"ANALYSIS OF RECTANGULAR CROSS SECTION OF PIPE MADE OF COMPOSITE MATERIAL"

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ABSTRACT

Composite materials have been widely used in the ship-building, aerospace and construction industries because of their distinct advantages of low weight, high stiffness, and high strength to weight ratios. These properties are due to the low weight of the epoxy core matrix and high strengths of the glass/carbon fibers. Composite pipes used in various applications are traditionally spherical in cross-section. In this study, non-conventional cross-sectioned composite pipes [i.e. rectangular and triangular cross-sections] have been proposed, fabricated, tested and analyzed because of their ability to be bundled without loss of space. The behaviors of these pipes under an internal pressure test have been studied and its failure mechanisms have been investigated.

KEYWORDS

FEA, Stress analysis, Composite Analysis, offshore, FRP composites

1. INTRODUCTION

Our search for oil is sending us deep into the sea, however this has its own challenges. The salinity of the sea, acts as an active corrosive agent, and it steadily weakens the structure to get around this, non-corrosive composite piping has been deployed in critical regions of the structure. However to enable pipe stacking, sometimes to avail of space constraints, instead of circular c/s, the pipes are increasingly being made of triangular or rectangular c/s. For such c/s theoretical calculations are not possible, hence we need FEA to help us understand the behavior of such c/s.

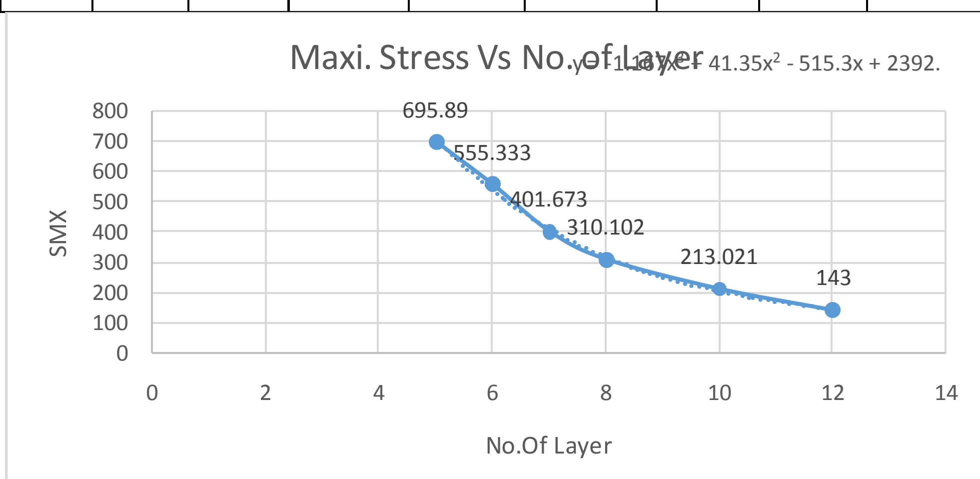
2. COMPOSITE MATERIALS

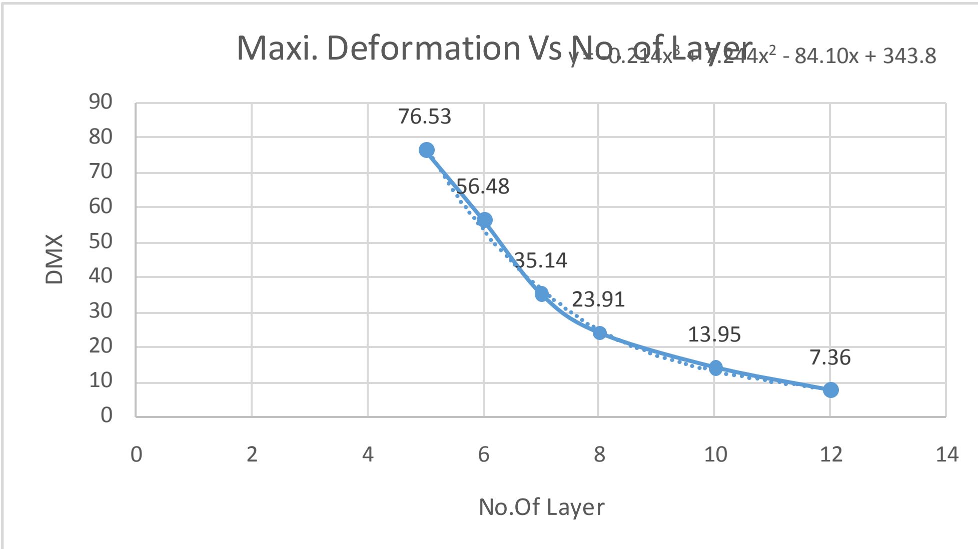
Composite materials are formed by the combination of two or more materials to achieve properties (physical, chemical, etc.) that are superior to those of its constituents. The main components of composite materials, or composites, are fibers and matrix. The fibers provide most of the stiffness and strength. The matrix binds the fibers together thus providing load transfer between fibers and between the composite and the external loads and supports. Also, it protects the fibers from environmental attack.

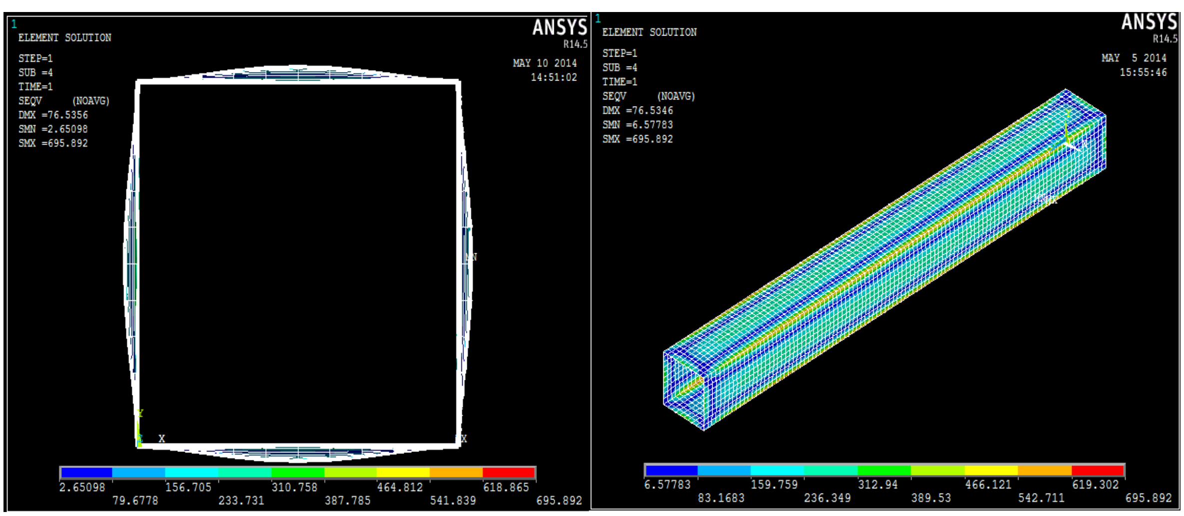
3 RESULT

3.1 DEFLECTION & STRESS GENERATION IN FIXED BEAM

A	B	C	D	Length	No.of Layer	Meshing Size	DMX	SMN	SMX	No. of Nodes
2000	2000	2000	2000	20000	5	200	76.53	6.57	695.89	12000
					6		56.48	2.96	555.333	
					7		35.14	0.94	401.673	
					8		23.91	0.44	310.102	
					10		13.95	0.4	213.021	
					12		7.36	0.4	143	




Maxi. Deformation Vs No. of Layer
- 84.10x + 343.8
DMX
No.Of Layer
76.53
56.48
35.14
23.91
13.95
7.36
0
10
20
30
40
50
60
70
80
90
0
2
4
6
8
10
12
14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MAY 10 2014
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2.65098
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156.705
233.731
310.758
387.785
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618.865
695.892
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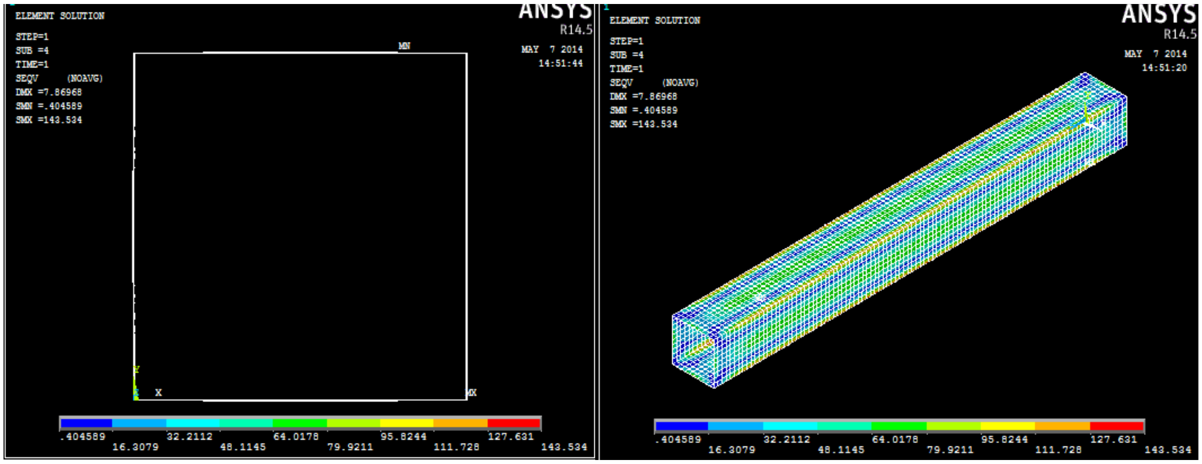
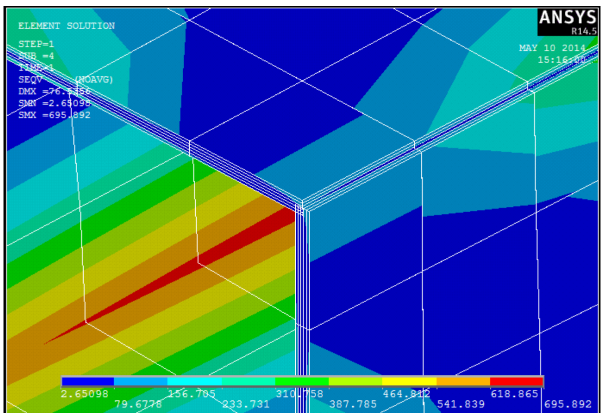
695.892

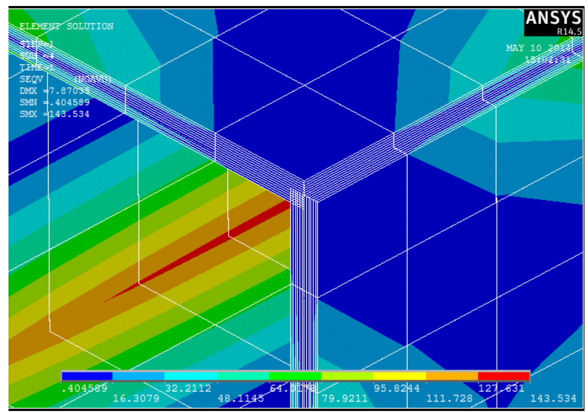
5 layer



12 layers

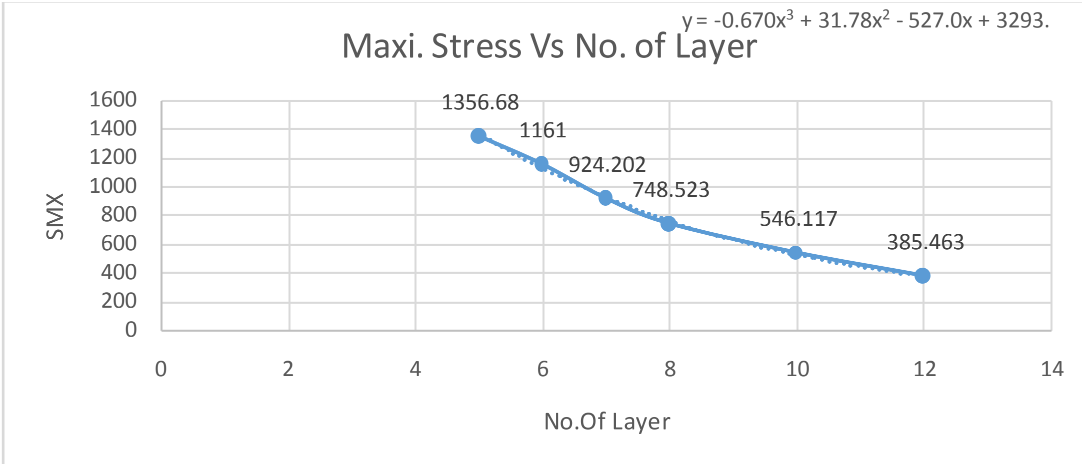


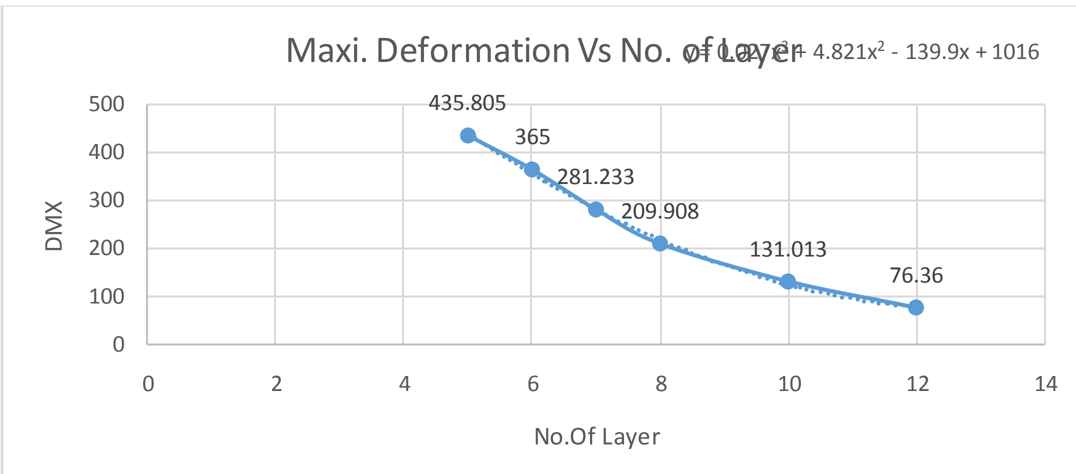
5 Layers

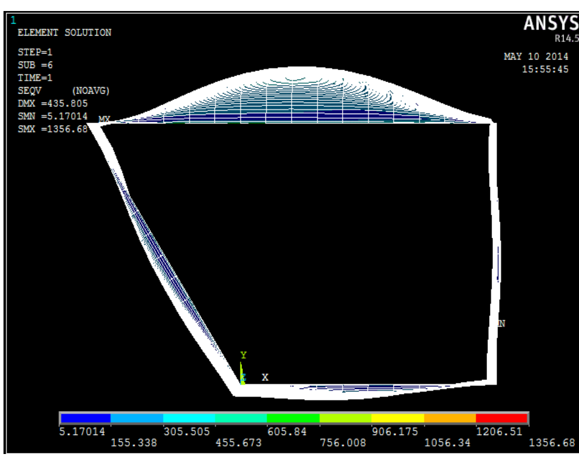


12 Layers

A	B	C	D	Length	No. of Layer	Meshing Size	DMX	SMN	SMX
2000	2000	3200	2332	20000	5	200	435.81	5.17	1356.68
					6		365	4.6	1161
					7		281.23	4.93	924.202
					8		209.91	2.6	748.523
					10		131.01	1.32	546.117
					12		76.36	0.921`	385.463







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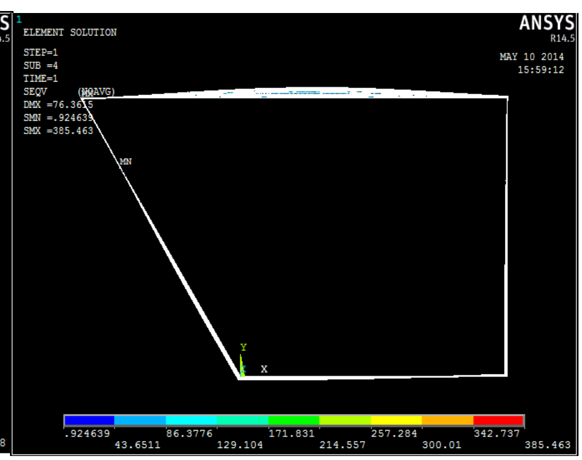
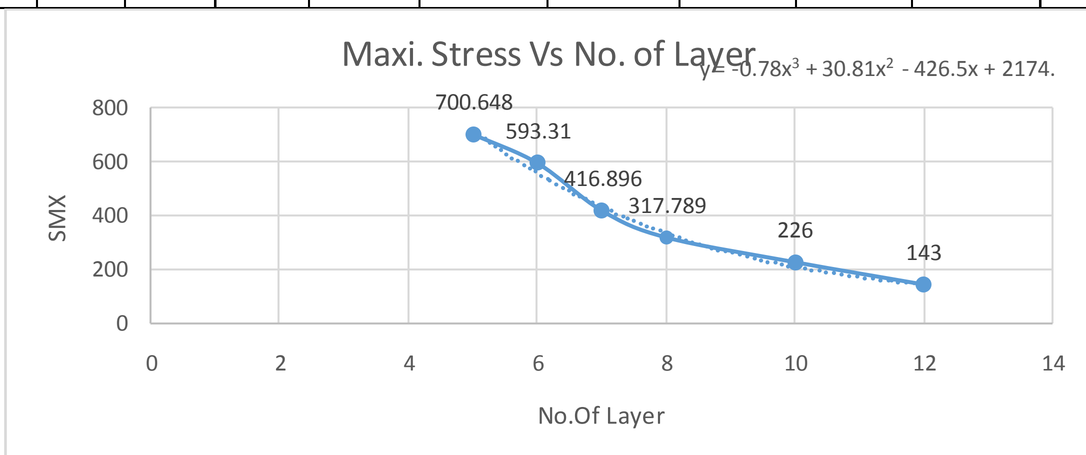
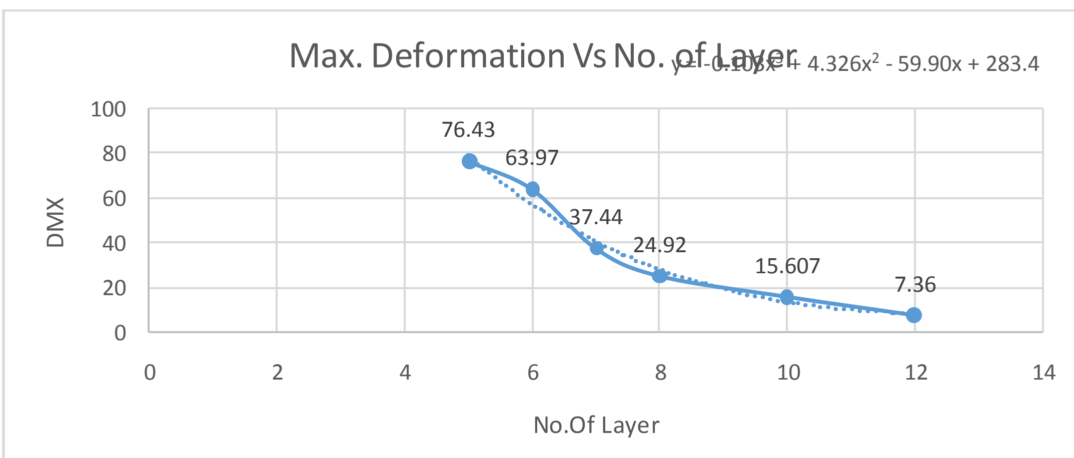


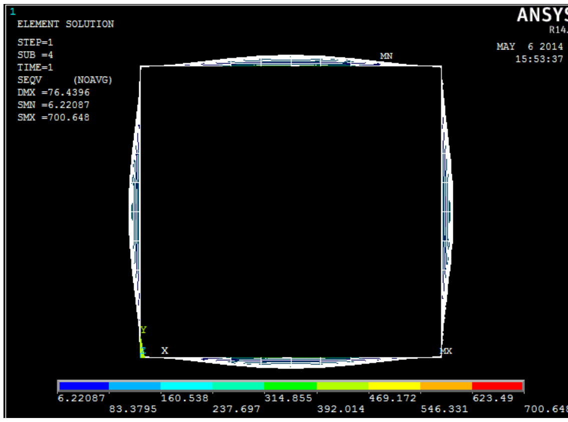
12 Layer

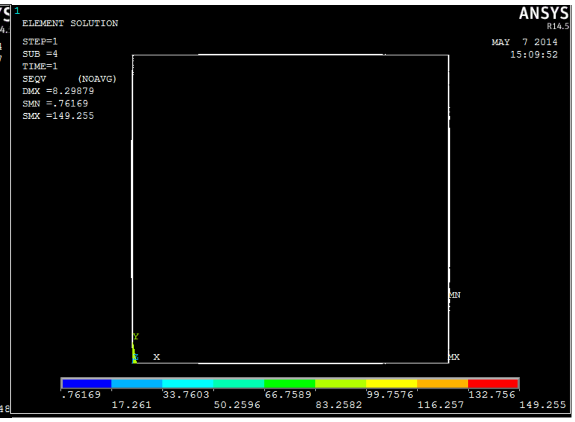
DEFLECTION & STRESS GENERATION IN CANTILIVER BEAM

A	B	C	D	Length	No.of Layer	Meshing Size	DMX	SMN	SMX	No. of Nodes
2000	2000	2000	2000	20000	5	200	76.43	6.22	700.648	12000
					6		63.97	0.97	593.31	
					7		37.44	0.85	416.896	
					8		24.92	0.61	317.789	
					10		15.607	0.42	226	
					12		7.36	0.4	143	





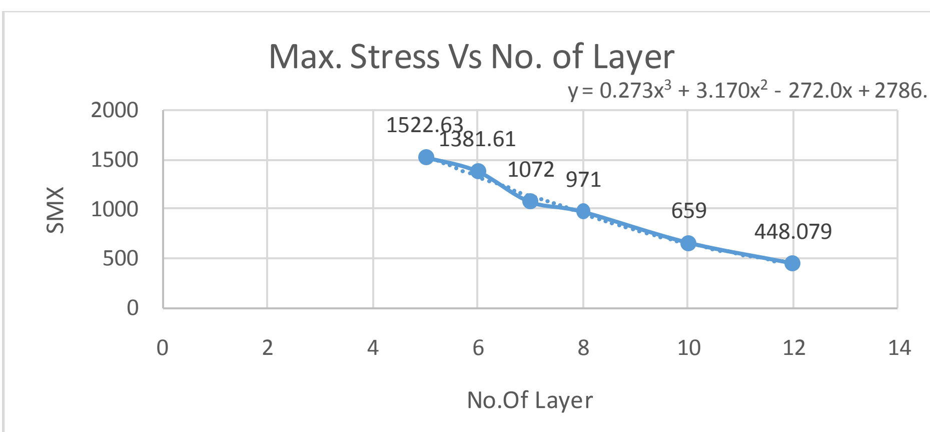


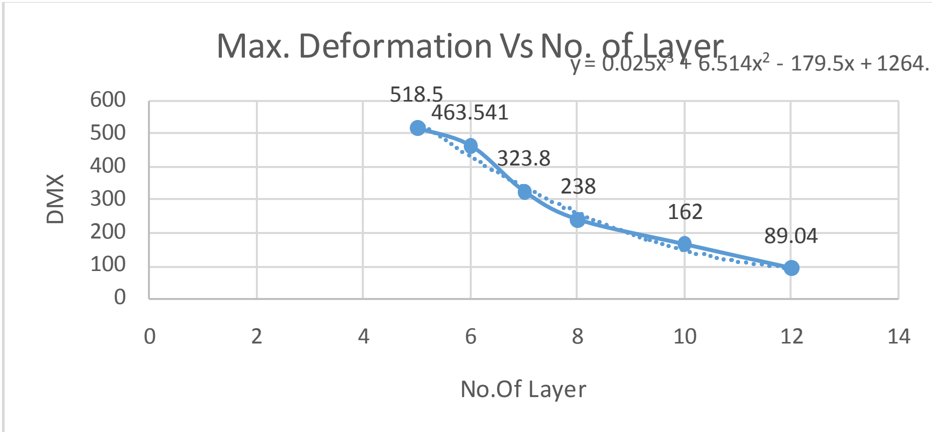


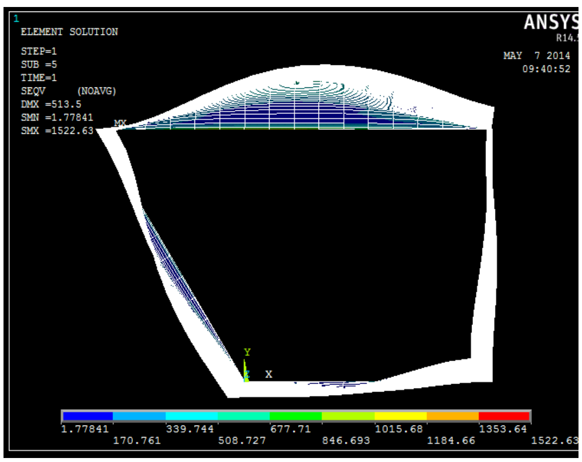
5 LAYER 12

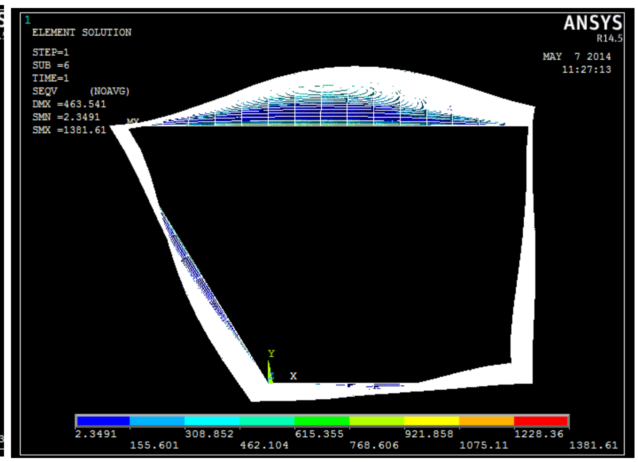
LAYER

A	B	C	D	Length	No.of Layer	Meshing Size	DMX	SMN	SMX
2000	2000	3200	2332	20000	5	200	518.5	1.77	1522.63
					6		463.541	2.34	1381.61
					7		323.8	0.23	1072
					8		238	0.5	971
					10		162	1.5	659
					12		89.04	0.52	448.079

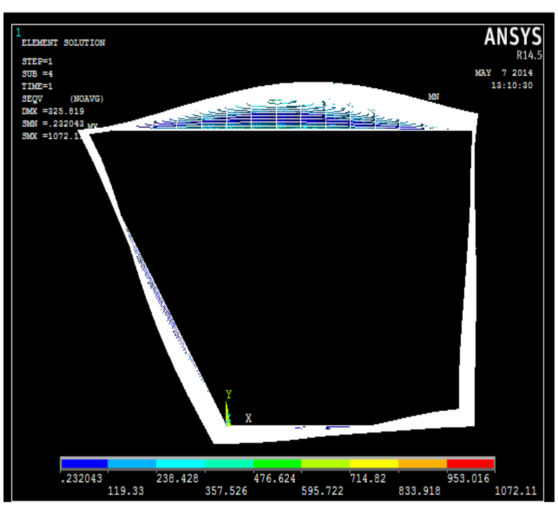


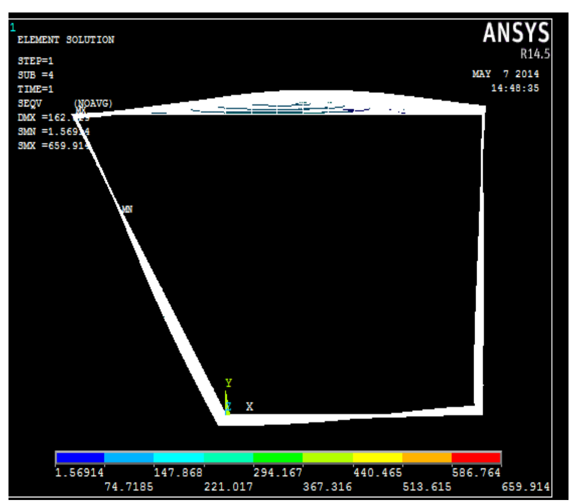






5 LA YER 6 LA YER





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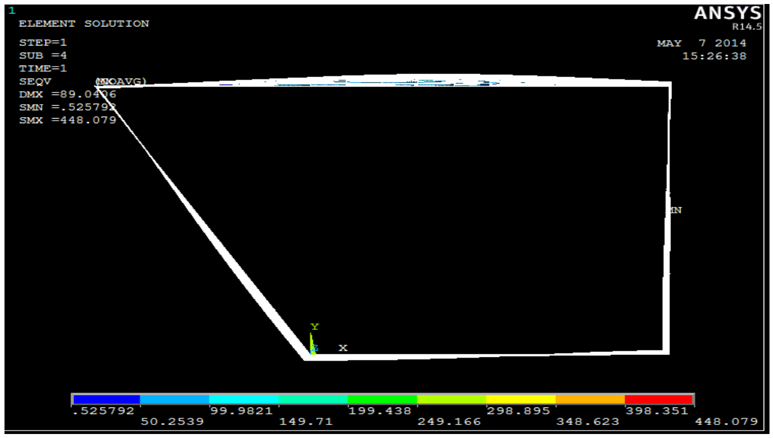

12 LAYERS

4. RESULT

I] With increase in no. of layer of pipe deformation decreases and stress induced in the pipe decreases.

The relation between the Max. Stress & max. Deformation with res. to No. of layers for fixed beam of 2000 x2000 square pipe is as follow,

1. Max. Stress = -1.1677(No. of Layer's)^3 + 41.351(No. of Layer's)^2 - 515.34(No. of Layer's) + 2392.2
2. Max. Deformation = -0.2142(No. of Layer's)^3 + 7.2442(No. of Layer's)^2 - 84.107(No. of Layer's) + 343.8

The relation between the Max. Stress & max. Deformation with res. to No. of layers for cantilever beam of 2000 x2000 square pipe is as follow,

1. Max. Stress = -0.78(No. of Layer's)^3 + 30.818(No. of Layer's)^2 - 426.52(No. of Layer's) + 2174.9
2. Max. Deformation = -0.1039(No. of Layer's)^3 + 4.3266(No. of Layer's)^2 - 59.903(No. of Layer's) + 283.4

II] With increase in the node number Max. Stress increases & Deformation vary in small amount.

5. CONCLUSION

. Analysis results are reliable as seen in Mesh Sensitivity convergence and actual Testing.

2. Concerned with FEA analysis more accurate results are achieved.

3. We conclude the point at which maximum stress occurs and the effect of stress and deformation with change in dimensions and change in layers with change in orientation.

Shape distortion i.e. change from square shape to trapezoidal shape has an effect on the stress an deformation levels,, as the distortion increases the stress start increasing with a cubic relation. .

4. Shape distortion also increases deformation with a cubic relation .

5. No of layers, as we increase them we see an increase in stiffness with is rapid which reduces the deformation and stresses also Shell 281 proves to be a good candidate for composite analysis, showing good mesh convergence characteristics

6. Parametric program enables data collection and database management in an efficient manner

6. FUTURE SCOPE

Further analysis can be done for different Non-conventional cross section components Pentagon, Hexagon, Triangle etc for evaluating the results to improve efficiency and life of the composite pipe.

7. REFERENCES

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