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Design and Analysis of Dumped Body

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Abstract - The power driven three-wheeled road vehicles, typically used in Indian on a large scale, are important part of transportation system in major cities and also becoming increasingly popular in smaller towns. Some of these are designed for commercial use with little engineering consideration and are marked as product in great demand. The next two decades are likely to witness a sharp rise in the use of three-wheelers. The main compelling reasons for this are scarcity of energy resources and space. This paper analyses the static behavior of the body using Finite Element Modeling (FEM). The results obtained from FEM were studied and are compared with those of rigid body modeling. Conclusions were derived from the study and some suggestions are made to improve the performance of vehicle.

Keywords: *Dumped Body, Cast iron, Aluminum, FEA, ANSYS*

I. INTRODUCTION

With the growing fuel costs, significant pressure has been put on automotive industries to develop more fuel-efficient passenger vehicles. Due to safety, emissions and economy requirements, automotive transportations will be undergoing vast changes in the next few decades.

Obviously, the automobile will become smaller and lighter in the search for the better fuel efficiency. As a result, the designs based on three-wheeled motor vehicles are likely to be the most popular made of public transport not only in India but in other countries as well.

A three-wheeler is essentially a motion disturbance vibrating system with the ground providing input. The tyres which are in contact with the ground, convert this input displacement into a forcing function which acts on the unsprung masses, these masses are constrained by linkages so that they follow certain paths. Springs and dampers which are the coupling between unsprung mass (vehicles body) transform this forcing function and transmit the resultant force to a sprung mass .

The sprung mass being a rigid body its response to the acting forces is decided by its physical properties (i.e., moment of inertia, mass, centre of mass location etc). Summarizing the ride response, it is dependent on the ground profile, tyre and suspension characteristics, physical dimensions and the vehicle. Fig.1 shows the basic components of terrain vehicle simulation model.

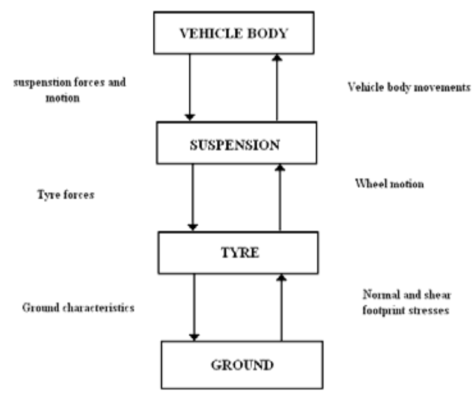

Figure 1 Terrain Vehicle Simulation Model

The advantages of three-wheeled motor vehicles is a three wheel chassis is inherently lighter because it does not have to resist one-wheel bump twisting loads as compared with four-wheels. A three-wheel vehicle allows a more efficient aerodynamics enclosure in that either the front or rear may be tapered more gradually.

In mass production, a three-wheeler is less expensive because of the elimination of the redundant wheel, tyre, brake and suspension components and reduced assembly time.

II. RELATED WORK

Curtis. F. Vail [3] illustrates the use of F. E. methods for modeling automatic structure for their static characteristics. The results obtained using F.E. Computer models were within 105 of test results. Data reparation typical F.E. Model, outline of the analysis and the display of the data in movie from is covered.

Hutton, David. [5] Illustrates the coarse and refined idealizations of the structure were analyzed by considering the effect of manufacturing tolerances. Stresses were predicated under bending and torsion loads.

Kiyoshi Miki, [7] present the outline of a theoretical analysis of bending and tensional vibrations of bodies. Body structure is stimulated by a frame work with tension rigs and additional panel stiffness. The frame work is a 3-D model for the bending and torsion vibration, or 2-D for the bending vibration, and is analyzed by the lumped mass system. All input data are calculated from drawings, and therefore characteri9stics of body structure are forecast and controlled in the design process. The analysis is also applicable to coupled vibration and forced vibration problems.

Mauritz Coetzee [8] presents an innovative Aluminum design gives a truck-body manufacturer the competitive edge in the world wide construction industry. Developing these structures is an engineering challenge, however, since body strength must be maintained with Aluminum material, which has different properties than steel; the amount of material must be minimized as much as possible for further reduction in weight and cost; and there is the additional desire to get new design released quickly without numerous physical prototype testing cycles.

Willy Peterson, Ford Motor Co., [4] reviews the recent developments in the partial application of The Finite Element Method for Automotive body Structural Analysis. He developed a computer program, structural analysis and matrix interpretive system (SAMIS), which provides the final result within 5% errors by considering the “Joint Efficiency” of an automobile structure.

III. ANALYSIS OF DUMPED BODY

In case of load bodies not made by OEM or as per OEM designs, the mounting arrangement for the load body or platforms shall be as per recommendations provided by the vehicle manufactures. Details of recommended practices for load body mounting including list of approved parts to be provided by vehicle manufacturer. OE developed and type approved designs may be used by local builders.

In constructing the body or load platform, all practicable steps shall be taken to keep the centre of gravity of the vehicle as low as possible. The construction of the body or load platform shall be such as not to impair the soundness and functioning of the wiring and braking circuits. The load body shall be constructed over a sub-frame to distribute the load evenly on the chassis frame and also to create gap between body and tyre / chassis for wheel articulation.

The material used for sub-frame construction shall be steel or aluminum alloy or any composite material with adequate strength to bear impact loads.

The floor, head board (also called crash guard or front wall) and a side wall is the main load bearing elements of the body. The side walls and crash guard shall be constructed to bear a part of load carried on the vehicle in case of barking, turning, travel on slopes etc. as given below, which can also be proved by FEM analysis.

- **Side walls :** 15% of load carried
- **Bottom or Platform :** 100% of load carried
- **Heard board :** 15% of load carried

By taking the above consideration into account, the diagram of the tipper body is shown below:

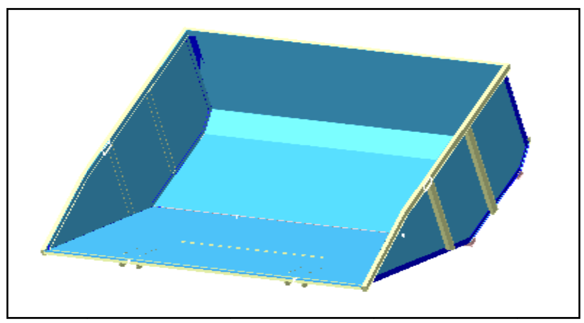

Figure 2 Model of a Dumped Body

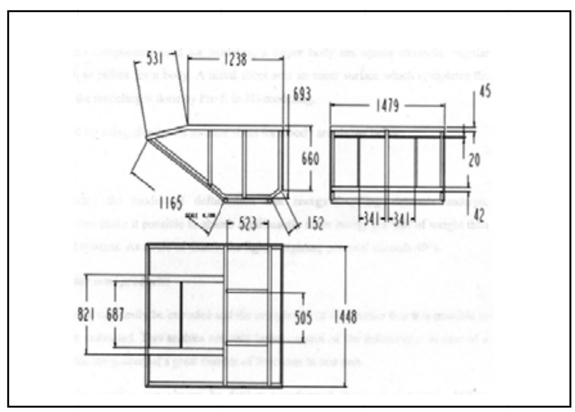

Figure 3 Dimensions of Dumped Body

The main components used for modeling a tipper body are square channels, angular channels which as pillars for a body.

A metal sheet acts an inner surface which completes the total body. All the modeling is done by Pro-E in 3D-modeling.

Lightness:

Considering the modes of deformation that energy-absorbing elements undergo, Aluminium systems make it possible to absorb significantly more energy per unit of weight than traditional steel systems. As a rule of thumb, the light-weighting potential exceeds 40%

High added value semi-products:

Aluminium can easily be extruded and the complexity of the profiles that it is possible to obtain is almost unlimited. This enables not only better control of the deformation in case of a crash, but also the integration of a great number of functions in one part.

If necessary, the profiles can always be further transformed (bending, stamping, drilling etc). Depending on production volume, solutions containing sheets, castings or forged products can also be used.

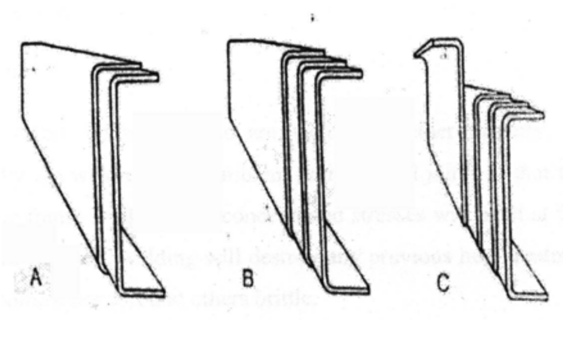

Figure 4 Frame Rail Arrangement

Diversity of alloys and treatments:

Depending on technical and economical constrains, a broad range of alloys and heat treatments allow designers to optimize their product. The most frequently used alloys are Aluminium-Magnesium-Silicon (series6000) and Aluminium-Zinc (series7000).

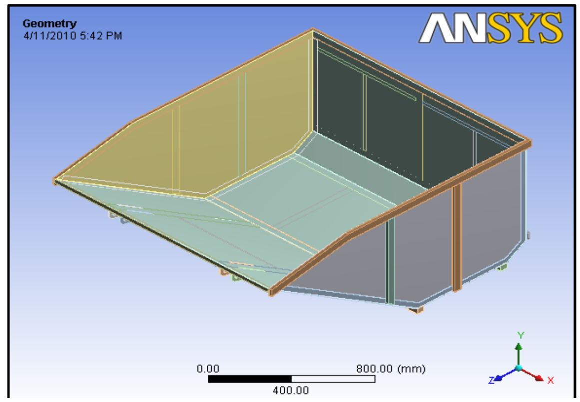

Figure 5 Geometry of Dumped body

This avoids the deformation of the car's structure during typical city accidents and facilitates repairs.

Table 1 Material Specification

Material Specifications	
Material used for construction	Mild steel, Aluminium alloys
Volume capacity	1.2543e+007 mm³
Weight of dump body	63.306 kg
Height of dump body	780 mm
Length of dump body	1769 mm
Pay load capacity	800 kg
Thickness of base sheet	3 mm
Thickness of side board	3 mm
Thickness of head board	3 mm
Nodes	87052
Elements	44235
Analysis type	3-D

Table 2 Element Statistics

Method	Tetrahedrons
Element size	100
Nodes	87052
Elements	44235

V. RESULTS AND DISCUSSIONS

The analysis type determines the results available for you to examine after solution. For example, in a structural analysis, you may be interested in equivalent stress results or maximum shear results, while in a thermal analysis, you interested in temperature or total heat flux.

The Result Types section lists various results available to you for post-processing. The body designed is found to be good less than 1 ton payload, but loading on truck just does not depends on the strength of the body, it depends on several other factors like engine power and number of tyres etc .

In real time the failure of the body due to overloading is very rare to see but in overloading condition suspensions failure take place, so the vehicle is not overloaded mainly owing to the failure of suspension. The strength of suspension is equally important as the strength of the body. By increasing the load of the vehicle, we can increase the loading capacity. By increasing the cylinder volume, we can increase the efficiency of the vehicle as a result of which the weight of the body can be increased.

As the shape and size of the body is smaller when compared to trucks, it can easily pass by narrow roads in the traffic. Even with the application of Aluminium in the fabrication of the dump body deformation takes place.

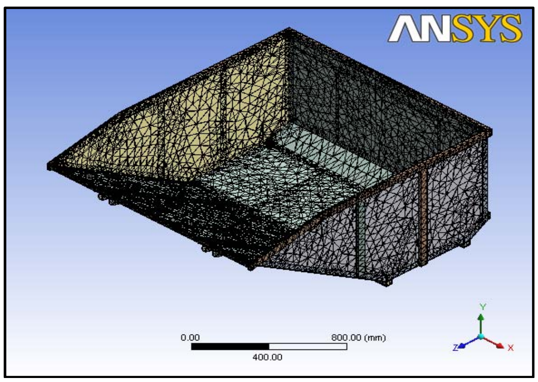

Figure 6 (A) Meshing of Dumped body

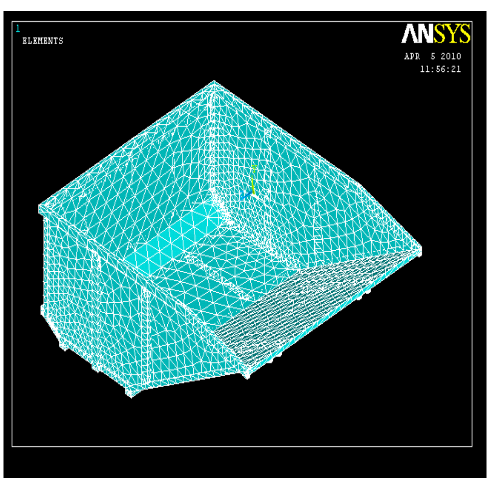

Figure 6 (B) Meshing of lumped body

This can be overcome with the use of Aluminium alloys instead of Aluminium. The strength of dump body can be improved by increasing the thickness of the sheet employed in its fabrication.

Since the total analysis is done in the static conditions, basing on these results we can follow for dynamic analysis where the vehicle is not stationary.

The deformation is minimum in base column and maximum in head board. Which are analyses independent of the time, when is in fixed position.

Table 3 Automatic Mesh Loop Analysis

Type	Total Deformation	Equivalent Stress	Maximum Shear Stress	Stress Intensity
Min	0 mm	3.131e-003 Mpa	1.8027e-003 Mpa	3.6055e-003 Mpa
Max	5.5455 mm	86.975 Mpa	44.507 Mpa	89.013 Mpa

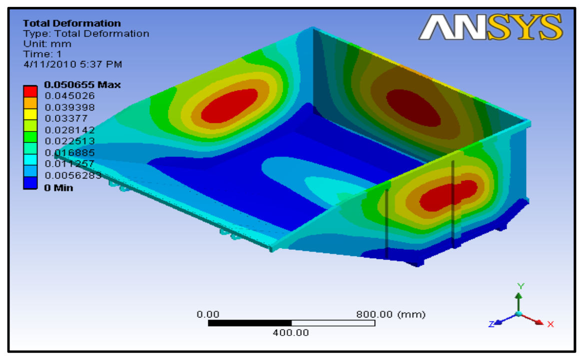

Figure 7 Total deformation of a dumped body

Table 4 Tetrahedron Meshing

Type	Total Deformation	Equivalent Stress	Maximum Shear Stress	Stress Intensity
Min	0 mm	9.4496e-004 Mpa	5.3716e-004 Mpa	1.0743e-003 Mpa
Max	0.080283 mm	10.69 Mpa	5.65 Mpa	11.3 Mpa

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