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Design and Analysis of a Missile Storage Container Using Composite Materials

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Abstract: *In this investigation a container was designed which is used for transportation and storage of missile. The Missile container is made of composite material with rectangular ribs on the interior surface. The opening to insert the missile is given at the rear end of the container. As a result manufacturing becomes easier than other containers. It was determine several causes of disturbances which damage the container such as internal pressure load, Braking load and lifting load. Missile storage containers have been made to design and optimize the above mentioned loads. The analysis is carried out to determine the static properties of the designed composite missile container structure under the various mechanical loads. Ansys software has been used to perform the structural analysis.*

Keywords: *Design, Analysis, Storage Container, Missile.*

1. INTRODUCTION

Missile is an object. A missile is usually a weapon that is self-propellant after the leaving of launching device. In other words of missile is a rocket-propellant weapon. Missiles are study, well-constructed machines. But, because of their size, weight, and bulk, they are not that easy to handle nor are missiles indestructible. Most missile damage is, unfortunately, a result of carelessness and poor handling practices. To reduce the possibility of damage, missiles are shipped, stowed and handled with special equipments. Approved containers, canisters, and handling equipments provide maximum missile safety with minimum handling by personnel. There are different and specialized types of containers, canisters, and handling equipments in the ordnance field. Many are designed for a single purpose or use and cannot be interchanged with comparable items. The containers, canisters, and handling equipments used to deliver missiles to a ship.

2. Composite Material

The advantages of composite materials are:

- High Strength
- Stiffness is high
- Corrosion resistance is high
- High wear resistance
- Attractiveness
- High fatigue life
- Temperature independent behaviour

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- Thermal insulation
- Acoustical insulation

The container of the missile is made of composite materials with rectangular ribs on the interior surface. The missile is placed on the bulk head which supports the weight of the missile. The arrestors are made of mild steel used to locate the missile in the container.

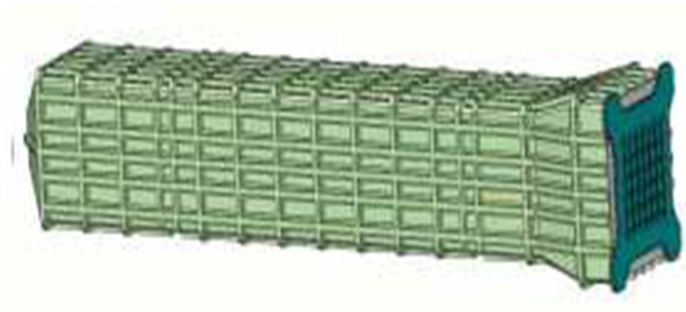

Figure 1: 3D view of the container

3. Design and Modelling

Missile container is constructed by using fiber reinforced composite materials, i.e., glass fiber with epoxy, because of its good properties like strength is high, density is low and easy to manufacture. Nitrogen gas is filled inside the storage container to maintain the low temperature. Fill port, vent port and pressure gauges are used for filling nitrogen gas. Lifting hooks are made of forged alloy steel are provide to lifting of the missile container. Fiber arrangement plays major role in carrying the loads. Fiber arrangement (layer orientation) is to optimize resistance to loads:

±45 degree plies give buckling stability and carry shear
0 degree plies give column stability and carry tension or compression
±90 degree plies carry transverse load Layer orientation = -90°, -45°, 0°, 45°, 90°

S.no	Thickness of each layer (mm)	Total number of layers	Thickness of container (mm)
1	0.4	10	4
2	0.6	10	6

4. Structural Analysis

Static analysis carried out by the bodies acted upon by forces. A static analysis can be either linear or non-linear. All types of non-linearity are allowed to large deformations, plasticity, creep and stress. Static analysis result of structural displacements, stresses and strains in structures for components caused by loads will give a clear idea about whether the structure or components will withstand for the applied maximum loads. If the stress values obtained in this analysis crosses the allowable values it will result in the failure of the structure in the static condition itself. To avoid such a failure, this analysis has been carried out.

4.1 Structural Analysis of Missile Container with 4 mm Thickness

Internal Pressure of 0.689 MPa

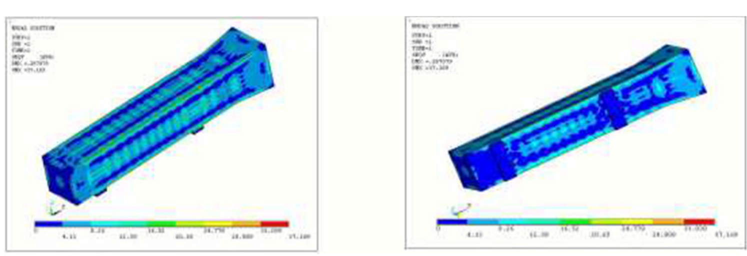

Figure 2 The maximum VonMises Stress observed is 37Mpa

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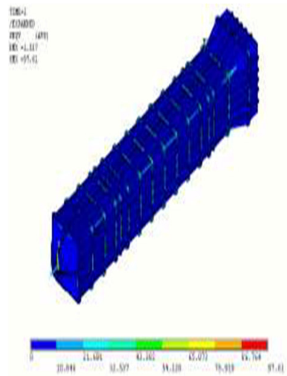

Figure 3 The maximum stress singularity is 97.4 MPa

Case 2– Braking Load of 6434.6 N

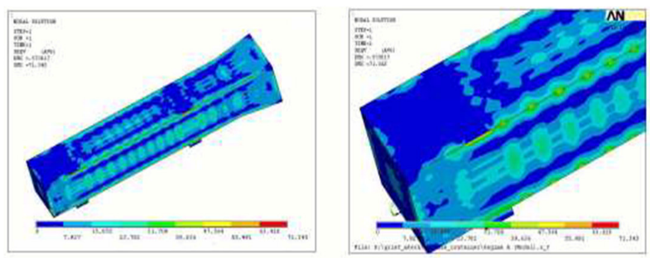

Figure 4 The maximum VonMises Stress observed is 71Mpa

Braking Lo ad of 6434.6 N

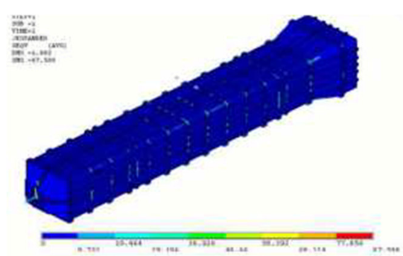

Figure 5 The maximum VonMises Stress observed is 170Mpa

Lifting Load of 1320 kg

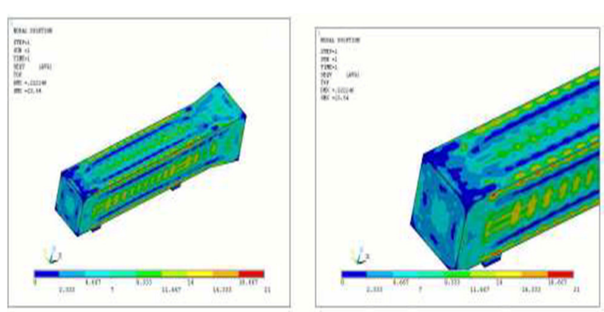

Figure 6 The maximum VonMises Stress o bserved is 36MPa

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Lifting Load of 1320 kg (Modified)

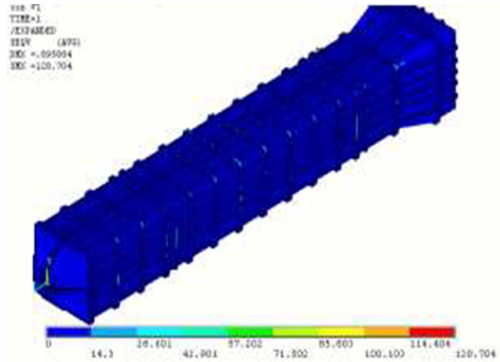

Figure 7 The maximum VonMises Stress o bserved is 207MPa

5. Results and Discussions

Composite container was studied for 4 different cases for existing and modified model with 4 mm and 6 mm thickness:

Case 1 – Internal pressure of 0.689 Mpa
Case 2 – Braking analysis with 0.5g acceleration Case 4 – Lifting analysis

The strength of EGlass/Epoxy in different directions is tabulated below.

Strength in the fiber direction, X_L (MPa)	1.03 X 10^3
Strength in the transverse direction, X_T (MPa)	33
Shear strength, S (MPa)	41.37

The above table shows the results of the missile container with 4 mm thickness. From the results shown in the above table for existing model with 4mm thickness it is observed that the maximum linearized stress of 37Mpa, 46Mpa, 71Mpa and 36Mpa is observed for Internal Pressure Stacking, Bracking and lifting loads respectively for the existing model with 4mm thickness. From these results it can be concluded that the stresses are more than the fibre strength in transverse direction and shear. From the above results it can be concluded that that existing missile container with 4 mm thickness is not safe under the given operating conditions.

From the results shown in the above table for Modified model with 4 mm thickness it is observed that the maximum linearised stress of 27.8 Mpa, 68 Mpa, 87 Mpa and 27 Mpa is observed for Internal Pressure, Stacking, Bracking and lifting analysis respectively for the modified model with 4 mm thickness. From these results it can be concluded that the stresses are more than the fibre strength in transverse direction and shear for stacking and bracking loads. From the above results it can be concluded that that modified missile container with 4 mm thickness is not safe under the given stacking and bracking operating conditions. The results obtained for various analyses with 4 mm thickness for existing and modified models are tabulated below:

		Internal	Lifting
Existing	Ux (mm)	0.16	0.009
	Uy (mm)	0.25	0.03
	Uz (mm)	0.18	0.12
	Max Stress (MPa)	37	36

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Modified	Ux (mm)	0.057	0.053
	Uy (mm)	1.33	1.26
	Uz (mm)	0.219	0.28
	Max Stress (MPa)	97.4	207
	Linearised Stress (MPa)	27.85	29

6. Conclusion

The Missile container is made of composite material which reduces the damages of missiles during shipping. It makes the design and manufacturing of missile container in critical position. It is also check the missile container is subjected to internal pressure load, Braking load and lifting load. The results observed that VonMises stress is exceeding the yield strength of the material with 4 mm thickness in braking analysis which is the worst case. So, it is concluded that the design is not safe for 4 mm thickness. Then the thickness of the container is increased from 4 mm to 6 mm, a detailed finite element analysis has been done for all above load cases. From the results it is identify that VonMises stress is lower than the yield strength .Therefore it is concluded that the modified model with 6mm thickness is safe for all above operation loads.

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