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"Design And Analysis Of Pressure Vessel Used In Missile Canister"

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Abstract: The primary aim for this study is to design, and analyze canister chamber manufactured from stainless steel material and also design for composite material. Canister is used for carrying, storing and launching of missile. During storage and launching, the canister is subjected to an internal pressure of 45 kg/cm2 .Thus, the primary objective of this thesis is to design a canister testing chamber and analyzing canister by ANSYS a finite element aim for this study is to design, develop and analyze of canister by using finite element analysis technique.

Keywords – *Cad, ISO, FEA, 3D Printing, SDO.*

I. INTRODUCTION

Canister is a cylindrical container for holding, carrying, storing and launching of missile. Usually specified object or substance.
Types of Canisters
1 Horizontal canister
2 Vertical canister
Components Used In Canister
1 Chamber shells
2 Canister dished ends
3 Support legs
4 Bolts
5 Pressure gauges
Chamber shells/Pressure vessels
A pressure vessel is enclosed container designed to hold gases or liquids at a pressure substantially different from the ambient pressure. A pressure vessel is defined as a vessel in which the pressure is obtained from an indirect source or by the application of heat from an indirect source or a direct source. The vessel proper terminates at: (a) the first circumferential joint for welded end connections; (b) the face of the first flange in bolted flange connections; or (c) the first threaded joint in threaded connections. Pressure vessels include but are not limited to compressed gas storage tanks, anhydrous ammonia tanks, hydro pneumatic tanks, autoclaves, hot water storage tanks, chemical reactors and refrigerant vessels, designed for a pressure greater than 15 psi and a volume greater than 5 cubic feet in volume or one and one-half cubic feet iv volume with a pressure greater than 600 psi.

Theoretically, a spherical pressure vessel has approximately twice the strength of a cylindrical pressure vessel. However, a spherical shape is difficult to manufacture, and therefore more expensive, so most pressure vessels are cylindrical with2:1 semi-elliptical heads or end caps on each end. Smaller pressure vessels are assembled from a pipe and two covers. A disadvantage of these vessels is that greater breadths are more expensive, so that for example the most economic shape of a 1000 litters (35 cu ft), 250 bars (3,600 psi) pressure vessel might be a breadth of 914.4 mm (36 in) and a width of 1,701.8 mm(67 in)including the 2:1 semi- elliptical domed end caps.

Finite Element Analysis (FEA)

The finite element is a mathematical method for solving ordinary and partial differential equations. Because it is a numerical method, it has the ability to solve complex problems that can be represented in differential equation form. As these types of equations occur naturally in virtually all fields of the physical sciences, the applications of the finite element method are limitless as regards the solution of practical design problems. Most of the processes can be described using partial differential equations (PDEs), but these complex equations need to be solved in order for parameters such as stress and strain rates to be estimated. FEA allows for an approximate solution to these problems. FEA is the basis of modern software simulation software, with the results usually shown on a computer-generated colour scale.

Element Type Used

Shell63 has both bending and membrane capabilities. Both in-plane and normal loads are permitted. The element has six degrees of freedom at each node: translations in the nodal x, y, and z directions and rotations about the nodal x, y, and z axes. Stress stiffening and large deflection capabilities are included. A consistent tangent stiffness matrix option is available for use in large deflection (finite rotation) analysis.

II. DESIGN, DEVELOPMENT AND ANALYSIS

Case 1: For material A516 Gr.70 Steel

Shell Design Calculations for internal pressure

- Formula for calculation of cylindrical shell Thickness
- $t = P_iR_i / (SE-0.6P_i)$
- Design Consideration:
- Operating internal pressure (P_i) = 4.5 MPa
- Shell Inside radius (R_i) = 735 mm
- Allowable stress (S) = 103.5 MPa
- Weld joint efficiency factor (E) = 1
- t1 = Minimum required thickness = 10.9 mm
- Standard nominal thickness considered = 14 mm
- Milling tolerance (m) = 0.06*t = 0.84 mm
- Modification in weld portion (w) = 1.5+ if (t>12) 0.6 else 0.8 = 2.3 mm
- Bending tolerance (b) = 0.002t
- (Considered at 0.2% of the nominal thickness) = 0.028 mm
- Final thickness (t1) = 13.78 mm
- Final standard thickness = 14 mm

Head design IS 2825 (1969)

- For high pressure vessels hemispherical head is selected
- Formula
- $t_{head} = P_iR_i / (2SE-0.2P_i)$
- Design Consideration:
- Operating pressure (P_i) = 4.5 MPa
- Shell Inside radius (R_i) = 735 mm
- Allowable stress (S) = 103.5MPa
- Weld joint efficiency factor (E) = 1
- After calculating we get t= 7.31 = 8 mm

Boundary Conditions for FEA analysis in ansys

Base plates are constrained in all degrees of freedom
Head closure is bolted to chamber using Constraint equations – Simulating bolts
Internal pressure of 9 bar is applied
Gravity – 9810 mm/sec2 is applied to simulate selfweight

Meshing Details

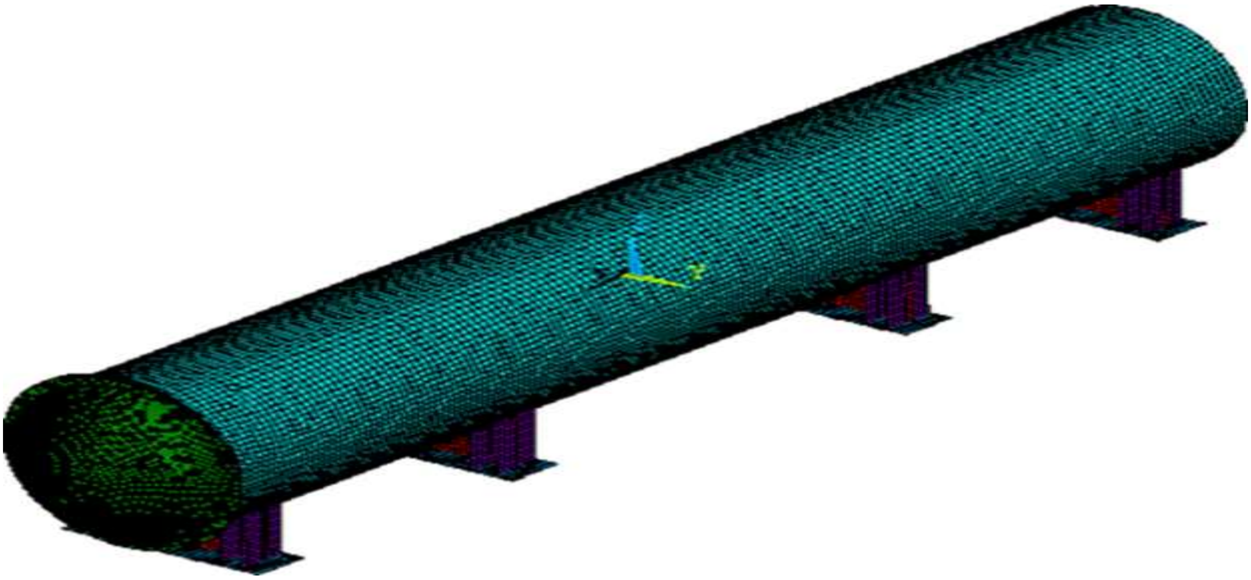

Figure 1 Meshed Finite Element Model of the canister testing chamber

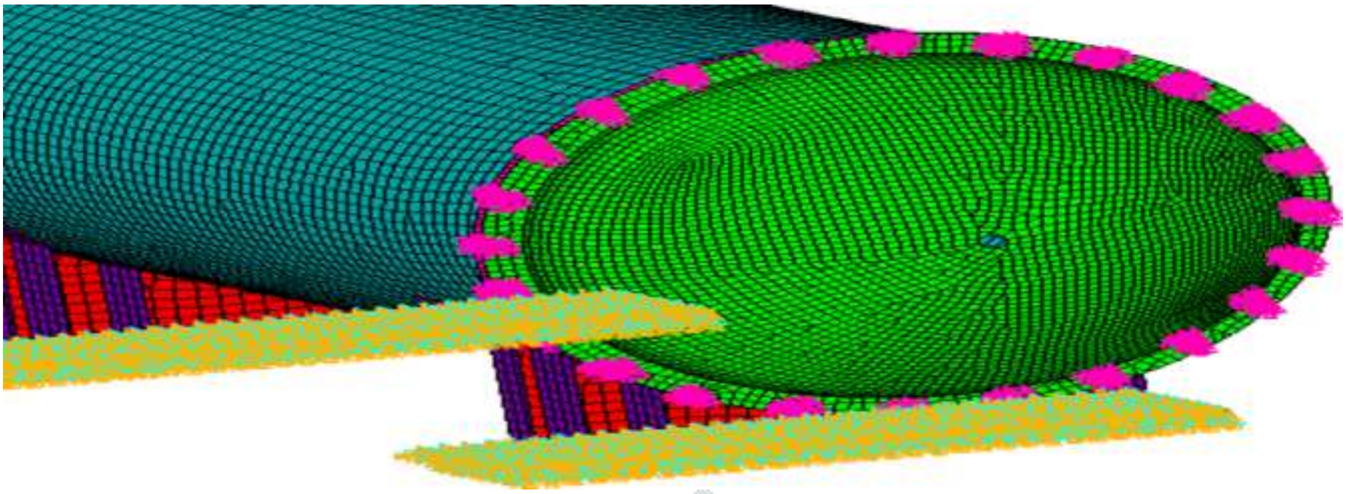

Figure 2 Base plates constrained in all degrees of freedom

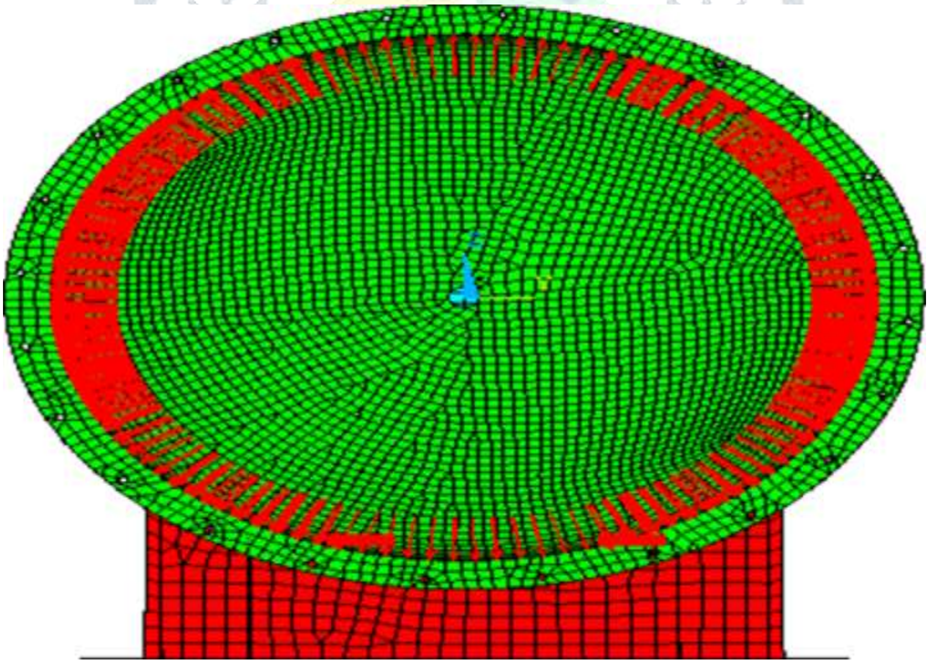

Figure 3 Application of Internal pressure

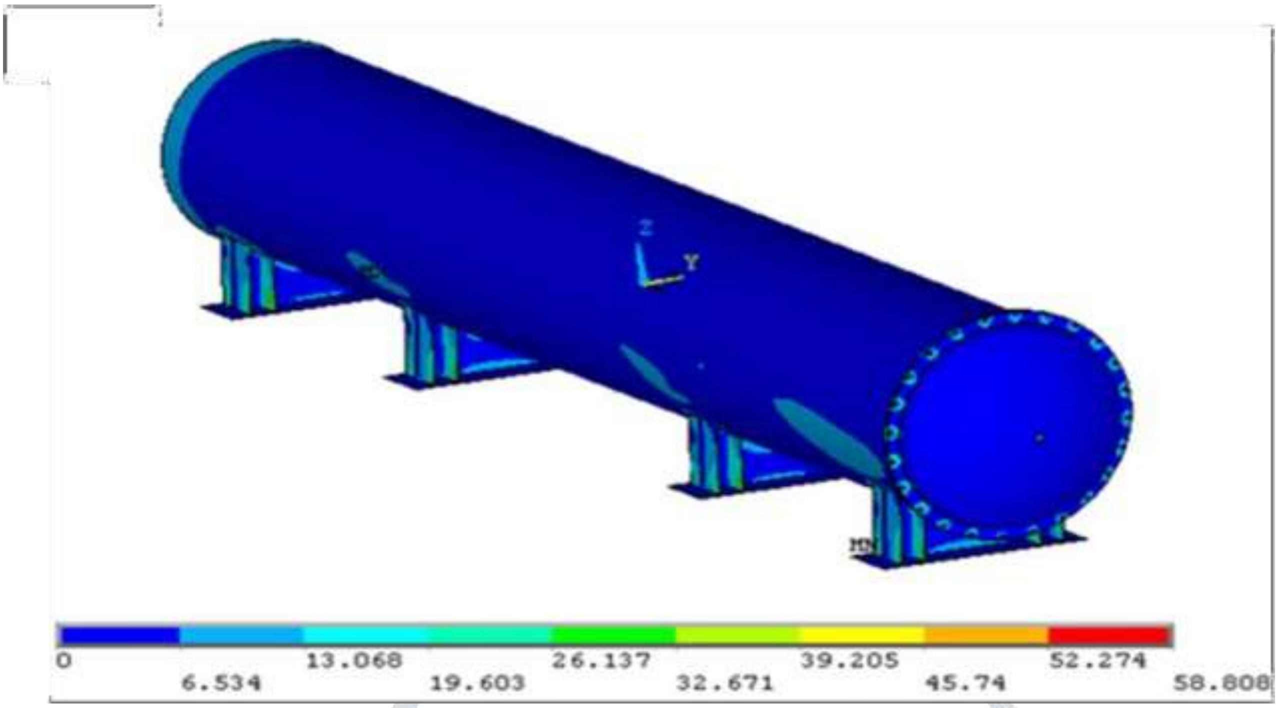

Figure 4 Von Mises Stress on the canister testing chamber

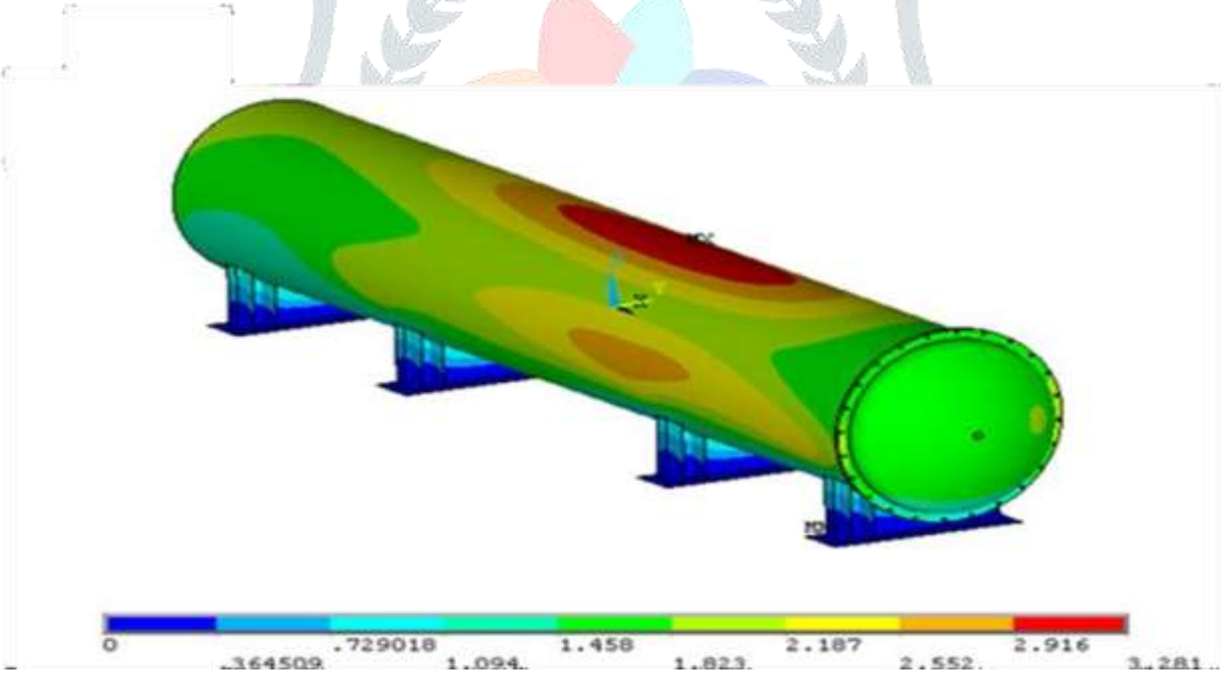

Figure 5 The total deflection of the canister testing chamber

III. RESULTS

In recent years, many computer-aided methods have been developed to find the most optimum design for a problem. These intelligent techniques have allowed engineers to create designs that were beyond what we could come up with manually. Fields such as aerospace, civil engineering, bio-chemical and mechanical engineering use this method proactively to create innovative design solutions that will outperform manual designs. Some Of Results Calculated Are

- The maximum hoops stress observed on canister testing chamber is 58 MPa
- The maximum deflection stress observed on canister testing chamber is 3.6 mm

- Shell thickness calculated in stainless steel material is 14 mm
- Shell thickness calculated in carbon epoxy composite is material is 8 mm

IV. CONCLUSION

From this study till now we have got some work related results and conclusions.

- The maximum Hoops stress observed on the canister testing chamber is 58 Mpa.
- The maximum deflection observed on the canister testing chamber is 3.2 mm.
- From the results, it is concluded that the designed horizontal canister testing chamber is safe for the internal pressure of 45 bar