DESIGN AND ANALYSIS OF THREE WHEELER AUTO DUMPED BODY

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***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. In many city municipalities garbage is handled by rickshaws, tractors and Lorries. Garbage trucks are not passing into a small street due to bulk in size and there is no unloading facility in rickshaws. For that a small capacity body with the required space for travelling on streets and capable of handle approximately 1 ton of garbage. Reducing weight and stress reduction the optimized model of tipper dump body is modeled and analyzed. The designed three wheeled dump bodies with and without side ribs has been analyzed for stress using the finite element modeling (FEM) in addition to payload weight of garbage has being considered to reduce fuel consumption cost of manufacturing three types of materials are used Mild steel, Aluminum and Stainless steel. Model analysis also performed to find the frequencies to the mode shapes by applying boundary conditions. With the optimized parameters, optimized Model is developed and analyzed, stress analysis is carried out and the results are obtained. After analyzing best body is found.

Keywords: Dumped body, Mild steel, payload, Aluminum, Stainless steel, ANSYS.

1.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 better fuel efficiency. As a result, the designs based on three-wheeled motor vehicles are likely to be the most popular mode of public and private transport not only in India but in other countries as well. Three wheelers also have the advantage of being the compromise between two wheeled and four wheeled vehicles in various aspects like cost, load carrying capacity, fuel consumption, space occupied, weight etc.

Three wheeled vehicles is best suited for travel in narrow streets and total weight of the vehicle is less as compared with garbage trucks and which can also suited for handling the different type of materials. Which having less space occupied and handle at least 750 Kg of material. If we arranged hydraulic seal system to three wheeled vehicles the dump body can easily tilt to rear and height of the body is also less as compared to other trucks while tilting operation. One body with suitable shape to unloading the garbage and avoid corrosion properties while handling wet garbage. It is better to provide the drain system to minimize the foul smell coming from the garbage during loading and unloading conditions. Such body is mounted on a three wheeler vehicle. It should be a convent for loading and unloading the garbage. The cost of transport is less compared to heavy dump body and it is moving faster than rickshaw. In a short time more area will be covered firm, collected and unloading the garbage.

1.1. Problem Definition

Garbage is increasing day by day. To reduce the garbage in city areas, industries are manufacturing the different type of truck bodies like garbage Lorries, Tractors etc. Manual interference is needed for loading and unloading the garbage from above specified truck bodies. These truck bodies are not suitable to transport in narrow streets or small, place streets due to it having a bulk in size. These truck bodies are having large fuel consumption due to the heavy weight of the truck. These bodies are easily failure due to corrosion properties. While the material contact with the wet garbage. Cost is also high for the heavier bodies. The main purpose of this work is to design a dumped body which is used for dumping the wastage from one place to the dumping region.

2. DESIGN OF THREE WHEELED AUTO DUMP BODY

The General requirements to design the body

• Overall dimensions: The overall dimensions of the load body shall comply be as per recommendations provided by the vehicle manufacturers.

• The capacity of the Auto Remover is 1.0 cubic meters
• The dumping height from the ground is 1000 mm
• The width of the dumping body is 1448 mm
• The length of the dumping body is 1762.9 mm

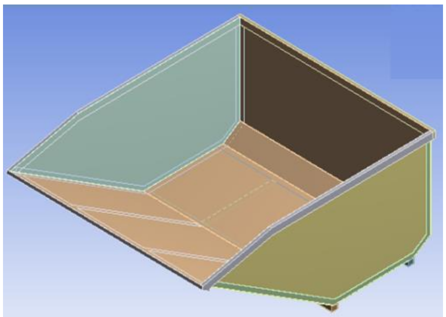

Fig.1.1: Dumped body with out side ribs

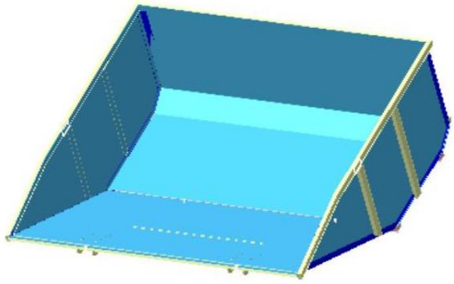

Fig.1.2: Dumped body with side ribs

Figure 1: Model of the dump body

- Side walls: 15 % of load carried
- Crash guard or head board: 15 % of load carried
- Rear wall or tail gate: 15% of load carried
- Bottom or platform: 100% of load carried

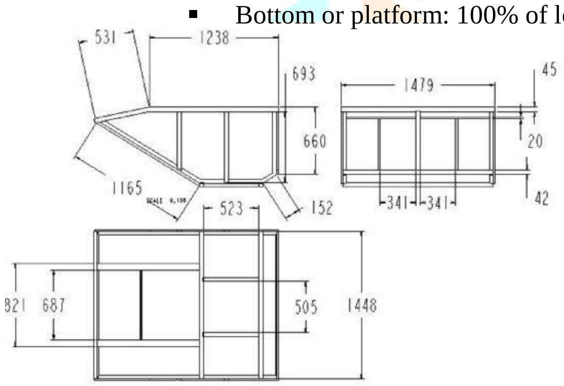

Figure 2: Dimensions of dumped body

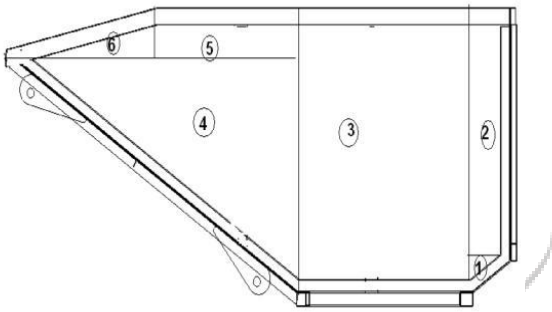

Figure 3: Volumes of dumped body

Volume of Three Wheeled Dump Body:

Figure 3 represents the total volume of the body divided into 6 numbers of volumes
Volume 1 is the triangle
Volume 1 = ½ X 35.1X 117 X1447.8 = 2972840.13 X 10-9 = 2.99 X10-3 m3
Volume 2 is the rectangle
Volume 2 = 661.4 X 35.1 X 1447.8 = 33610879.7 X 10-9 = 0.0336 m3
Volume 3 is the rectangle
Volume 3 = 623.4 X 740.76 X 1447.8 = 668579249.3 X 10-9 = 0.6685 m3
Volume 4 is the triangle
Volume 4 = ½ X 989.33 X631.26 X 1447.8 = 452093253.6 X 10-9 = 0.452 m3
Volume 5 is the triangle
Volume 5 = 459.38 X109.501 X1447.8 = 72828059.95 X 10-9 = 0.0728 m3
Volume 6 is the triangle
Volume 6 = ½ X 520.95 X109.501 X1447.8 = 41294546.81 X 10-9 = 0.04129 m3
Total volume of the body = 2.99 X 10-3 + 0.0336 + 0.6685 + 0.452 +0.0728+0.0412 = 1.27 m3
Total volume of the body = 1.27109 m3

3. STRUCTURAL ANALYSIS OF THREE WHEELED DUMP BODY

Table 1: Type of Material Properties

MATERIAL USED	YOUNGS MODULUS (MPa)	POISSION'S RATIO	DENSITY Kg/mm^3

MILD STEEL	2.1e+005	0.25	7.85e-006
ALUMINIUM	71000	0.33	2.77e-006
STAINLESS STEEL	190000	0.265	7.6e-006

3.1. Apply mesh controls

Figure 5 represents the meshing of the given dump body is done with the tetrahedron element type of mesh, table 3 shows finite element details of tetrahedron in different methods [6]. The element is defined by 10 nodes having three degrees of freedom at each node: translations in the nodal x, y, and z directions. The element has plasticity, hyper elasticity, creep, stress stiffening, large deflection, and large strain capabilities. It also has the mixed formulation capability for simulating deformations of nearly incompressible elastic-plastic materials, and fully incompressible hyper elastic materials.

Table 2: Finite Element Details

PARAMETERS	DUMPED BODY WITH SIDE RIBS	DUMPED BODY WITH OUT SIDE RIBS
Element type	**Tetrahedron**	**Tetrahedron**
Element size	**50**	**50**
Nodes	**48488**	**42651**
Elements	**22026**	**21602**

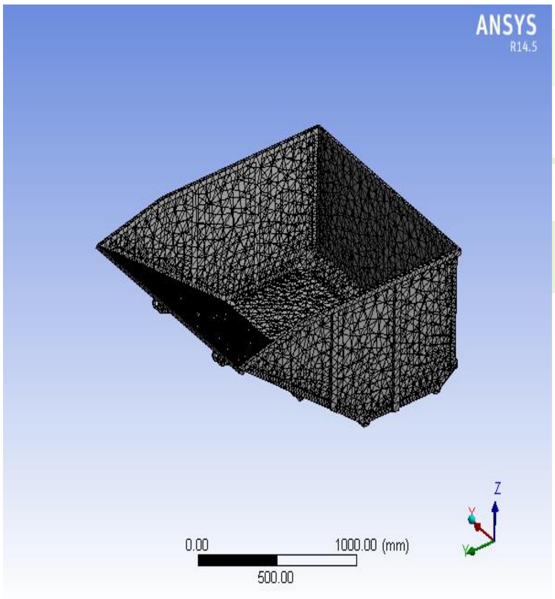

Figure 4: Meshing of the dump y body

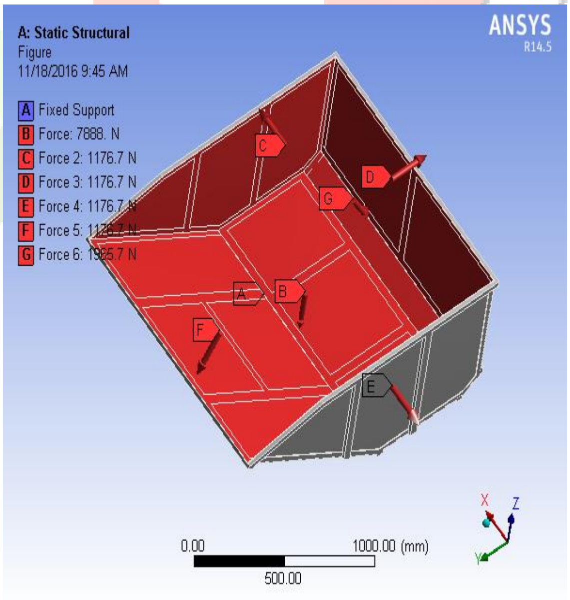

Figure 5: Various Forces acting on the dump body

3.2. Loading conditions

Figure 5 represents the following loads and load combinations are considered for analysis

Total weight at bottom (platform) = total mass of material used X acceleration due to gravity
=800 x 9.8066
=7888N

Total weight applied to side wall& rear inclined plate = 15% of the total mass of material used x Acceleration due to gravity
=0.15 x 800x 9.8066
=1176.7 N

Total weight applied to chamfer = 800x9.8066x(0.217/0.866)

=1965.7N

4. Results and discussions

To minimize induced stresses in body deformation, material properties are changed and applied to the modified body. As per material properties dumped bodies divided into three type's and basic model, totally four dumped bodies has been analyzed mild steel body (basic model, modified model), aluminum body and stainless steel body.

4.1 Deformation results for actual and modified dumped bodies

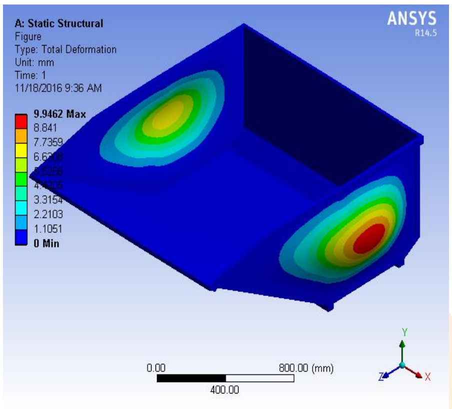

Figure 6: Total deformation for mild steel body (Actual model)

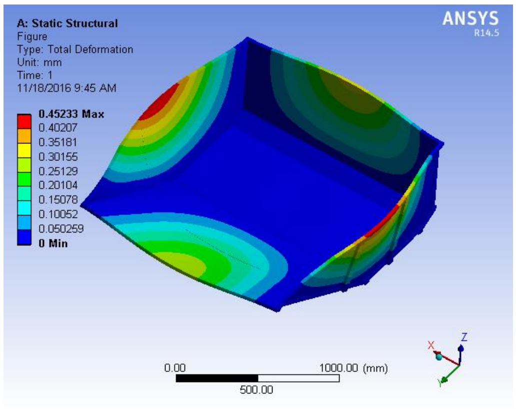

Figure 7: Total deformation for mild steel body (Modified model)

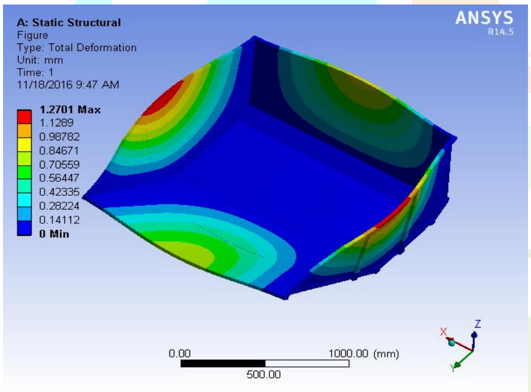

Figure 8: Total deformation for aluminum body

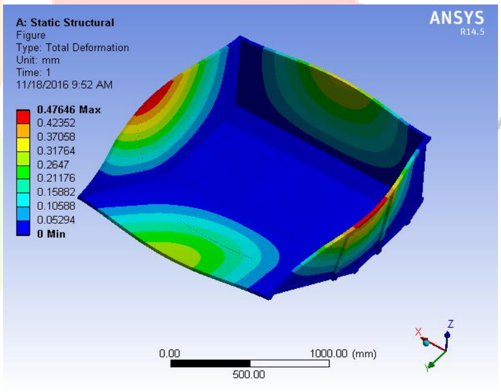

Figure 9: Total deformation for stainless steel body

The figure represents the deformation of the body using Workbench ANSYS software. Here the deformation of the mild steel (actual body) occurs which is a maximum of 9.98 mm, which is very high when compared to all the modified dump bodies. In modified model, the maximum deformation occurs in aluminum dumped body but which is within allowable deformation limits. Minimum for mild steel dumped body this is also within allowable deformation limits.

4.2 Stress intensity results for actual and modified dumped bodies

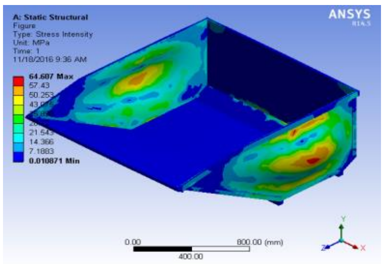

Fig.10: Stress intensity of mild steel body (actual model)

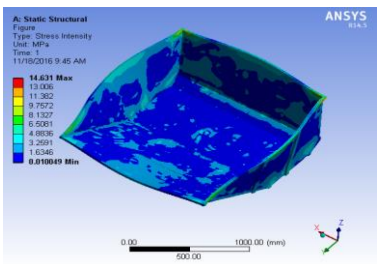

Fig.11: Stress intensity of mild steel body (modified model)

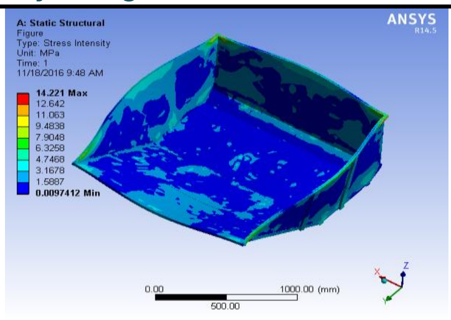

Fig.12: Stress intensity of aluminum body

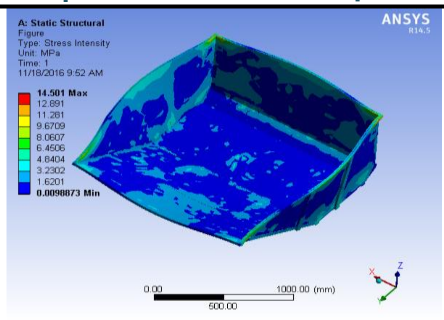

Fig.13: Stress intensity of stainless steel body

The figure represents the stress intensity results of the body using Workbench ANSYS software. Here the stress intensity of the mild steel (actual body) occurs which is a maximum of 64.607 MPa, which is very high when compared to all the modified dump bodies. In modified model, the maximum stress intensity occurs in mild steel dumped body but which is within allowable deformation limits. Minimum for aluminum dumped body this is also within allowable stress limits.

Random vibration analysis

This analysis enables you to determine the response of structures to vibration loads that are random in nature. Loads such as the acceleration caused by the pavement roughness are not deterministic. Hence it is not possible to predict precisely the value of the load at a point in its time history. Such load histories, however, can be characterized statistically (mean, root mean square, standard deviation). Also random loads are non-periodic and contain a multitude of frequencies. The frequency content of the time history (spectrum) is captured along with the statistics and used as the load in the random vibration analysis. This spectrum, for historical reasons, is called Power Spectral Density or PSD.. This analysis is based on the mode-superposition method. Hence a modal analysis that extracts the natural frequencies and mode shapes is a prerequisite. This feature covers one type of PSD excitation only- base excitation. The base excitation is applied in the specified direction to all entities that have a Fixed Support boundary condition. In a random vibration analysis since the input excitations are statistical in nature, so are the output responses such as displacements, stresses, and so on.

Table 3: Results comparison of random vibration analysis

PARAMETERS	Mild Steel (Actual model)	Mild Steel (Modified model)	Stainless steel (Modified model)	Aluminum (Modified model)
EQUIVALENT STRESS	66.5471	57.803	57.336	20.134
NORMAL STRESS	72.99	33.1	33.083	11.7
DIRECTIONAL DEFORMATION(X)	0.262	1.1339	0.2047	1.163
DIRECTIONAL DEFORMATION(Y)	0.726	1.3681	1.4511	1.402
DIRECTIONAL DEFORMATION(Z)	0.918	2.1902	2.326	2.2434
SHEAR STRESS	14.94	6.2844	6.263	2.222

The table represents the random vibration analysis results of the body using Workbench ANSYS software. Here the equivalent stress of the mild steel (actual body) occurs which is a maximum of 66.547 MPa, which is very high when compared to all the modified dump bodies. In modified models, the minimum equivalent stress, shear stress occurs in aluminum dumped body.

5. CONCLUSIONS

The three wheeled auto dumped body is designed by considering various parameters like internal load acts on the body, vibration forces and corrosion resistance etc. The total assembly model is performed in CATIA V5 software. Analysis is done by ANSYS Workbench. The actual and modified designed bodies were imported to ANSYS WORKBENCH through IGES file by changing material properties of a modified wheeled dumped body three types of analysis are performed to find a required body.

The actual mild steel body has been analyzed and obtains finite element results which are very high compared to the modified dumped body. The modified mild steel dumped body results are within the design limit but it is not suitable for the wet garbage due to easily effected by corrosion. Aluminum and stainless steel are taken as the second and third materials and it can be analyzed in finite element results are within the design limit but the total cost of manufacturing is high. Since the total analysis is done in static conditions and model analysis also performed to find the frequencies to the mode shapes by applying boundary conditions.

The finite element results within the desired limits as per capacity of loading, cost of manufacturing and corrosion resistant. The final body is chosen as the best body for dry and wet garbage purpose.

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