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Design, Modeling and Analysis of Composite Pressure Vessel for Different Orientation Angles

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ABSTRACT:
Cylindrical pressure vessels ar wide used for business, underneath water vehicles and in region applications. at the moment the outer shells of the pressure vessels ar created from typical metals like steels and metal alloys. The payload performance/ speed/ in operation vary depends upon the load. The lower the load the higher the performance, a way of reducing the load is by reducing the load of the shell structure. the utilization of composite materials improves the performance of the vessel and offers a major quantity of fabric savings.Moreover, the stacking sequence is incredibly crucial to the strength of the stuff.

This Project involves numerous objective functions like stiffness, buckling load and Weight at every level of improvement. analytical model is developed for the Prediction of the minimum buckling load with / while not filler composite shell of continuous angle ply laminas (±45°,±55°,±65°,±75°,±85°) for investigation. Comparisons square measure created for 2 completely different approaches i.e. the finite component model and therefore the theoretical model. ANSYS-14.5 version package into thought, for static structural modal and random vibrational analysis on the pressure vessel.

I. INTRODUCTION:
Pressure vessels, like refrigerant and gas storage tanks containing substances stressed, cause a possible hazard to instrumentality and personnel from rupture or explosion/implosion.

Classification of Pressure Vessels:
The pressure vessels may be classified as follows:
1. According to the dimensions.
2. According to the end construction.

Stresses in an exceedingly skinny Cylindrical Shell because of an enclosed Pressure
When a skinny cylindrical shell is subjected to an interior pressure, it's seemingly to fail within the following 2 ways:
1. It should fail on the longitudinal section (i.e. circumferentially) cacophonous the cylinder into 2 troughs, as shown in Fig. (a).
2. It should fail across the transversal section (i.e. longitudinally) cacophonous the cylinder into 2 cylindrical shells, as shown in Fig. (b).

Fig. Failure of a cylindrical shell.

Design Methodology:
In general, pressure vessels designed in accordance with the ASME Code, Section VIII, Division 1, area unit designed by rules and don't need an in depth analysis of all stresses. it's recognized that top localized and secondary bending stresses could exist however area unit allowed for by use of the next ratio and style rules for details.

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it's needed, however, that every one loadings (the forces applied to a vessel or its structural attachments) should be thought-about. While the Code provides formulas for thickness and stress of basic parts, it's up to the designer to pick applicable analytical procedures for decisive stress thanks to different loadings. The styleer should conjointly choose the foremost probable combination of concurrent masses for a cheap and safe design.

Loads:

Design pressure is that the wont to confirm the minimum needed thickness of every vessel shell element and denotes the distinction between the interior and external pressure (usually the planning and part pressures). It includes an acceptable margin higher than the operative pressure (10% of operative pressure or ten psi min) and any static head of operative liquid. Minimum style pressure for Code stamping isn't needed. Vessels with negative gauge operative pressure ar usually designed for full vacuum.

Temperature Loads:

Design temperature is additional a style status than a style load, +since solely a activity combined with somebody restraint or bound temperature gradients can originate thermal stresses. However, it's a crucial style condition that influences a good degree the suitableness of the chosen material for construction. Decrease in metal strength with rising temperatures, redoubled crispiness with falling temperature, and therefore the incidental dimensional changes ar simply some of the phenomena to be taken into consideration for the look.

II. LITERATURE REVIEW:

The Work done by Mr. MukundKavekar [1],Weight Reduction Of Pressure Vessel exploitation Frp material. These industries square measure in would like of pressure vessels which is able to have low weight to strength quantitative relation while not moving the strength.

On the premise of research it's found that FRP pressure vessel has additional strength than steel pressure vessel and it's conjointly all over that the pressure within the vessel may be reduced up to seventy five handy commutation steel with FRP material.

The Work done by M.A. MujeebIqbal [2], style and Stress Analysis of FRP Composite Pressure Vessel. Pressure vessels ar containers that operate at pressures higher than air pressure. A pressure vessel is outlined as a comparatively high-volume pressure element (like a spherical or cylindrical instrumentality) that contains a cross section larger than the associated pipe or tube .The composite materials are wide used for the producing of pressure vessels from a really long term. These pressure vessels ar factory-made by filament winding method.

The Work done by RaoYarrapragada K.S.S [3], Composite Pressure Vessels. Cylindrical pressure vessels square measure wide used for business, underneath water vehicles and in part applications. typically composite pressure vessels square measure designed for minimum mass underneath strength constraints. A graphical analysis is bestowed to seek out optimum fiber orientation for given layer thicknesses. within the gift work.

The Work done by M. Madhavi [4], style and Analysis of Filament Wound Composite Pressure Vessel with Integrated-end Domes. Filament-wound composite pressure vessels square measure a crucial sort of aggressive instrumentation that's wide utilized in the business and part industries. The mechanical and physical properties so obtained square measure utilized in the planning of the composite shell. the planning of the composite shell is delineate intimately. Netting analysis is employed for the calculation of hoop and whorled thickness of the shell. A balanced bilaterally symmetric ply sequence for carbon T300/epoxy is taken into account for the whole pressure vessel.

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Progressive failure analysis of composite pressure vessel with geodesic finish domes is meted out. A package code SHELL problem solver is developed victimization Classical Lamination-theory to see matrix crack failure, burst pressure values at numerous positions of the shell. The results is used to know structural characteristics of filament wound pressure vessels with integrated finish domes.

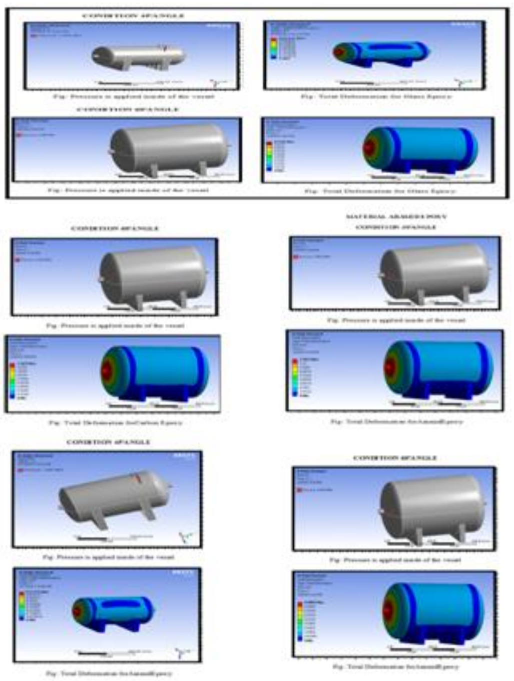
III. Analysis of wounded pressure vessels by using FRP material

Boundary Conditions:

The material properties are specified in the below table which are taken from website www.matweb.com

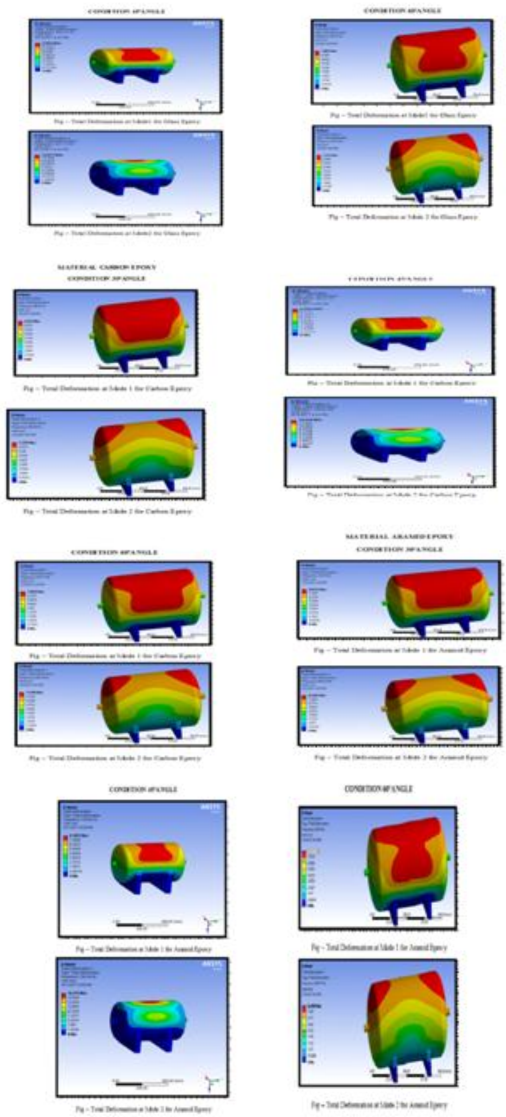
MATERIAL	Density (g/cc)	Young's modulus (GPa)	Poisson's ratio
GLASS EPOXY	1.90	300	0.3
CARBON EPOXY	1.90	140	0.27
ARAMID EPOXY	1.44	179	0.34

Table -1 Material Properties



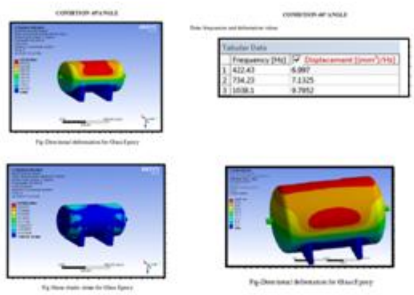
Modal analysis of wounded pressure vessels

Material glass epoxy , Condition 30°angle



Randam vibration alanalysis of wounded pressure vessel

Material glass epoxy, condition-at 30° angle



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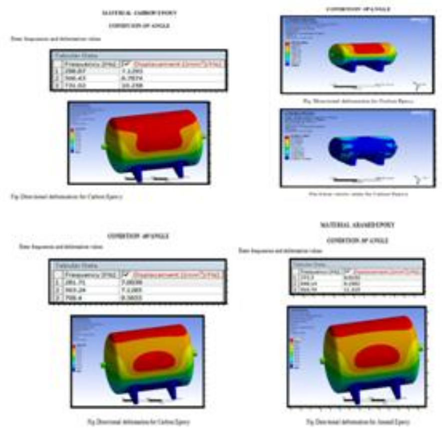

IV. Static analysis:

Tabular column for 30°angle:

Material	Pressure (MPA)	Deformation(mm)	Strain	Stress(N/mm²)
Glass Epoxy	1.5458	1.5458	0.0020326	596.66
Carbon Epoxy	3.5339	3.5339	0.0046894	641.66
Aramid Epoxy	1.3613	1.3613	0.0017685	310.25

RESULTS TABLE
STATIC ANALYSIS
TABULAR COLUMN FOR 30°ANGLE

Material	Pressure (MPA)	Deformation(mm)	Strain	Stress(N/mm²)
Glass Epoxy	1.5458	1.5458	0.0020326	596.66
Carbon Epoxy	3.5339	3.5339	0.0046894	641.66
Aramid Epoxy	1.3613	1.3613	0.0017685	310.25

TABULAR COLUMN FOR 45°ANGLE

Material	Pressure (MPA)	Deformation(mm)	Strain	Stress(N/mm²)
Glass Epoxy	3.5908	0.97317	0.001567	428.87
Carbon Epoxy	3.872	2.2579	0.003674	468.69
Aramid Epoxy	1.5756	0.71115	0.0011289	184.77

TABULAR COLUMN FOR 60°ANGLE

Material	Pressure(MPA)	Deformation(mm)	Strain	Stress(N/mm²)
Glass Epoxy	0.7101	0.7101	0.00093373	274.09
Carbon Epoxy	1.3679	1.3679	0.008151	248.36
Aramid Epoxy	1.0386	0.49055	0.0006373	111.8

MODAL ANALYSIS
TABULAR COLUMN FOR 30° ANGLE OF LAMINATED PLATES

Material	Pressure (MPA)	Frequency (Hz)	Deformation 1 (mm)	Frequency (Hz)	Deformation 2 (mm)	Frequency (Hz)	Deformation 3 (mm)
Glass Epoxy	1.5458	422.43	6.9697	734.23	7.1325	1038.1	9.7952
Carbon Epoxy	3.5339	298.87	6.7874	506.43	7.1293	731.02	10.258
Aramid Epoxy	1.3613	373.5	8.0153	648.14	8.1992	916.74	11.325

TABULAR COLUMN FOR 45° ANGLE OF LAMINATED PLATES

Material	Pressure (MPA)	Frequency (Hz)	Deformation 1 (mm)	Frequency (Hz)	Deformation 2 (mm)	Frequency (Hz)	Deformation 3 (mm)
Glass Epoxy	3.5908	492.21	6.954	831.72	14.072	888.4	6.23
Carbon Epoxy	3.872	344.41	6.8869	599.43	13.348	612.32	6.282
Aramid Epoxy	1.5756	439.84	8.1097	740.36	16.475	794.23	7.2429

TABULAR COLUMN FOR 60°ANGLEOF LAMINATED PLATES

Material	Pressure (MPA)	Frequency (Hz)	Deformation 1 (mm)	Frequency (Hz)	Deformation 2 (mm)	Frequency (Hz)	Deformation 3 (mm)
GLASS EPOXY	0.7101	415.27	7.0856	732.31	7.1323	1024..3	9.3264
CARBON EPOXY	1.3679	287.71	7.0039	503.24	7.1285	708.4	9.5655
ARAMID EPOXY	1.0386	366.8	8.1583	646.37	8.1989	903.95	10.686

RANDOM VIBRATION ANALYSIS
TABULAR COLUMN FOR 30°ANGLEOF LAMINATED PLATES

Material	Pressure(MPA)	Directional Deformation (mm)	Shear Stress (N/mm²)	Shear Strain
GLASS EPOXY	1.5458	438.69	14316	0.21433
CARBON EPOXY	3.5339	345.57	9568.7	0.1736
ARAMID EPOXY	1.3613	434.14	24081	0.2087

TABULAR COLUMN FOR 45°ANGLEOF LAMINATED PLATES

Material	Pressure(MPA)	Directional Deformation (mm)	Shear Stress (N/mm²)	Shear Strain
GLASS EPOXY	3.5908	543.62	28917	0.25061
CARBON EPOXY	3.872	447.81	11380	0.20647
ARAMID EPOXY	1.5756	555.83	17371	0.26008

TABULAR COLUMN FOR 60°ANGLEOF LAMINATED PLATES

Material	Pressure (MPA)	Directional Deformation (mm)	Shear Stress (N/mm²)	Shear Strain
GLASS EPOXY	0.7101	448.07	14162	0.21204
CARBON EPOXY	1.3679	360.83	9355.8	0.16974
ARAMID EPOXY	1.0386	442.71	23832	0.20654

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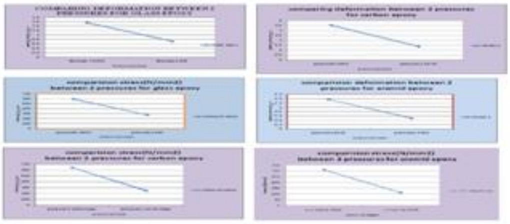
GRAPHS FOR STRUCTURAL ANALYSIS



V. CONCLUSION:

By observing the static analysis results, the deformations and stresses are reducing by increasing the orientation angle from 30^0 to 60^0. The stress values are less than the respective allowable stress values for all materials. The values are less when Aramid Fiber is used than other two materials. by observing the modal analysis results, the deformations and frequencies are reducing by increasing the orientation angle from 30^0 to 60^0. Since the frequencies are reducing, vibrations will decrease. Carbon Epoxy has lesser frequencies but the deformations are more. By observing the Random vibration analysis, the directional deformations and shear stresses are reducing by increasing the orientation angle from 30^0 to 60^0 due to lesser frequencies and also Carbon Epoxy has lesser values than other two materials. So it can be concluded that increasing orientation angle and Carbon Epoxy material is better.

REFERENCES:

[1] Tsai S W 1987 Composite Design, Think Composites USA.

[2] Babu M S, Srikanth G &Biswas S 2007 Composite Fabrication by Filament Winding - An Insight. http://www.tifac.org.in/news/pub.htm.

[3] Sinha M &Pandit S 2012 Maximum Stress and Burst Pressure Analysis of CFRP Composite Pressure Vessel International Journal of Emerging trends in Engineering and Development 4(2) 714-21.

[4] Onder A, Sayman O, Dogan T &Tarakcioglu N 2009 Composite structures 89(1) 159.