International Journal of Recent Trends in Engineering & Research

ISSN (ONLINE) : 2455 – 1457 IMPACT FACTOR : 4.101

STRESS ANALYSIS USING DIFFERENT COMBINATION OF COMPOSITE MATERIAL

R.Praveen Kumar[1], Lohitesh Jaga Kumar[2], Praveen D.N[3], T.P. Bharathesh[4]

[1,2,3,4] *Dept.of Mechanical Engineering, Akshaya Institute of Technology, Tumkur, Karnataka*

Abstract— The report mainly emphasizes on the structural analysis of Hybrid Composite Cylinders which are used for under water respiration using ansys software using Solid45 and Layered46 elements. The results were noted down and a study was carried out to find out the hoop stress developed in the cylinder for different fiber combinations. For optimizing the thickness and hence to reduce the weight of the cylinder filament winding thickness were calculated for different winding angles. A comparison was made between the theoretical results and the analysis results which were found to be satisfactory. The margin of safety was found to be positive in all cases and thus the results are concluded to be satisfactory. The results so obtained were tabulated and conclusions were derived for different fiber combinations of cylinder.

Keywords— FEM, Ansys

I. INTRODUCTION

Fiber wound composite weight vessels are a vital kind of high weight compartments. At the point when isotropic materials like metals are utilized for understanding the equipment, the material isn't completely used in the longitudinal/meridonial l heading bringing about finished weight parts. Then again half and half composite strands like glass, twaron, Kevlar, carbon with strengthened polymers with their high particular quality and moduli brings about the lessening of weight and expands the quality to weight proportion. Fiber fortified polymers are fundamental load passing on people and the including system keeps them in needed region and presentation. It goes about as a store trade medium and shields it from frustration.

II. ALUMINUM

Aluminum is brilliant for the metal's low thickness and for its ability to contradict disintegration in light of the wonder of passivation. Fundamental fragments created utilizing aluminum and its composites are pivotal to the flight business and are basic in various regions of transportation and essential materials. In high weight vessels it is used as a liner to expect spillage and goes about as a store trading medium.

2.1 ALUMINIUM ALLOYS

The following are the most commonly used aluminum alloys:

1. Aluminum 2024
2. Aluminum 7075
3. Aluminum 6061
4. Aluminum 5052
5. Aluminum 7050

Alloys	Density(g/cm3)	Yield strength (Mpa)	Ultimate strength(Mpa)
Aluminum **7075**	2.81	510-538	434-476
Aluminum **6061**	2.79	300	240
Aluminum **2024**	2.78	470	280
Aluminum **5052**	2.80	365	275
Aluminum **7050**	2.82	480	360

The project mainly emphasizes on Al 6061T6 alloy whose description is given in the following section.The phrase 061T6 indicates the heat treatment process conditions for Al 6061 alloy.

III. CIRCUMFERENTIAL PRESSURE

A tractable pressure acting toward a path distracting bearing to the circuit is called circumferential pressure or circle pressure. As it were, it

For thin cylindrical vessel

Hoop stress $\sigma_{H=}$ PD/2t

Where,

P=Internal pressure in N/mm^2

D=Diameter of cylinder in mm

T=thickness of cylinder in mm

L=Length of cylinder in mm

3.1 LONGITUDINAL PRESSURE

An elastic pressure acting toward hub is called longitudinal pressure. At the end of the day, it is an elastic pressure following up on the transverse or circumferential area.

For thin cylindrical vessel

Longitudinal stress $\sigma_{L=}$ PD/4T

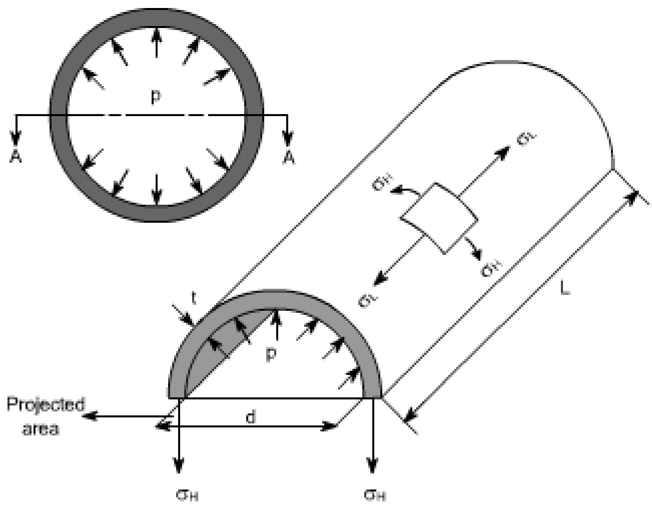

Figure.3.4 Hoop stress and longitudinal stress in thin cylinder

3.2 STRESS DEVELOPED IN THE FILAMENT WINDING:
$\sigma_{w=}(PR-T\sigma_H)/T_w$
$\sigma_{w\,=}$Stress developed in the winding in mm
$t_{w\,=}$thickness of the winding in mm

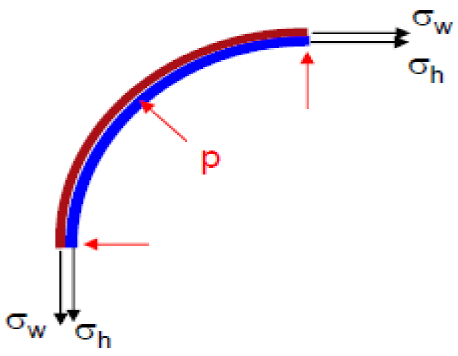

Figure.3.5 Hoop stress in winding

IV. FINITE ELEMENT METHOD

It is a numerical procedure for acquiring surmised answer for a wide assortment of designing issue. Demonstrating and limited component investigations are the two most prevalent building applications. This is credited to the way that the limited component strategy is maybe the most well known numerical procedure for taking care of designing issues. The strategy is sufficiently general to deal with any unpredictable shape or geometry, any material properties, any limit condition and any stacking conditions. The consensus of the limited component strategy fits the examination necessity of today s complex building framework and outline, it is an effective plan instrument by which creators can perform parametric outline thinks about by considering different plan cases, break down them and can pick the ideal outline.

V. PROPERTIES OF THE MATERIALS BEING USED

1. Aluminum 6061-T6
Density ρ = 2.78g/cc
Tensile strength = 275Mpa
Elastic modulus = 68.9Gpa
2. Carbon
Density ρ = 1.78g/cc
Tensile strength = 2.1Gpa
Elastic modulus = 150Gpa
3. Kevlar 49
Density ρ = 1.44g/cc
Tensile strength = 3.5Gpa
Elastic modulus = 87Gpa
4. E-Glass
Density ρ = 2.78g/cc
Tensile strength = 3.4Gpa
Elastic modulus = 72Gpa

VI. THEORETICAL RESULTS

6.1 CYLINDER SPECIFICATIONS

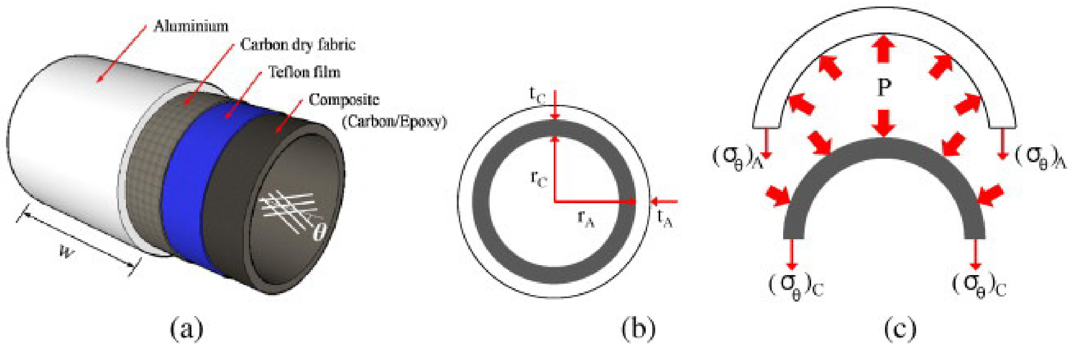

Figure.6.1 Cylinder Specification

a. Diameter= 80.5mm
b. Length=240mm
c. Burst pressure= 900bar

6.2 CALCULATIONS:

Thickness of the aluminium liner

$t=PD/2\sigma_F$

where,
P= 1/6 of the burst pressure
D= Diameter in mm
$\sigma_{F=}$ Working stress in mm
Factor of safety= 1.5

t= 15*80.5*1.5/(2*275)

t=3.2932mm

6.3 Helical and hoop thickness of the winding fiber

a. Helical thickness t_h= PR/(2 σ_FCOS$^2\theta$)

Where,
R=Radius of the cylinder in mm
θ=Winding angle in degree
σ_F= Strength of the fiber in N/mm2

For helical thickness 80% strength consideration
Helical thickness of the carbon fiber
t_h= 90*43.5432/(2*0.8*2.1*10^9*COS^{2}18)

t_h= 1.964mm

b. Hoop thickness T_{hoop}= PR(2-Tan$^2\theta$)/2 σ_F

For hoop thickness 90% strength consideration
Hoop thickness of the carbon fiber
t_{hoop}= 90*43.5432*(2-Tan^{2}18)/(2*0.9*2.1*10^9)

t_{hoop}= 1.2895mm

Similarly hoop and helical winding thickness are calculated using the above equations for different winding angles.

6.4 Theoretical calculation

Stress at any radius of cylinder

$\sigma_h =\{p_i(r_i)^2 / [(r_o)^2 - (r_i)^2] \} * [1+ (r_o)^2/ x^2]$

where ,

σ_h = hoop stress in N/mm^2

p_i = applied pressure in N/mm^2

r_o = outer radius in mm

r_i = inner radius in mm

x = any radius in mm

6.5 Calculation

$\sigma_h =\{p_i(r_i)^2 / [(r_o)^2 - (r_i)^2] \} * [1+ (r_o)^2/ x^2]$

$\sigma_h =\{90(40.25)^2 / [(49.5128)^2 - (40.25)^2] \} * [1+ (49.5128)^2/ 40.25^2]$

σ_h = 440.72N/mm^2

VII. ALUMINIUM, CARBON AND GLASS COMBINATION CYLINDER

Material	Winding type	Winding angle in deg	Thickness in mm
Aluminium	-------------------------------	-------------------------------	3.2932
Carbon	Hoop	18	1.964
Glass	Helical	18	0.7964
Carbon	Hoop	23	1.8867
Glass	Hoop	18	1.2131
Carbon	Hoop	54	0.1094

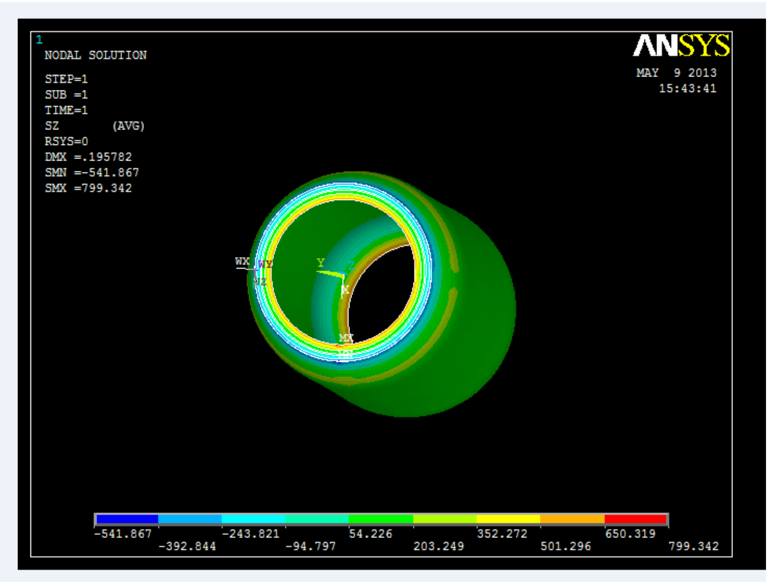

Figure.7.1 Hoop stress for cylinder 1

7.1 Hoop Stress at different Radius of Cylinder

Sl.no	Radius in mm	Hoop Stress in MPa
1	40.25	440.72
2	43.54	402.09
3	45.50	382.95
4	46.30	375.87
5	48.19	360.48
6	49.40	351.40
7	49.51	350.72

VIII. ALUMINIUM, CARBON AND KEVLAR COMBINATION CYLINDER

Material	Winding type	Winding angle in deg	Thickness in mm
Aluminium	-------------------------------	-------------------------------	3.2932
Carbon	Hoop	23	1.8867
Kevlar	Helical	73	0.7733
Carbon	Helical	18	1.2895
Kevlar	Hoop	23	1.1320
Carbon	Hoop	54	0.1094

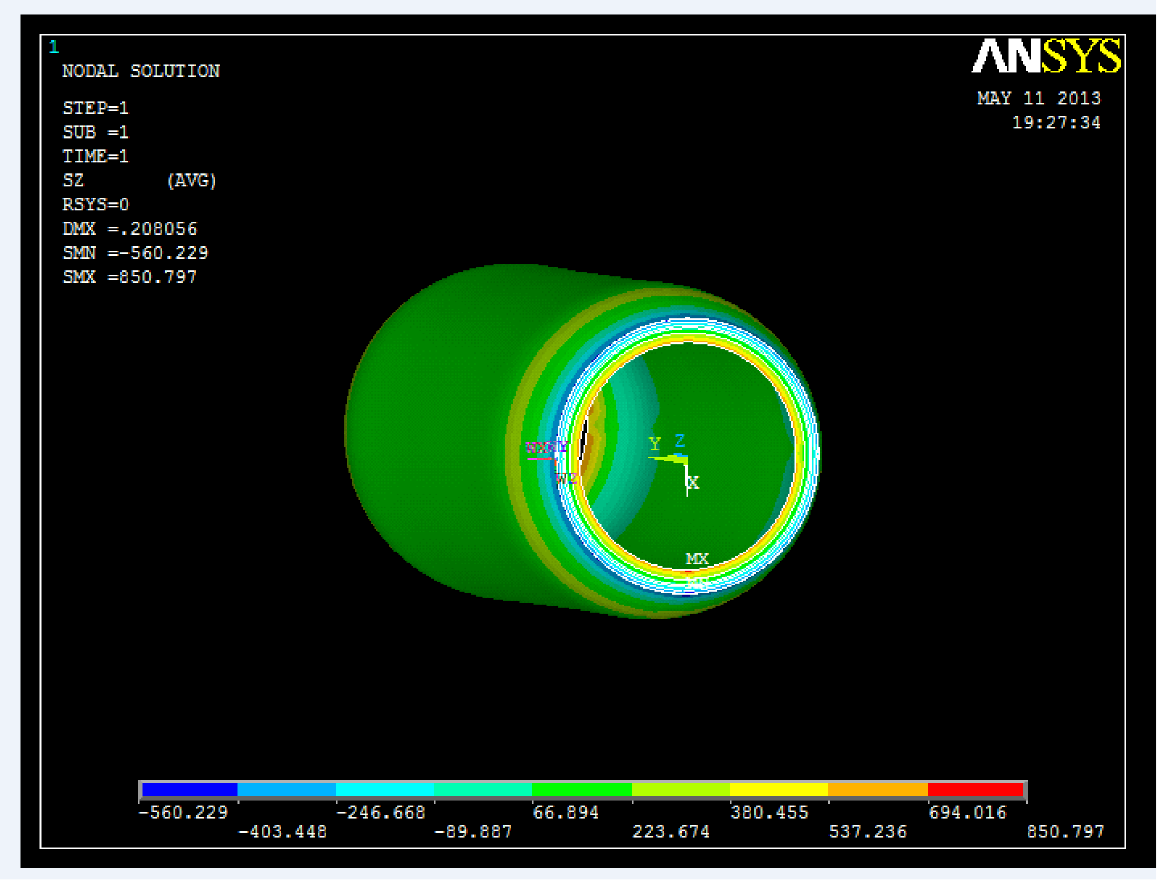

Figure.7.4 Hoop stress for cylinder 4

8.1 Hoop Stress at different Radius of Cylinder

Sl.no	Radius in mm	Hoop Stress in MPa
1	40.25	476.25
2	43.54	435.05
3	45.42	415.38
4	46.20	408.00
5	47.49	396.49
6	48.62	387.13
7	48.73	386.26

IX. CONCLUSION

From the static analysis of composite cylinder the following conclusions are drawn

1. Theoretical results were calculated and same compared with the analysis results.
2. The conduct of the fiber wound structure subjected to inner weight was broke down considering the winding edge change through the thickness.
3. For a few outline parameters, for example, a helical winding edge and thickness, the measure of winding point alter in the thickness course was evaluated.

REFERENCES

1. LohiteshJaga Kumar et al., "Study of the static structural analysis of the mono crankshaft for bending and torsional load", Volume 4, Issue 6, June 2018.
2. Ahmed Ibrahim,et.al., "Stress Analysis of Thin-Walled Pressure Vessels", 3 February 2015.
3. Dhanaraj,et.al, "Design & Stress Analysis of a Cylinder with Closed ends using ANSYS",ISSN : 2248-9622, Vol. 5, Issue 4, (Part -6) April 2015.
4. Dr.Ragbe.M.Abdusslam,et.al. "Stresses Analysis of Petroleum Pipe Finite Element under Internal Pressure",IJERA,ISSN : 2248-9622, Vol. 6, Issue 8, (Part -4) August 2016.
5. T. Subramani,et.al, "Finite Element Analysis of Thin Walled-Shell Structures by ANSYS and LS-DYNA",IJMER Vol.2, Issue.4, ISSN: 2249-6645 July-Aug 2012 .
6. Atul Kumar Raikwar, et.al, "Design and optimization of automobile propeller shaft with composite materials using FEM Analysis", in 2016 IJEDR , Volume 4, Issue 4 , ISSN: 2321-9939.