# DESIGN AND ANALYSIS OF A MISSILE CANISTER USING COMPOSITE MATERIALS

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**Abstract:-** *Cylindrical pressure vessels are widely used for commercial, under water vehicles and in aerospace applications. At present the outer shells of the pressure vessels are made up of conventional metals like steels and aluminium alloys. Canister is a cylindrical pressure vessel used to store and launch a missile. The canister is designed based on the specifications of AGNI-5. The matrix and fibre reinforcement used are Epoxy resin and glass fibre cloth. The design considerations are 30 bar (internal pressure) and 5 bar (external pressure). External pressure causes buckling and buckling analysis is also performed. Theoretical calculations are done to find out the inclination of piles, fiber fraction for maximum strength. The Comparisons are made for two different approaches i.e. the finite element model and the theoretical model. A 3-D finite element analysis is built using ANSYS-18.1 version software into consideration, for static and buckling analysis on the pressure vessel. Safe design is known by comparing the factor of safety of theoretical and analysis.*

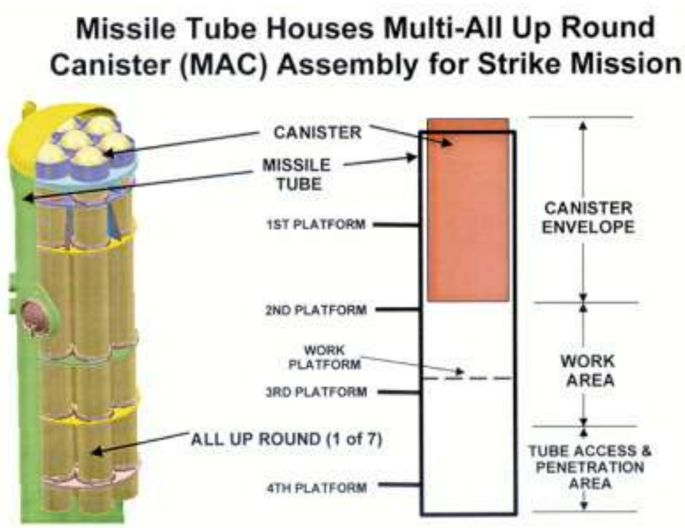
**Key Words:** *Composite material, Shells, Fiber orientation, composition, Critical Pressure, Buckling.*

## 1. INTRODUCTION

Missile is an object capable of being projected, usually with the intent of striking some distant object. All the more especially, a missile is generally a weapon that is self-propelled in the wake of leaving the starting gadget. As it were, missile is a rocket propelled weapon intended to convey an unstable warhead with awesome exactness at fast. Missiles are tough, very much developed machines. Be that as it may, in light of their size, weight, and mass, they are not that simple to deal with nor are missiles indestructible. Most missile harm is, sadly, an aftereffect of imprudence and poor dealing with rehearses. To decrease the likelihood of harm, missiles are shipped, stored and handled with unique equipment's. Affirmed containers, canisters, and dealing with gear's furnish most extreme missile security with least taking care of by work force. The missile compartment utilized in advance turned into of pinnacle type (bag) containers. This form of compartment has enormous touch territory on the cease locale. So it's far imperative that the producer desires to take outrageous care in delivering this compartment without a war page at the end district. There are unique and particular sorts of containers, canisters, and taking care of hardware's in the weapons field. Many are intended for a solitary reason or utilize and can't be traded with tantamount things. The containers, canisters, and taking care of hardware's utilized to convey missiles to a ship.

### 1.1 CANISTER – MISSILE LAUNCHER

Canister is a round and hollow pressure vessel used to dispatch a missile. The capacity of the canister is to shield the missile damage during storage, transport, and establishment on the launcher, transportation on the launcher in field conditions, and missile dispatch.




Key design requirements for the canister

1. Light in weight for mobility and transportability
2. Severe acceleration loads, thermal loads
3. Ballistic impact resistance to little arms fire
4. Corrosion-resistance
5. Low cost creation and system life cycle cost.

**1.2 CANISTER LAUNCH METHOD**

**Composite Materials**

A composite is a basic cloth that comprises of at least two joined constituents that are consolidated at macroscopic level and aren't dissolvable in every other. One constituent is referred to as the reinforcing section and the one in which it's miles inserted is called the grid. The reinforcing segment fabric is probably as fibers, debris, or flakes. Cases of composite frameworks incorporate cement strengthened with steel and epoxy fortified with graphite fibers, and so forth.

**Advanced Composite Materials**

Superior composites are composite materials which might be commonly applied inside the aerospace organizations. these composites have superior fortifications of a thin distance throughout in a framework fabric, as an instance, epoxy and aluminum. Illustrations are glass substances have now determined programs in enterprise ventures additionally.

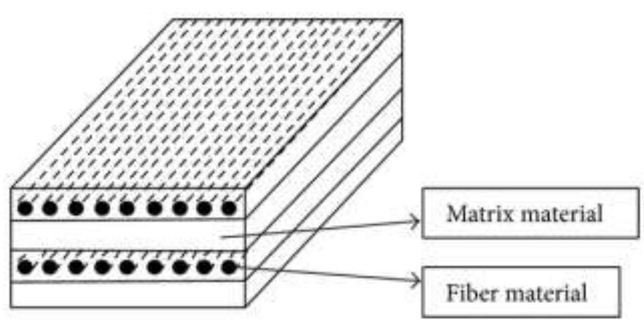



Figure 1.1: Fiber Composite

**Polymer Matrix Composites**

The most broadly recognized superior composites are polymer matrix composites (p.c.)comprising of a polymer The reasons why they are the most widely recognized composites incorporate their minimal effort, high power and simple manufacturing requirements.

**Glass Fiber**

Glass is most well-known fiber applied in polymer matrix composites. Its focal factors contain its high power, ease, excessive substance resistance and exceptional insulating houses. The dangers contain low bendy modulus, negative adhesion to polymers, excessive specific gravity, sensitive to scraped spot (diminishes elasticity) and occasional fatigue energy.

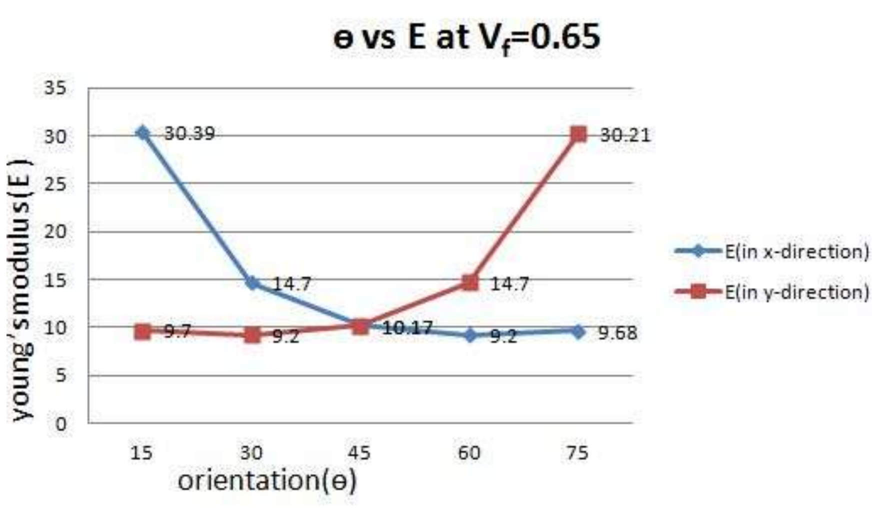
**DESIGN OF A CANISTER**

**LAUNCHING OF A MISSILE**

The launching of a missile involves creating an internal pressure of 30 bar by using chemical reactions inside the canister due to which missile is ejected. Here we are considering the specifications of canister AGNI V for the design .It is designed for resisting a pressure of 30 bar internal pressure. Since we are considering that missile is in submarine, an external pressure is also created. As we know for every 2 meters depth a pressure of 1 bar is developed, presently we are considering the canister is at 10 meters depth and a pressure of 5 bar is acting externally. So our design must resist an external pressure of 5 bar and internal pressure of 30 bar.

**ORIENTATION OF FIBER**

To find out in which orientation the young's modulus is optimum the graph is plotted between angles (ɵ)Vs E(young's modulus) at various volume proportions of fiber as shown below:



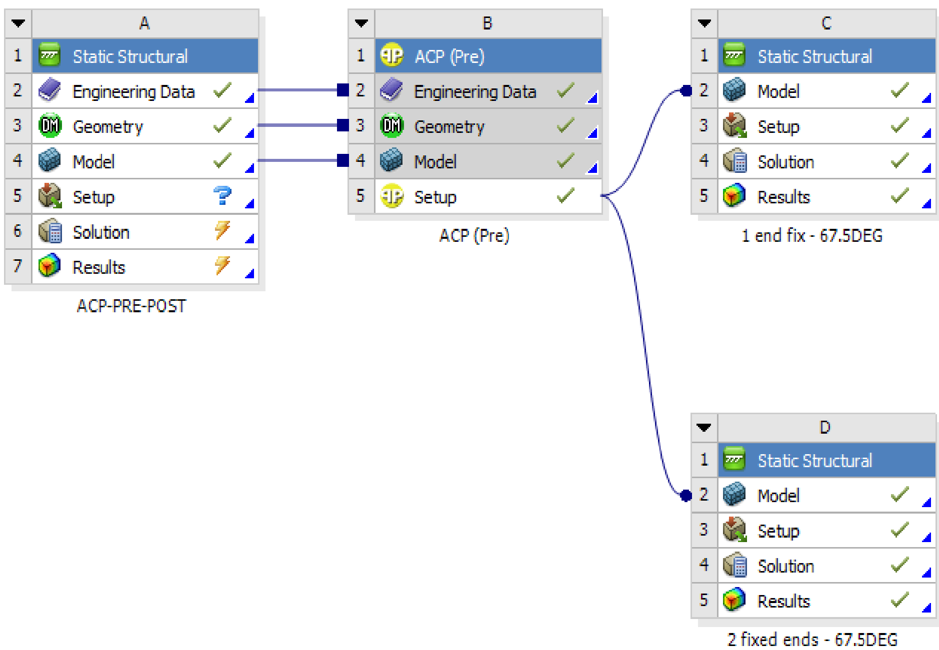

**Plot 1 :Variation of young's modulus with orientation at 0.65**

**Conclusion from Graphs**

Since the thickness under internal pressure is inversely proportional to young's modulus,more over a unidirectional laminates cannot offer high strength and stiffness properties in transverse direction.So it is important to find out at which orientation maximum young's modulus is obtained.From the graph (plot 1 to 7)) it is clear that between 60° and 75° increase in young's modulus is more.So a fiber orientation angle can be considered between 60° and 75°.Here we took angle of orientation as 67.5°.

**ANALYSIS OF A CANISTER**

Finite element analysis (FEA) turned into first created in 1943 with the aid of R.Courant, who used the Ritz strategy for numerical evaluation and minimization of variety calculus to get envisioned solutions for vibration structures. currently, a paper dispensed in1956 by means of by using the mid 70's, FEA became limited to steeply-priced centralized laptop computer systems for the maximum part claimed by aeronautics, automotive, protection and nuclear ventures. given that the fast decrease in the price of computers and the super increment in figuring power




**Workflow of Structural and ACP module in ANSYS Workbench**

**Finite Element Analysis Procedure**

1. **Loads and Boundary Conditions**

**Case: 1**

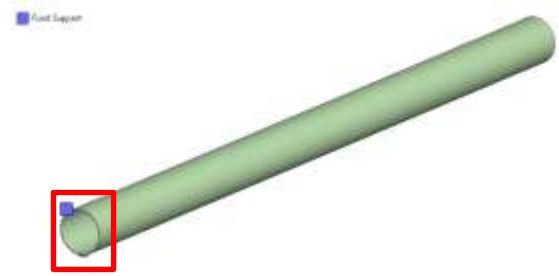
1. Applying 30 bar internal pressure
2. Applying 5 bar external pressure
3. One end of the shell is fixed

**Case: 2**

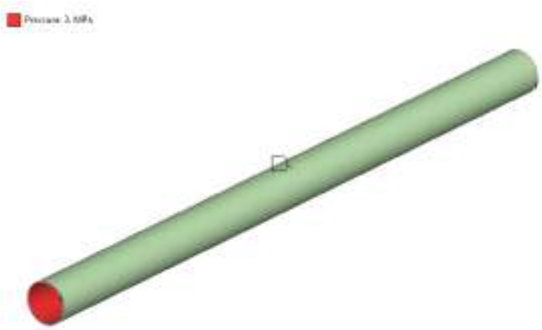
1. Applying 30 bar internal pressure
2. Applying 5 bar external pressure
3. Two ends of the shell is fixed

**External pressure of 0.5 MPa is applied on the shell body**

**Internal pressure of 3 MPa is applied on the shell body**

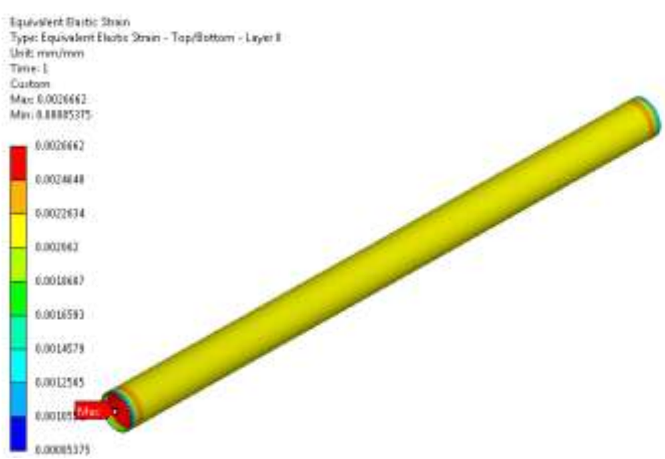


**Case: 1** **Case: 2**



**RESULTS AND DISCUSSION**

In this chapter calculation of vonmises stresses and strains at required angle is done and analysis is done on canister by applying 30 bar internal and 5 bar external pressure by fixing ends. The results of theoretical and finite element analysis are compared. From tsai wu failure theory the stresses are calculated and are compared with finite element analysis.



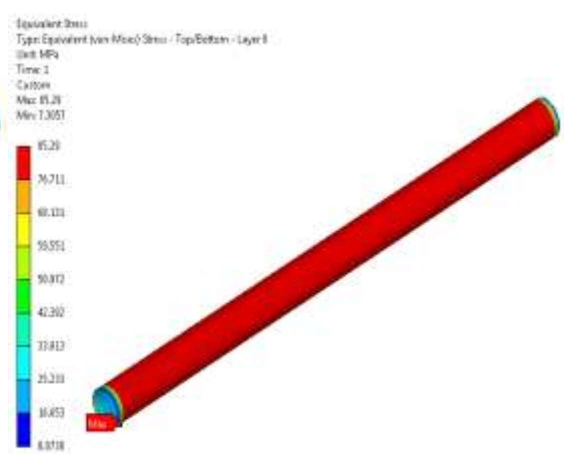




**Fig 2: Two end fixed at 67.5° strain** **Fig 3: Two end fixed at 67.5° stress**

Stress and strains of canister when 30 bar internal pressure applied are as follows

| Sl.No. | | Vonmises stress (MPa) | Vonmises strain (mm/mm) |
|---|---|---|---|
| 1 | **Unidirectional(one end fixed)** | 108.76 | 0.00622 |
| 2 | **Unidirectional(two end fixed)** | 119.91 | 0.00611 |
| 3 | **67.5° orientation(one end fixed)** | 92.32 | 0.00290 |
| 4 | **67.5° orientation(two end fixed)** | 85.29 | 0.00266 |

**Table 1: Vonmises stresses and strains at different end conditions for unidirectional and 67.5 oriented laminates**

**Stress and strain for unidirectional lamina are calculated as follows:**

$$\begin{pmatrix}\sigma_1\\ \sigma_2\\ \tau_{12}\end{pmatrix} = \begin{pmatrix}111713.10\\ -1822.33\\ 0\end{pmatrix}\text{MPa}$$

**Stress and strain for 67.5 oriented lamina are calculated as follows:**

$$\begin{pmatrix}\sigma_1\\ \sigma_2\\ \tau_{12}\end{pmatrix} = \begin{pmatrix}0.0350\\ -0.043\\ -3.246\times 10^{-3}\end{pmatrix}\text{MPa}$$

| Unidirectional | 67.5 orientation |
|---|---|
| 405 MPa | 492 MPa |

**Table 2: strength ratios for unidirectional and 67.5 oriented laminates**

Factor of safety for unidirectional and 67.5 oriented laminates and tabulated as follows

| unidirectional | 67.5 orientation |
|---|---|
| 2.6 | 2.15 |

**Table 3: Factor of safety for unidirectional and 67.5 oriented laminates**

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