Design & Performance Evaluation of Chemical Tanker at Spectra India

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Abstract— The modern civilization is very largely dependent on the products of oil and massive quantities of oil / chemical are transported throughout the world. The design of vehicles transporting flammable fluid is important for public safety and economic implications. In this research we will develop a CAD model of tanker transporting the oil / chemical according to the dimensions provided by Spectra India, Nagpur and analyze the bursting pressure of tank using FEA.

Key words: Chemical /Acid tanker, analysis of tanker

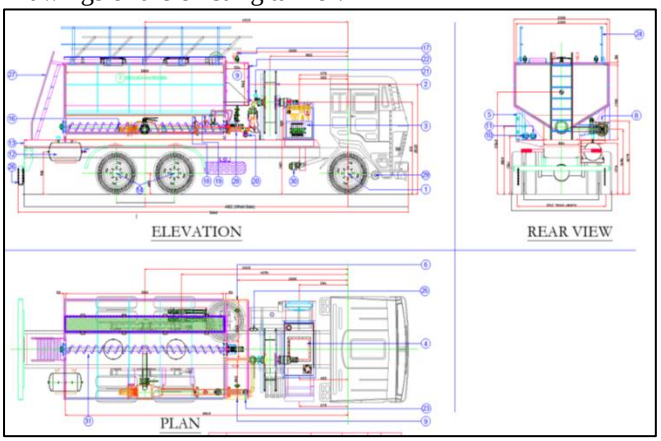
I. INTRODUCTION

In the case of flammable fluid transportation. Society gain benefit from the use of these fluids, but also bear the certain risks in order to transport them from their place of production to the consumptionpoint. To minimize the risk, considerable attention has been paid to the tanker which transports the fluid. In this project we will analyze thebursting pressure of chemical tanker using FEA to identifythecurrent design of tanker can safely withstand the forces.

Fig. 1: Chemical tanker designed at SPECTRA INDIA

II. EXISTING MODAL DATA:

Drawings of the existing tanker:



III. NEED OF ANALYZING AND OPTIMIZATION

- During a visit to the SPECTRA INDIA, it was revealed that there is a requirement for analysis of a chemical/acid transporting tanker.
- The drawings were collected and analyzed to see the scale of work to be done.
- After a detailed conversation with the general manger it was decided that the existing designing needed to be modeled in a CAD software and FEA analysis was needed to be done in analysis software.
- By performing the FEA analysis we will be able to find the structural performance of the existing design and to identify the critical locations in the existing design.
- With the help of the FEA analysis we will be able to find out the bursting pressure for the existing tanker.
- With this project the company will be benefited from the advancements of computer technologies and thus will be able to improve its design of chemical/acid tanker.

IV. RESEARCH METHODOLOGY

In present study, we create the CAD model of tanker. Then analysisof the existing design will be performed. Then

CALCULATION: LOAD DISTRIBUTION AND STABILITY RATIO

1) VEHICLE DETAILS: MAKE : ASHOK LEYLAND
MODEL: 2516nL / 1
GROSS VEHICLE WEIGHT 25000 KG

2) CHASSIS WEIGHT:
FRONT AXLE 2898 KG
REAR AXLE 3402 KG

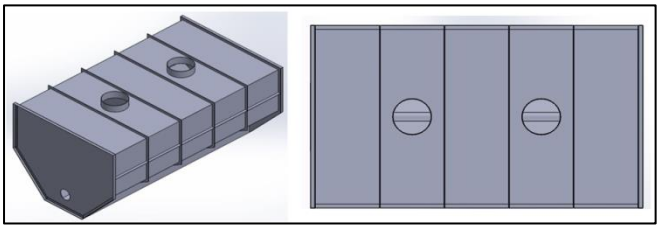
FRONT AXLE 6000 KG
REAR AXLE 19000 KG

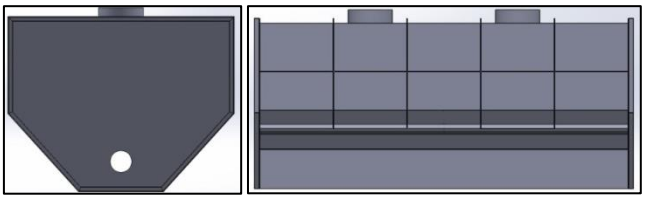
INDIVIDUAL ITEMS LOAD & GRAVITY DETAILS:-
CALCULATION OF STABILITY RATIO & LOAD DISTRIBUTION FOR PUMP TRUCK - ASHOK LEYLAND 2516nl / 1

SR NO:	DESCRIPTION OF GOODS	EMPTY WEIGHT (KG)	CAPACITY (KG)	TOTAL (KG)	HORIZONTAL DISTANCE FROM FRONT AXLE (M)	MOMENT (KG-M)	VERTICAL DISTANCE FROM GROUND (M)	MOMENT (KG-M)
		ew	c	w= ew+c	d	w x d	h	w x h
1	Front Axle	2898	0	2898	0	0.0	0	0.0
2	Hose Reel	400	0	400	1.882	752.8	2.111	844.4
3	Control Panel	120	0	120	1.179	141.5	1.679	201.5
4	Hyd. Oil Tank	170	550	720	1.183	851.8	1.621	1167.1
5	Hyd. Oil Cooler	25	0	25	1.184	29.6	1.559	39.0
6	Water Tank	175	600	775	2.68	2077.0	2.523	1955.3
7	Emulsion Matrix Bin	1820	12000	13820	4.92	67994.4	2.342	32366.4
8	Discharge Pump With Motor	135	0	135	4.92	664.2	1.494	201.7
9	Gassing Agent Tank	155	400	555	2.68	1487.4	2.523	1400.3
10	Water Pump With Motor	25	0	25	4.034	100.9	1.341	33.5
11	Gassing Agent Pump With Motor	25	0	25	4.034	100.9	1.341	33.5
12	Air Tank	40	75	115	6.84	786.6	0.981	112.8
13	Sub Frame	340	0	340	4.292	1459.3	1.176	399.8
14	Rear Axle	3402	0	3402	4.902	16676.6	0.485	1650.0
15	Misc. Items	500	0	500	0	0.0	0	0.0
	Total	10230		23855	0	93122.8	0	40405.4

THEORETICAL WHEEL BASE (IN M)	4.902			
LOAD DISTRIBUTION:				
GROSS VEHICLE WEIGHT (GVW) IN KG =	25000			
CALCULATED MAX. LOAD =	23855	<=	25000	WITHIN PRESCRIBED LIMITS
LOAD ON REAR AXLE (RA) = SUM OF MOMENT/ WHEEL BASE	18996.90412	<=	19000	WITHIN PRESCRIBED LIMITS
LOAD ON FRONT AXLE (FA) = MAX. LOAD - REAR AXLE LOAD	4858.096	<=	6000	WITHIN PRESCRIBED LIMITS
STABILITY RATIO:				
CG FROM GROUND (H) = SUM Of w x h / W	1.694			
TRACK LENGTH (TL) =	2.142			
STABILITY RATIO (H / TL) =	0.791	<=	0.9	WITHIN PRESCRIBED LIMITS

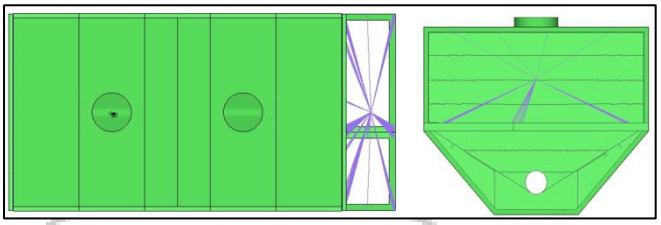
V. CAD MODELING OF CHEMICAL TANKER





CAD Model views of Chemical Tank

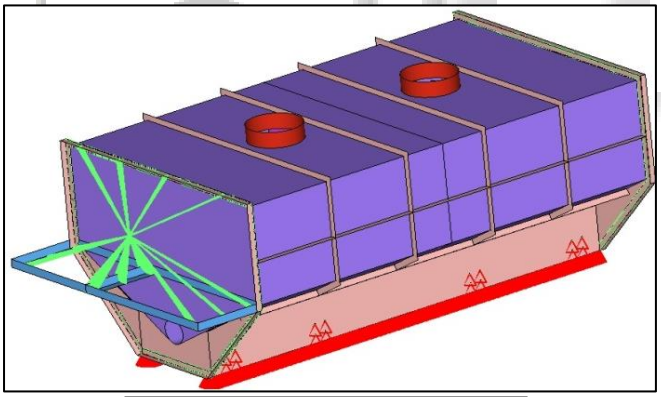
VI. FE MODEL

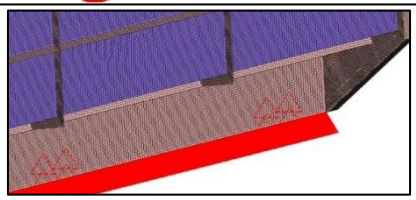


FE Model views of Chemical Tank

VII. BOUNDARY CONDITION

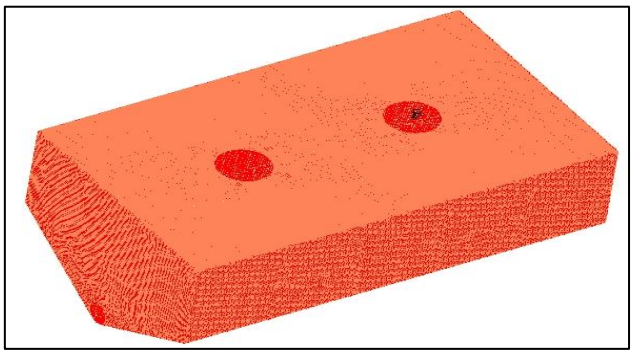
A. Constraints





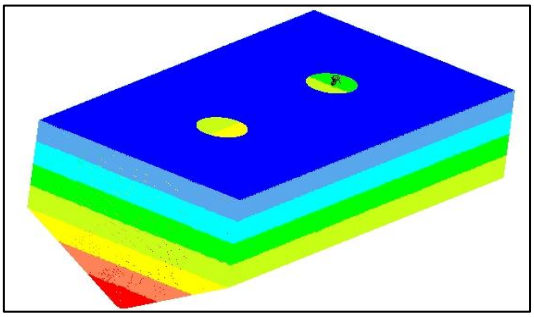
Down side of the existing tank fitted on the main trailer frame so in our FEA model that portion will be constraint.

B. Forces_1



In a physical model, Bursting Pressure Acting on a inside portion of the existing tanker so In our FEA model that portion applied a bursting pressure i.e., 0.0075 N/mm^2.

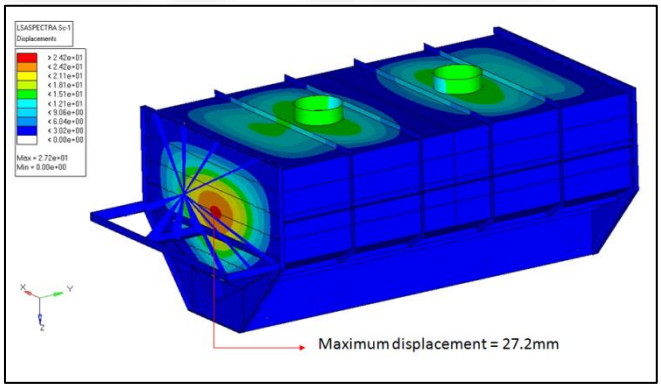
C. Forces_2



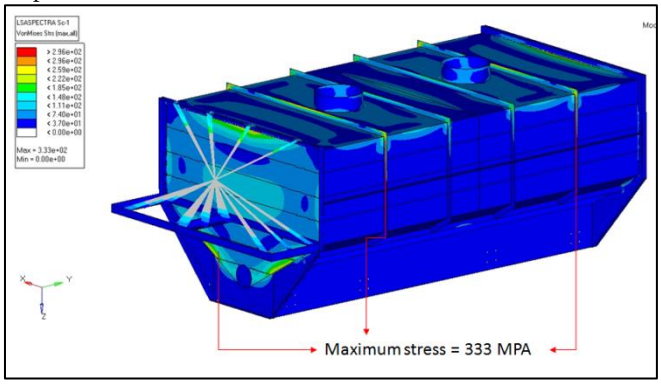
In a physical model ,hydrostatic Pressure Acting on a base and top portion of the existing tanker so In our FEA model that base portion applied a Hydrostatic pressure i.e., 0.01 N/mm^2 and Minimum 0.0005 N/mm^2 at top of the tank.

VIII. FINITE ELEMENT ANALYSIS:

A. Results for Case 1

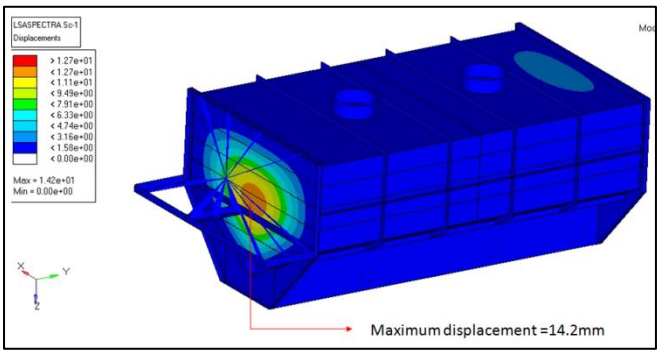


Frontal portion of the tanker indicated maximum displacement that is 27.2mm.

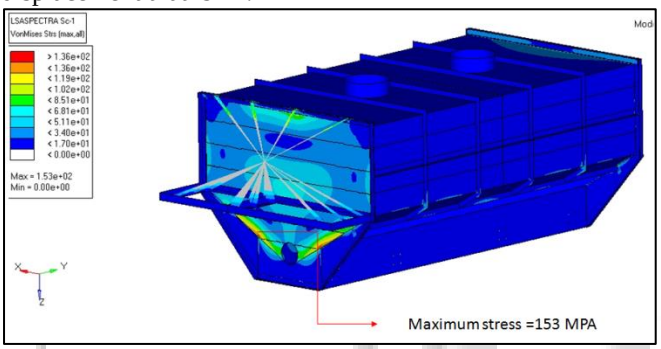


Frontal portion of the tanker and every supporting member of the tanker indicated maximum stress that is 333 mpa.

B. Results for Case 2



Frontal portion of the tanker indicated maximum displacement that is 14.2mm



Frontal Portion Of The Tanker Indicated Maximum Stress That Is 153 Mpa.

IX. FINDINGS

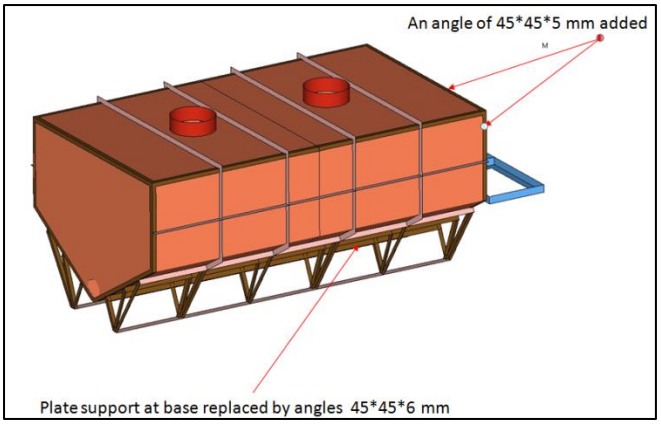
Case1: Bursting pressure obtained is 0.0075 N/mm^2 (0.075 bar)

Case2:

- Maximum displacements observed 14.2 mm
- Vonmises Stresses observed in high Stress concentration region is 153 MPA
- Vonmises stresses observed in low stress concentration region is 57 MPA

Recommendation

- Thickness of high stress concentration plate modified from 5 mm to 10 mm
- An angle of 45*45*5 mm added and Plate support at base replaced by angles 45*45*6 mm
- 10. Modification: 1



An angle of 45*45*5 mm added. The plates that supports at base are replaced by angles 45*45*6 mm.

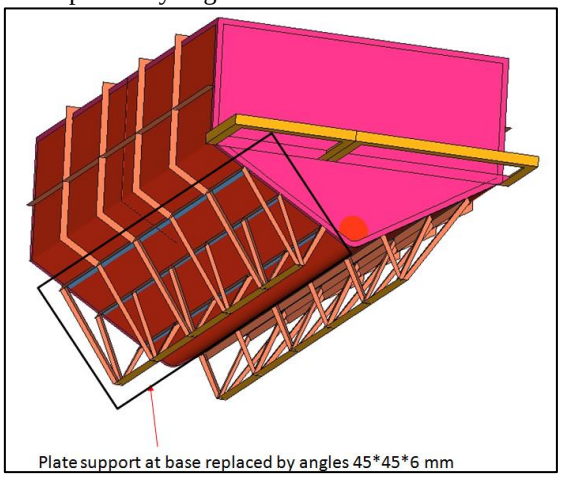
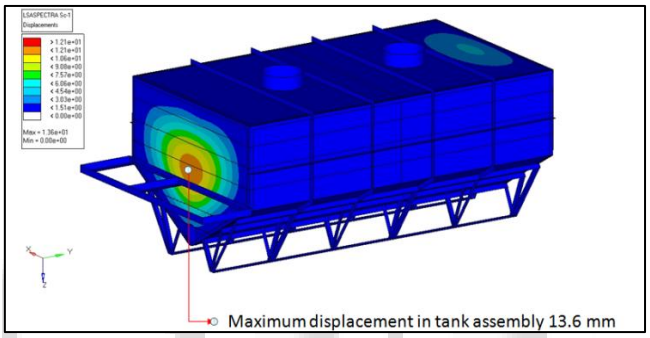
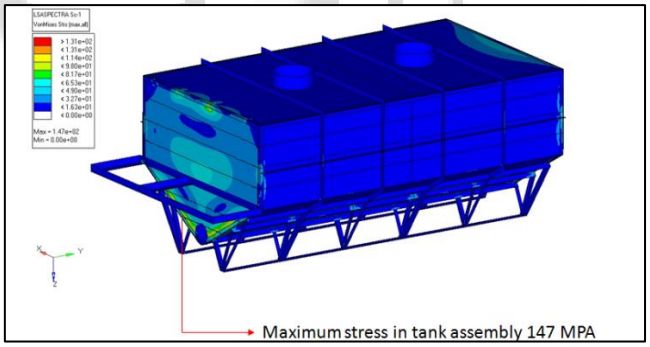


Plate Support at Base Replaced By Angles 45*45*6mm

A. FEA Results for Modified Design1:



The structure is analyzed 12 Tons pressure of liquid. See the contour plot images for displacement and Von-mises stresses.

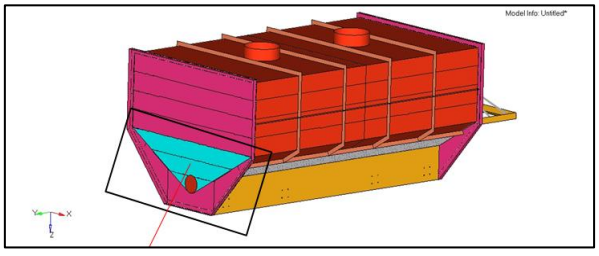


Frontal Portion of the tanker indicated Maximum displacement that is 13.6 mm.

From the results we can see the there is no considerable changes in stresses, hence this modification will not fulfill our project need.

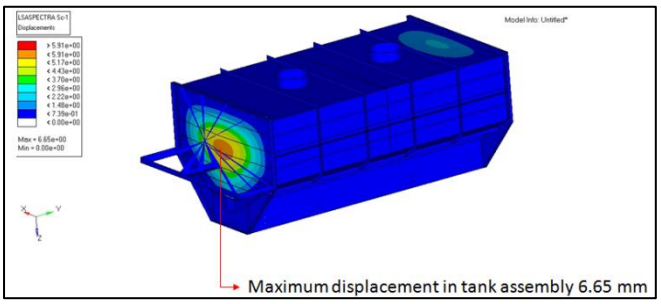
X. MODIFICATION: 2

Thickness of plate modified from 5 mm to 10 mm shown below

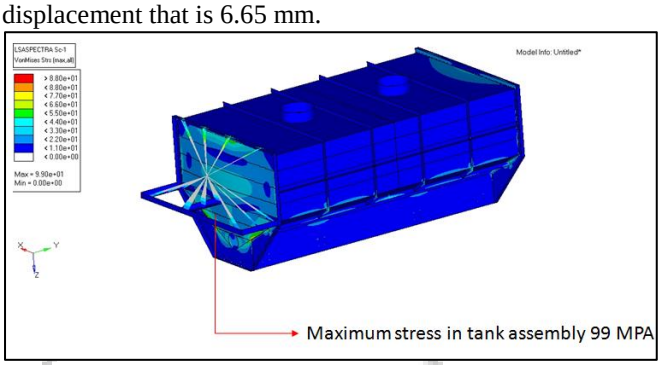


A. FEA Results for Modified Design2:

The structure is analyzed 12 Tons pressure of liquid. See the contour plot images for displacement and Von-misses stresses.



Frontal Portion of the tanker indicated Maximum displacement that is 6.65 mm.



Frontal Portion of the tanker indicated Maximum stress that is 99 MPA. Here the displacement and stresses are considerably less than the yield stress of the tank material.

XI. CONCLUSIONS

In our FEA model through accumulated a bursting pressure is 0.0075 N/mm^2 (0.075 bar) and based on hydrostatic pressure FEA model indicated a maximum displacements is 14.2 mm, vonmises stresses in high concentration region is 153 MPA and, vonmises stresses in low concentration region is 57 MPA, we did calculations according to bursting and hydrostatic pressure suitable data to develop modified chemical tanker.

In modified model we do a two changes i.e. add on some stiffness and some change on thickness. First case, add on some Stiffness based FEA model indicated a maximum displacements is 13.6 mm, vonmises stresses is 147 MPA that result was same to existing so that's modification not affected. Hence, we alter design till we get safer results.

Second case,in change on thickness based FEA model indicated a maximum displacement is 6.65 mm, vonmises stresses is 99 MPA.With this project the company benefited from the advancements of computer technologies and thus was able to improve its design of chemical/acid tanker.

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