Design & CAD Simulation of Right Side Dropping Dumper (for Small Vehicle)

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Abstract— In this research work an improved way of unloading material from dumper is design. Conventional Dumper unloads material only at back side of dumper which may cause problem of road blockage in limited space area. The right side dropping dumper overcomes problem of unloading the material by using hydraulic cylinder. Modern right side dropping dumper has been conceived by observing difficulty in unloading the material. Hence suitable arrangement has been designed for small vehicle (TATA ace). The vehicles can be unloading material from right side. The concept leads to efficient working.
Key words: Dumper, dropping side, right side dropping

I. Introduction

A dumper is a vehicle designed for carrying bulk material, often on building sites. Dumpers are distinguished from dump trucks by configuration: a dumper is usually an open 4-wheeled vehicle with the load skip in front of the driver, while a dump truck has its cab in front of the load. The skip can tip to dump the load; this is where the name "dumper" comes from. They are normally diesel powered. A towing eye is fitted for secondary use as a site tractor. Dumpers with rubber tracks are used in special circumstances and are popular in some countries.

Early dumpers had a payload of about a ton and were 2-wheel drive, driving on the front axle and steered at the back wheels. The single cylinder diesel engine (sometimes made by Lister) was started by hand cranking.

The steering wheel turned the back wheels, not front. Having neither electrics nor hydraulics there was not much to go wrong. The skip was secured by a catch by the driver's feet. When the catch is released, the skip tips under the weight of its contents at pivot point below, and after being emptied is raised by hand.

Modern dumpers have payloads of up to 10000kg and usually steer by articulating at the middle of the chassis. A dumper is an integral part of any construction work and hence its role is important for completion of any constructional site. One of the problem are cited with dumper in the time and energy for setting the huge dumper in the proper direction to dump the material it in carrying and hence the need of the project work riser which is about Design & CAD simulation of Right Side Dropping Dumper.

II. Literature review

A. Design and Development Of 3-Way Dropping Dumper, Www.Ijetae.Com (ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 4, Issue 9, September 2014):

A small scale model has developed using light weight material i.e. plastic and hydraulically operated piston and cylinder arrangement. This hydraulic arrangement actuates on motor driven which makes the prototype semi-automatic. The trolley piston gets out and makes the trolley to tilt by operating various cylinders; the material can be dropped in 3 ways. Limitation- Increased complexity: It requires complex mechanism for getting desired

B. Development of Three Axes Lifting Modern Trailer, Volume I, Issue 5, May 2015 (Issn: 2394 – 6598)

In this work the trailer is pulled up in three axis. The working principle of hydraulic cylinder used in this modern trailer. For the trailer action we are using hydraulic as a source. The 3/2 direction control valve is used to control the direction of the hydraulic. When the inlet port is open the hydraulic is pumped from the sump using hydraulic pump. The trailer is now pushed upward in the "Y" axis direction and the outlet port is activated now, then the trailer was pushdown in Y axis direction. Now the knee joint of the trailer is removed for trailer action in „Z" axis. Then again the inlet port is open. The trailer is now pushed upward in the "Z" axis direction and the outlet port is activated now, then the trailer was pushdown in „Z" axis. Again the knee joint is removed for the trailer action in „X" axis. Then again the inlet port is open. The trailer is now pushed upward in the "X" axis direction and the outlet port is activated now, then the trailer was pushdown in „X" axis. we can dispatch the load in three axis in the trailer by using the universal joint in the hydraulic cylinder.

C. Design and Fabrication of Unidirectional Dumper, International Journal for Scientific Research & Development| Vol. 3, Issue 02, 2015 | ISSN (Online): 2321-061.

An operating system consists of electric motor, worm & worm gear mechanism to rotate the dumper horizontally in required direction. Two Chassis (Frame) is provided on which trolley is mounted, where first frame of chassis is stationary & attached to the worm & worm gear to rotate the trolley horizontally in required direction.

Second frame of chassis consists, one end of Pneumatic cylinder which is hinged with this frame of chassis and other end of pneumatic cylinder is also hinged but to the one end of trolley to give vertical movement

Limitations:

Increased Complexity: As, it requires complex mechanism to get desired output.

Cost Increases. As more will be the complications to perform the operation, more will be the cost encountered with it.

Maintenance Increases: More parts in working leads to more maintenance.

III. Identified gaps in the literature

Problem and drawbacks of existing Dumpers

Fig. 1:

1) Collisions:
Dump trucks are normally built for some amount of road or construction site driving; as the driver is protected by the chassis and height of the driver's seat, bumpers are either placed high or omitted for added ground clearance. The disadvantage is that in a collision with a standard car, the entire motor section or luggage compartment goes under the truck. Thus the passengers in the car could be more severely injured than would be common in a collision with another car.
2) Tipping:
Another safety consideration is the leveling of the truck before unloading. If the truck is not parked on relatively horizontal ground, the sudden change of weight and balance due to lifting of the skip and dumping of the material can cause the truck to slide, or even—in some light dump trucks—to turn over.
3) Back-up accidents:
Because of their size and the difficulty of maintaining visual contact with on-foot workers, dump trucks in car parks can be a threat, especially when backing up. Mirrors and back-up alarms provide some level of protection, and having a spotter working with the driver also decreases back-up injuries and fatalities.
4) Working condition:
Because of constructional side road limitation, it is difficult to drop material at proper location

IV. PROBLEM FORMULATION

Conventional dumper mechanism unload materials only at the backside of the dumper using hydraulically operated cylinder which may cause the problems of road blockage in the limited space area. The problem of dropping material are cited with dumper in the time and energy for setting the huge dumper in the proper direction to dump the material it in carrying and hence the need of the project work riser which is about Right side dropping dumper which can dump the material in side direction except the back one. The main objective of this project work is to improve dropping side. So here right side is selected instead of any side because in Indian vehicle driver seat is located in right side so it is very easy to see obstacles in dropping side.

V. PROJECT OBJECTIVE

- Design of conceptual trolley & system for Tata Ace which would help in unloading material with much easy.
- Design & selection of hydraulic cylinder.
- Design of pins for hydraulic cylinder.
- Design of pins for Trolley.
- Analysis of trolley by using Ansys.

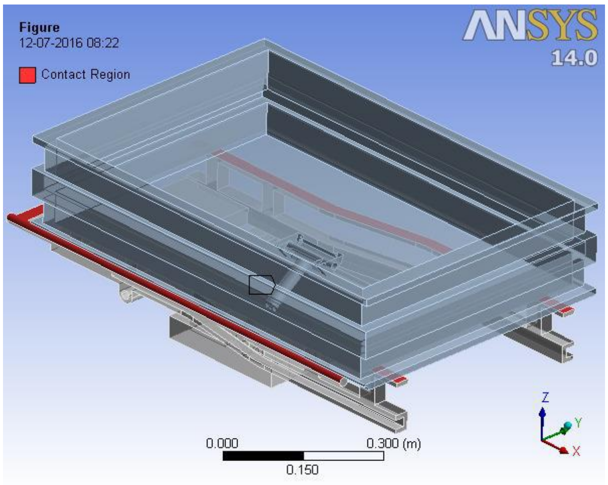


Fig. 2: Conceptual set-up

VI. CALCULATIONS

Selection of Hydraulic Cylinder for Right Side Dropping
Trolley Data -
Trolley width = 1430 mm
Trolley Length = 2140 mm
Trolley height/Depth = 290 mm
Pay Load on Trolley = 1000 Kg
Trolley self weight =144.92 Kg
Capacity for design considering overloading =1500 Kg
Standard components calculation and selection

A. Calculation for Stroke Length Of Hydraulic Cylinder

Stroke Length (L) = Sin (45˚) x (1430/2)
= 505.58 mm

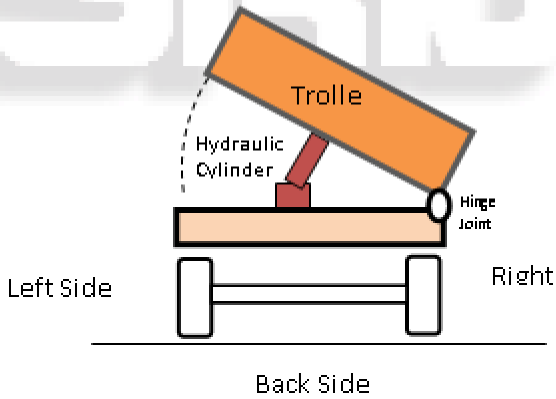


Fig. 3: Tilting diagram

B. Calculation for Hydraulic Cylinder Bore Diameter

Considering maximum working pressure 3000 Psi (20.68 N/mm^2) due to limitation of many hydraulic valve.

$$P = \frac{F}{A}$$

$$20.68 = \frac{(1500+144.92) X\ 9.81}{\frac{\pi}{4} X d^2}$$

$$20.68 = \frac{16136.66}{\frac{\pi}{4} X d^2}$$

d =31.52 mm

Selecting d=40mm from hydraulic cylinder catalogue of SMC.

C. Exact Working Pressure

$$P = \frac{F}{A}$$

$P = \frac{16136.66}{\frac{\pi}{4} X (40)^2}$

$P = 12.84 \cong 13$ N/ mm^2.

D. Calculation for Volume Flow of Oil:

Assuming maximum evacuation time of 2 min in which complete hydraulic cylinder operate to its maximum stroke.

$\text{Speed} = \frac{\text{Maximum Stroke of hydraulic cylinder}}{\text{Maximum evacuation time}}$

$= \frac{505.58}{2}$

$= 252.79$ mm/min

Flow quantity

Q = A X V

$Q = \frac{\pi}{4} X (40)^2 X\ 252.79$

$Q = 317.66 \text{ X } 10^3$ mm^3/min.

E. Design of Pin for Hydraulic Cylinder:

Considering En8 / C 40 (cold drawn) material for pin

Ultimate tensile strength = 670 Mpa. [from IS 1570 (part 2 / sec 1)]

Bending Stress

$$\sigma_b = \frac{M}{Z_{XX}}$$

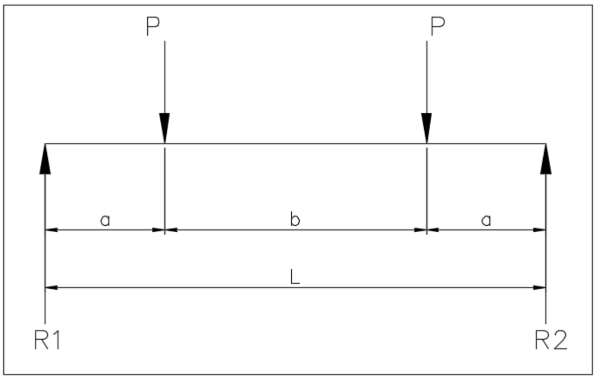


Fig. 4: Force diagram

M = w x a

M = 16136.66 X 8

M = 129093.28 N.mm

Moment of inertia (Ixx) calculation

$I_{XX} = \frac{\pi}{64} X d^4$

$I_{XX} = \frac{\pi}{64} X (16)^4$

$I_{XX} = 3216.99$ mm^4

Section modulus (Zxx) calculation

$Z_{XX} = \frac{\pi}{32} X d^3$

$Z_{XX} = \frac{\pi}{32} X (16)^3$

$Z_{XX} = 402.12$ mm^3

F. Bending Stress Calculation:

$$\sigma_b = \frac{M}{Z_{XX}}$$

$$\sigma_b = \frac{129093.28}{402.12}$$

$\sigma_b = 321.03$ N/mm^2 $<$ 335 N/mm^2

Hence safe

G. Shear Stress Calculation:

$\tau = \frac{P}{A}$

$\tau = \frac{16136.66}{\frac{\pi}{4} X (16)^2}$

$\tau = 80.25$ N/mm^2 $<$ 167.5 N/mm^2

Hence safe

H. Design of Pin for Trolley:

Considering En8 / C 40 (cold drawn) material for pin

Ultimate tensile strength = 670 Mp [from IS 1570 (part 2 / sec 1)]

Considering pin length = 150 mm

No. of pin = 4 nos.

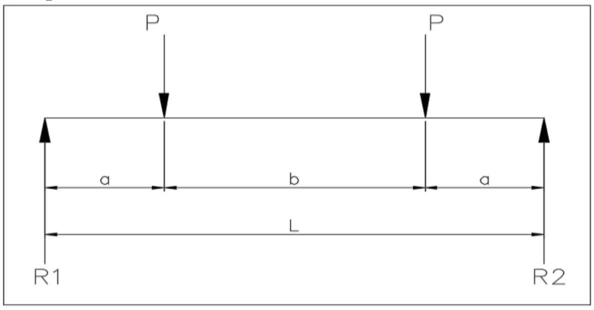


Fig. 5: Force diagram

$M = \frac{W}{4} \text{ X a}$

$M = \frac{16136.66}{4} \text{ X } 50$

M = 201709.25 N.mm

To find dia.of pin

$$\sigma_b = \frac{M}{Z_{XX}}$$

$$335 = \frac{201708.25}{\frac{\pi}{32} X d^3}$$

$d = 18.30 \text{ mm} \cong 20\text{mm}$

Moment of inertia (Ixx)

$I_{XX} = \frac{\pi}{64} X d^4$

$I_{XX} = \frac{\pi}{64} X (20)^4$

$I_{XX} = 7853.98$ mm^4

Section modulus(Zxx)

$Z_{XX} = \frac{\pi}{32} X d^3$

$Z_{XX} = \frac{\pi}{32} X (20)^3$

$Z_{XX} = 785.39$ mm^3

I. Bending Stress Calculation:

$$\sigma_b = \frac{M}{Z_{XX}}$$

$$\sigma_b = \frac{201708.25}{785.39}$$

$\sigma_b = 256.82$ N/mm^2 $<$ 335 N/mm^2

Hence safe

J. Shear Stress Calculation

$\tau = \frac{P}{A}$

$\tau = \frac{4034.165}{\frac{\pi}{4} X (20)^2}$

$\tau = 12.84$ N/mm^2 $<$ 167.5 N/mm^2

Hence safe

VII. RESULT

A. *30˚ Inclined Position:*

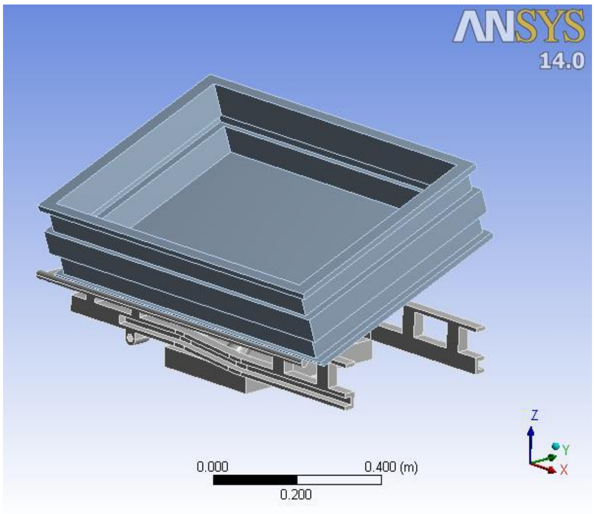


Fig. 6: Trolley inclined at 30˚

Model (A4) > Connections > Contacts > Contact Region > Figure

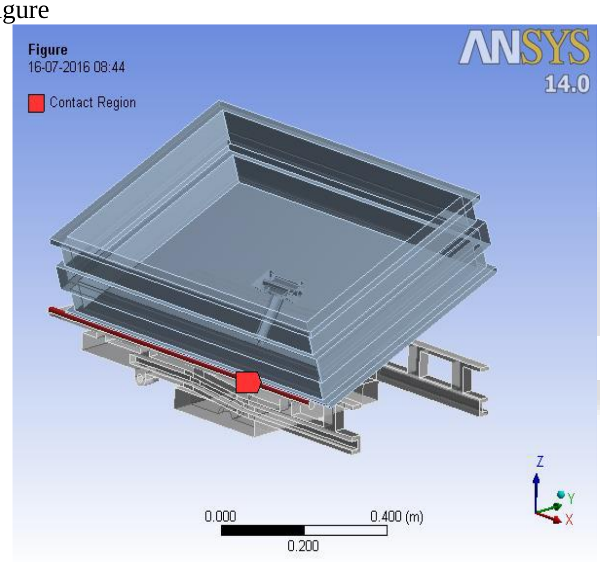


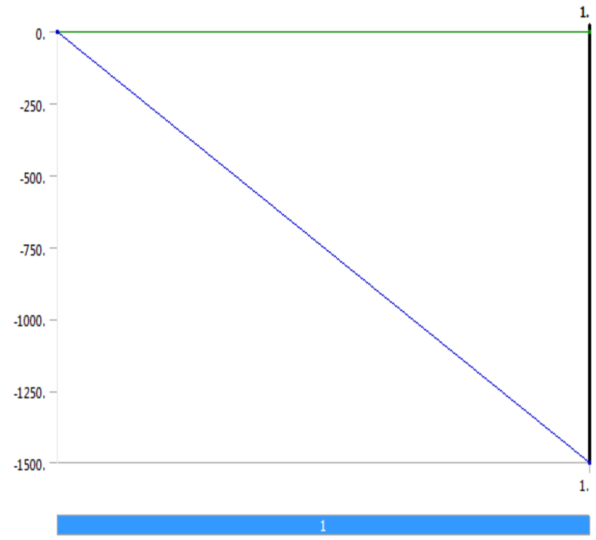
Fig. 7: Contact Region

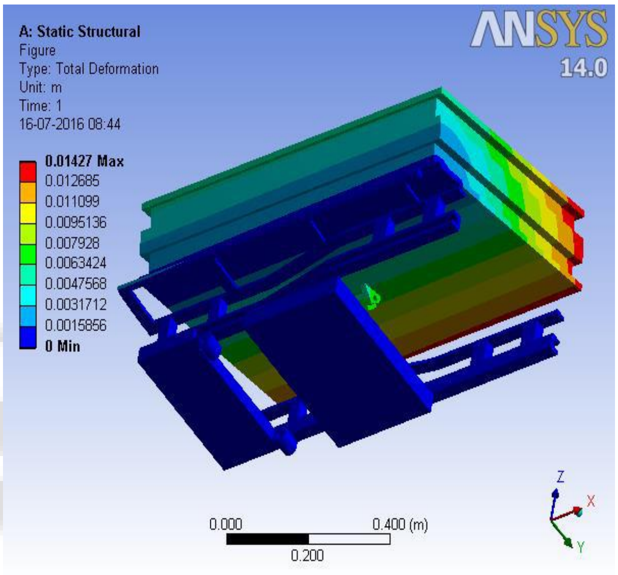
B. *Static Structural*

Model (A4) > Static Structural (A5) > Loads

Object Name	*Fixed Support*	*Force*
State	Fully Defined	
Scope		
Scoping Method	Geometry Selection	
Geometry	6 Faces	1 Face
Definition		
Type	Fixed Support	Force
Suppressed	No	
Define By		Components
Coordinate System		Global Coordinate System
X Component		0. N (ramped)
Y Component		0. N (ramped)
Z Component		-14715. N (ramped)

Table 1: Load Table





Maximum deformation 0.01427m

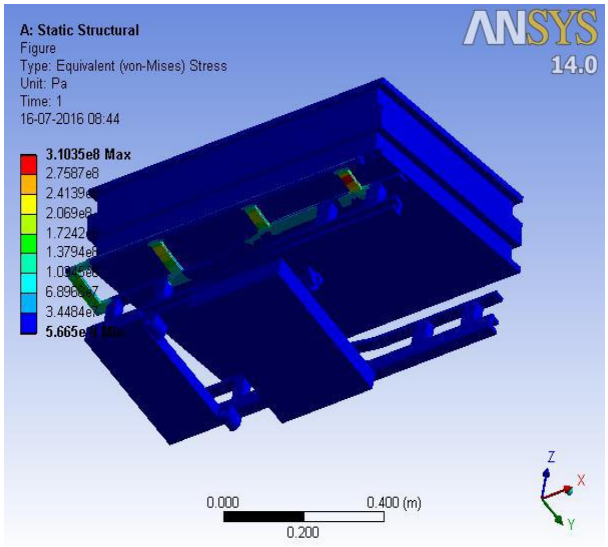
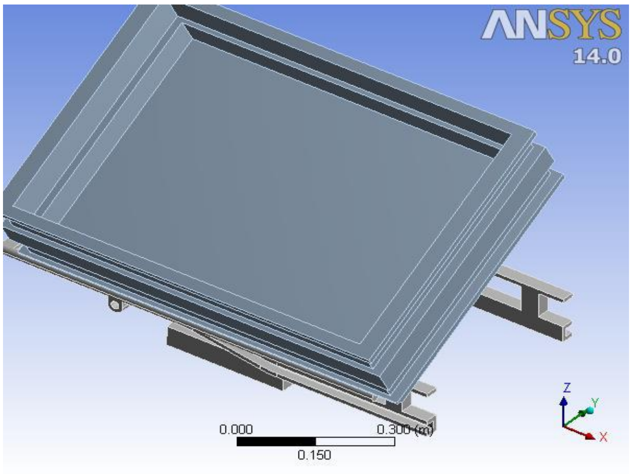


Fig. 8: Maximum equivalent (von misses) stress is 3.10 x 10^2 MPa.

C. 45˚ Inclined Position:

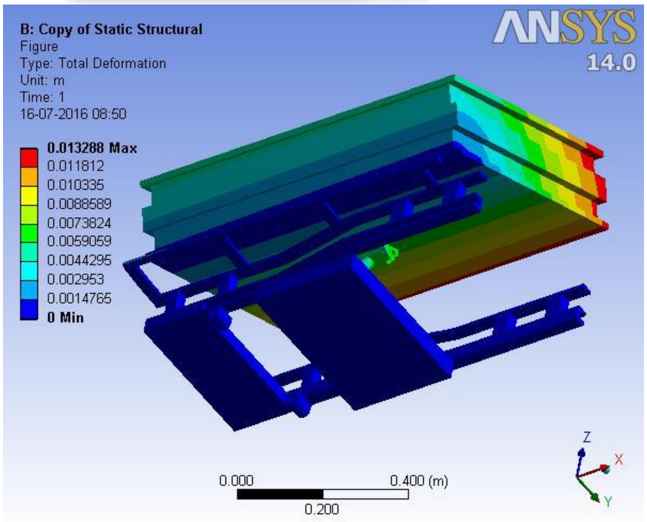


D. Static Structural:

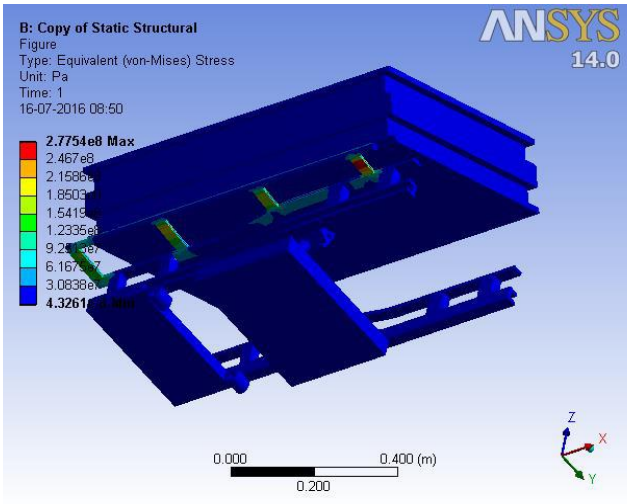
Model (B4) > Static Structural (B5) > Loads

Object Name	*Fixed Support*	*Force*
State	Fully Defined	
Scope		
Scoping Method	Geometry Selection	
Geometry	6 Faces	1 Face
Definition		
Type	Fixed Support	Force
Suppressed	No	
Define By		Components
Coordinate System		Global Coordinate System
X Component		0. N (ramped)
Y Component		0. N (ramped)
Z Component		-14715. N (ramped)

Table 2: Load Table



Maximum deformation 0.0132

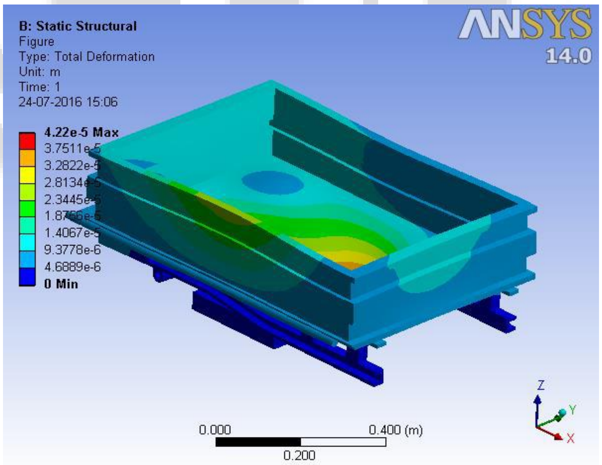


Maximum equivalent (von misses) stress is 2.77 x 10^2 MPa.

E. Horizontal Position:

Object Name	*Fixed Support*	*Force*
State	Fully Defined	
Scope		
Scoping Method	Geometry Selection	
Geometry	5 Faces	1 Face
Definition		
Type	Fixed Support	Force
Suppressed	No	
Define By		Vector
Magnitude		14715 N (ramped)
Direction		Defined

Table 4: Load Table



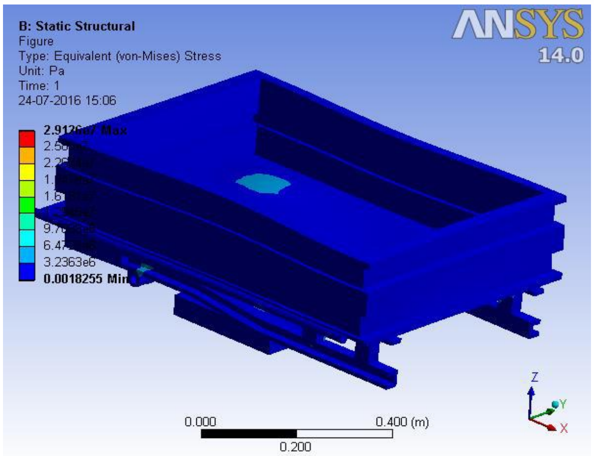


Fig. Maximum equivalent (von misses) stress is 2.91 x 10^2 MPa.

VIII. CONCLUSION

In this project the various activities that are involved are:

- Gathering the functional and structural requirement of system.
- Making General arrangement drawings.
- Hand Calculations.
- CAD model generation.
- Analysis of proposed system on Ansys.
- Publishing of drawings of the final design.

As this concept saves time & energy as well this may lead to efficient working, which helps constructional work or the infrastructural work demands of efficient and user friendly machinery will lead to more and more use of the project work like Right side dropping dumper.

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