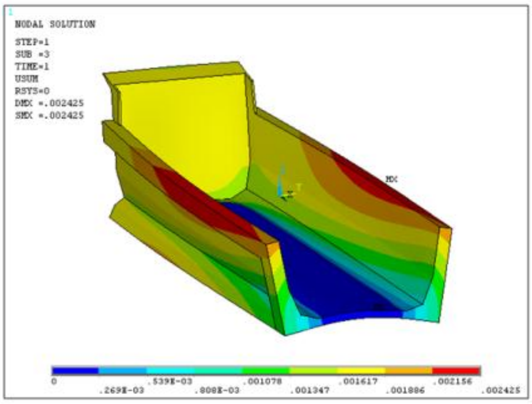

Fig 2.8.1: Deformation plot

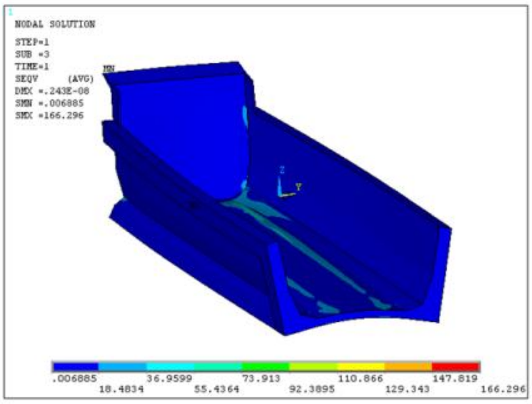

Fig 2.8.2: von-Mises stress plot

2.9 Load case-5 : "Design load" (35 tons)

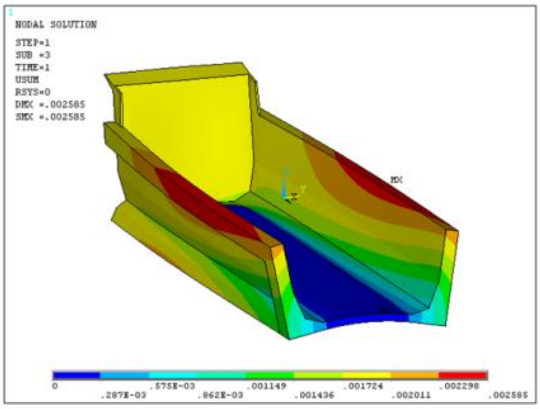

Fig 2.9.1: Deformation plot

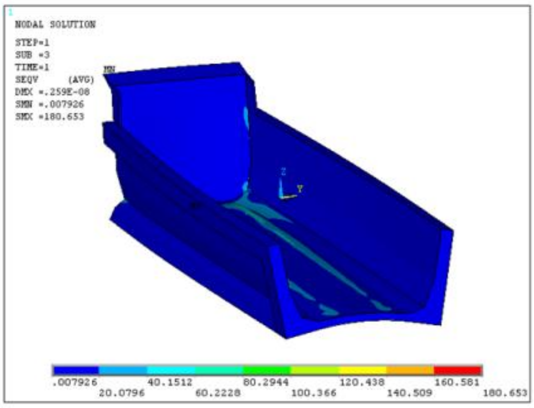

Fig 2.9.2: von-Mises stress plot

3. CONCLUSION

From the FE Analysis on the tipper for all the loads cases actual load carrying capacity of the vehicle is done. The following are the conclusions made from the investigation

- Considering factor of safety of 2, allowable stress=yield/2=355MPa/2=177.5MPa.
- Stress in case "+1g" load condition is less than allowable. So, no failure can happen due to component's own weight.
- Current analysis is performed with "large deformation ON" which can capture all non- linear effects in the component.
- Below is the summary of load cases.

Iteration details	Loads	Deformation (mm)	Max stress (Mpa)	Compare with allowable stress
Load case 1	self-weight	1.5	87	Pass
Load case 2	self-weight +18 tons	2	141	Pass
Load case 3	self-weight +26 tons	2.3	155	Pass
Load case 4	self-weight +30 tons	2.4	166	Pass
Load case 5	self-weight +35 tons	2.58	181	Fail

Table 1: Comparison of loads, deformation and von-Mises stress values of all the load cases.

Even though, component is designed for 18 ton, but it can be used up to 30 ton. This is quite suitable for Indian road operating conditions where overloading is quite usual.

REFERENCES

1. Sankararao Vinjavarapu, Unnam Koteswararao, V. Lakshmi Narayana, '*The Design Optimization of Tipper Truck Body*'.
2. N.Nagendra Kumar, B. Jithendra and Malaga. Anil Kumar, *'The Optimization of Weight and Stress Reduction of Dump for Automotive Vehicles*', ijerd.
3. Deepesh Garg and Dr. R S Bindu, '*The Design Optimization of Truck Body Floor for Heavy Loading. Generally for dumping and carrying, tipper trucks are used*'.
4. Sitaramanjaneyulu.k, P.Vijaya kumar Raju, '*The Modeling and Analysis of Heavy Truck at Variable Loads'.*
5. *S. Timosenko, 'Theory of plates and shells*'.