

Design of Circular Core Composite Structure for Structural Applications

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ABSTRACT

In this present work is carried out on modeling and analysis of circular core composite structure to replace the earlier circular core steel structure. The work is to reduce the overall weight of circular core composite structure and improve load carrying capacity of the circular core composite structure. The Circular core steel structure which is used in application of aircrafts, wind turbine blades, marine, space and also in other industrial sectors. In this paper analysis of circular core steel structure and circular core composite structure is done in Ansys work bench and total deformation and equivalent stress is analyzed. The model of composite structure is generated in Poe-E. Result shows that, the circular core composite structure has stresses much lower than circular core steel structure and weight of circular core composite structure is reduced.

Keywords— E-Glass/Epoxy, Pro-E, Composite structure, Ansys 14.5, Mild steel.

1. INTRODUCTION

In steel sandwich structures top plate and bottom plate made up of steel and core which is made up of steel are called as steel sandwich structure. Core structures having different types which are O- core, I core, web core, Vf- core, corrugated core, c- core, z-core, hat- core, x- core which are shown in Figure 1. In this paper Circular core composite structure have two plates i.e. top and bottom side of plates are made from mild steel material and core which is made up of glass fiber reinforced polymer (E-glass/epoxy).

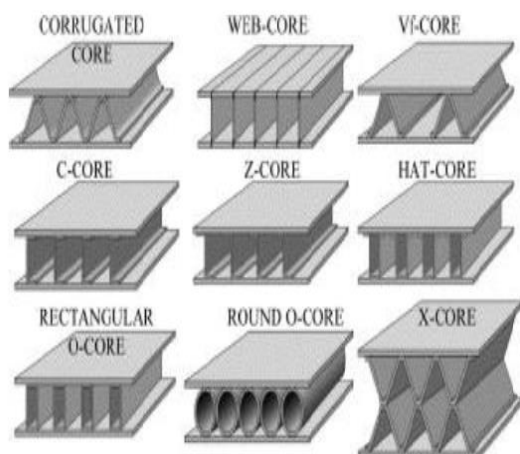


Fig-1: Different steel sandwich structure with various cores.

A.Gopichand made a design and analysis of corrugated sand which panel with stainless steel face sheets and mild steel as core is done using Ansys work bench and compressive strength is compared with experimental value. For given length and height of the structure increasing the number of curved waves (3 waves to 4 waves) the strength increases effectively. For increase of 4% weight, the strength is increase to 66% [8]. Pentti Kujala make a review on steel sandwich panels and when this sandwich panels are welded by laser then save 30-50% of weight as compared to conventional steel structure[6].

2. OBJECTIVE OF WORK

Objective is to increase strength of circular core composite structure and also reduction of weight of circular core composite structure as compare to circular core steel structure. There are different methods are available to increase the strength but we use best method to increase the strength. Following are the major objectives of work.

1. The major objective is to increase the strength at minimum weight.
2. Analyze Effect of equivalent stress on circular core composite structure.

3. Analyze Effect of weight on circular core composite structure.

3. DESIGN AND ANALYSIS OF COMPOSITE STRUCTURE

Circular core composite structure and Circular core steel structure which is generated in Pro-E and this both models are then it is imported into ANSYS workbench. In ANSYS workbench geometry shows three contact pairs. Material properties are given to the circular core composite structure i.e. top and bottom plates are selected as a mild steel and core which is selected as a glass fiber reinforced polymer (E-glass/epoxy). Material properties are given to the circular core steel structure i.e. top plate, bottom plate and core material which is selected as mild steel. Select the mesh size 3mm. For structural analysis of circular core composite structure and circular core steel structure fixing the bottom plate from bottom side and applying the uniform load on top side of the plate and total deformation and equivalent stress noted.

Properties	Value
Tensile modulus along X-direction (E_x)	34000 MPa
Tensile modulus along Y-direction (E_y)	6530 MPa
Tensile modulus along Z-direction (E_z)	6530 MPa
Tensile strength of the material	900 MPa
Compressive strength of the material	450 MPa
Shear modulus (G_{xy})	2433 MPa
Shear modulus (G_{yz})	1698 MPa
Shear modulus (G_{zx})	2433 MPa
Poisson ratio along XY-direction (μ_{xy})	0.217
Poisson ratio along YZ-direction (μ_{yz})	0.366
Poisson ratio along ZX-direction (μ_{zx})	0.217
Mass density of the material (ρ)	2.6×10^6 kg/mm ³

Flexural modulus of the material	40000
Flexural strength of the material	1200

Table-1: Material properties of E-Glass/epoxy.

3.1. Circular Core Steel Structure

Top and bottom side plate of structure - 100mmx100mm5mm.

Core shape –Circular.

Core Height – 20.5 mm.

Inner diameter of Core structure – 15mm

Outer diameter of Core structure – 20.5mm

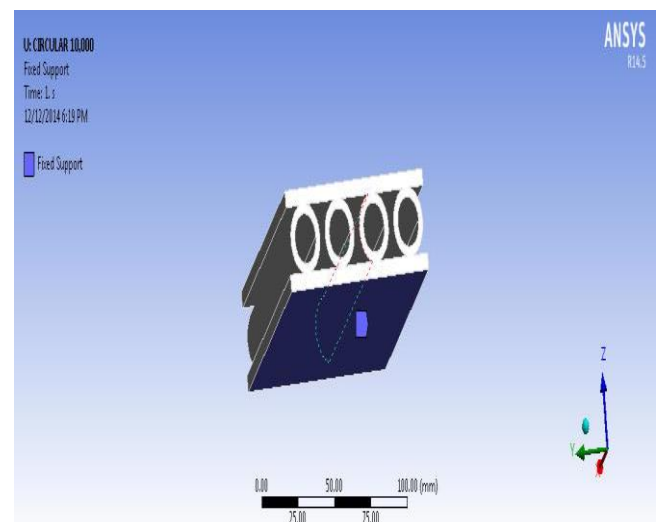


Fig-2: Position of fixing bottom plate in Circular core steel structure

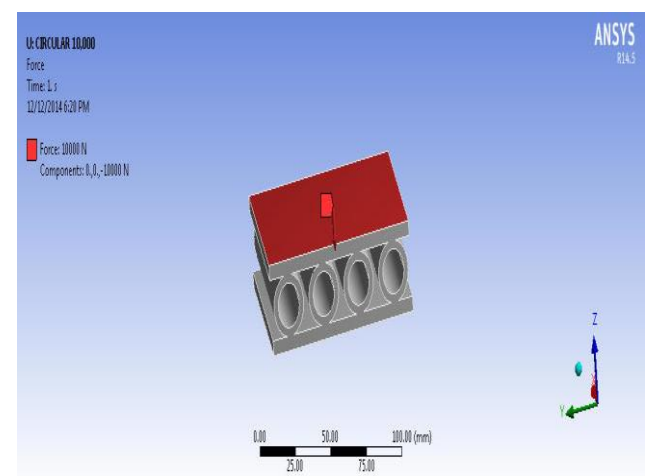


Fig-3: Position of applying force (10000N) on Circular core steel structure.

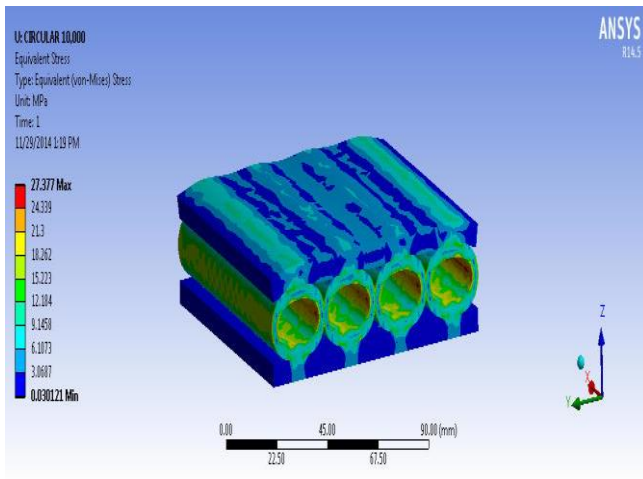


Fig-4: Equivalent stress of Circular core steel structure.

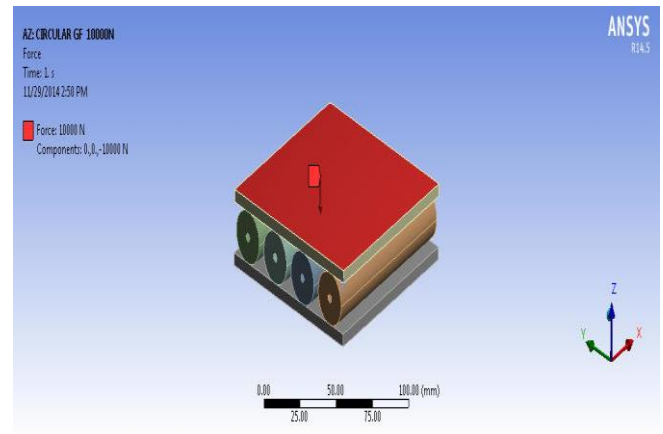


Fig-7: Position of applying force (10000N) on circular core composite structure

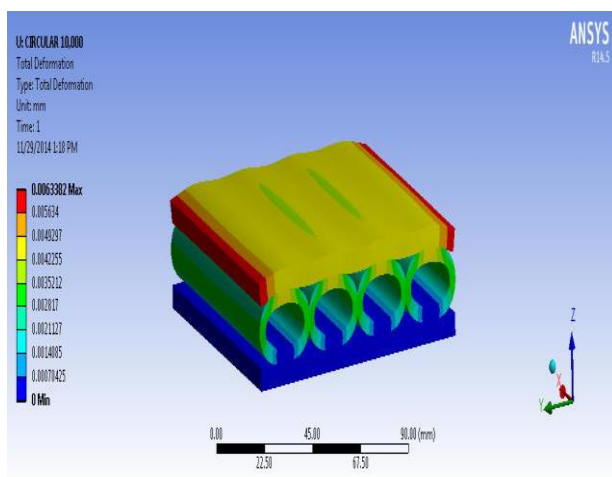


Fig-5: Total deformation of Circular core steel structure.

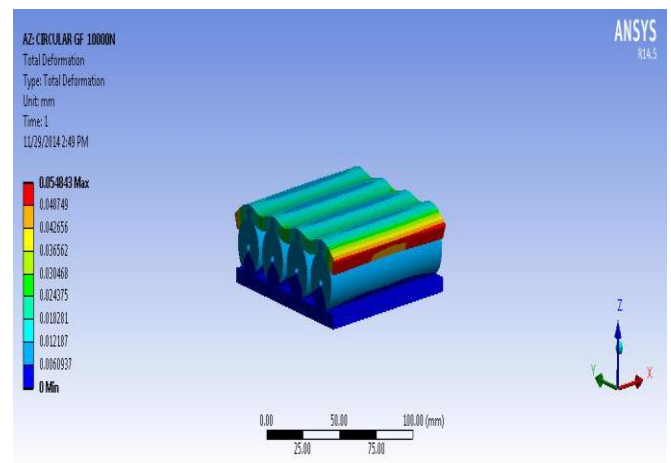


Fig-8: Total deformation of circular core composite structure.

3.2 Circular Core Composite Structure

Top and bottom side plate of structure - 100mmx100mm5mm.

Core shape –Circular.

Core Height – 20.5 mm.

Inner diameter of Core structure – 3mm

Outer diameter of Core structure – 20.5mm

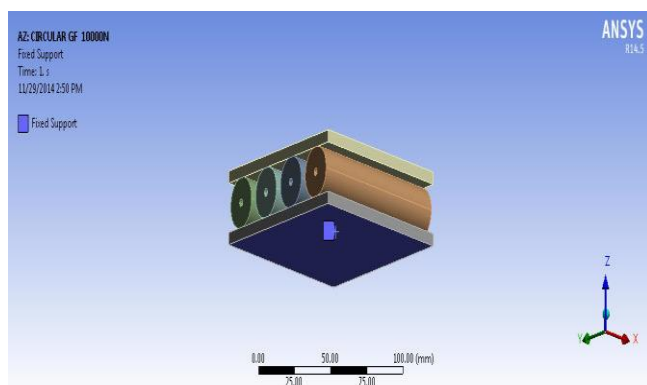


Fig-6: Position of fixing bottom plate in Circular core composite structure.

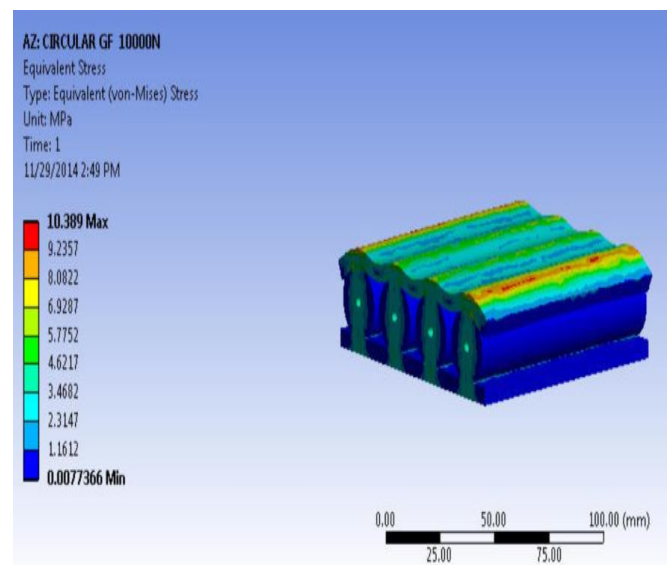


Fig-9: Equivalent stress of circular core composite structure.

4. RESULTS AND DISCUSSIONS

The table 2 shows the obtained value of total deformation of the Circular core steel structure and Circular core composite

structure for an applied force of 1000N, 5000N, and 10000N. The table 3 shows the obtained value of equivalent stress of the Circular core steel structure and Circular core composite structure for an applied force of 1000N, 5000N, 10000N.

Force (N)	Circular core steel structure Total Deformation (mm)	Circular core composite structure Total Deformation (mm)
1000	0.0041719	0.0054843
5000	0.020859	0.027421
10000	0.041719	0.054843

Table-2: Total deformation comparison of all structures.

Force (N)	Circular core steel structure Equivalent stress (Mpa)	Circular core composite structure Equivalent stress (Mpa)
1000	2.7377	1.0389
5000	13.689	5.1946
10000	27.377	10.389

Table-3: Equivalent stress comparison of all structures.

Comparative graphs of equivalent stress presented in Fig-10. From the graphs, it can be observed that the equivalent stress is always lower in circular core composite structure when compared with circular core steel structure. At the lowest force, i.e. at 1000N the equivalent stress in circular core steel structure more than that of circular core composite structure. Figure-11 shows that the weight of rectangular composite structure is lower than rectangular steel structure.

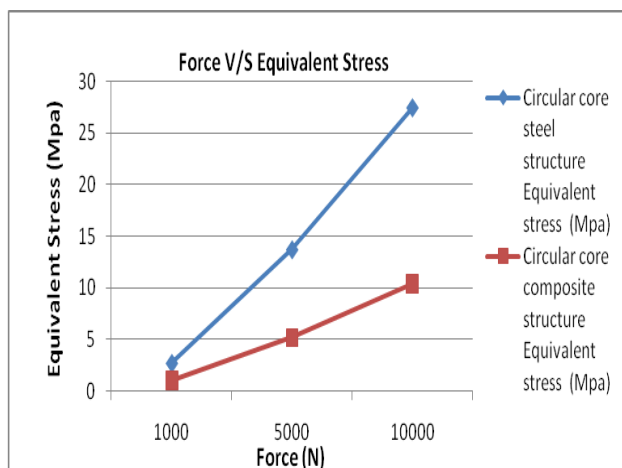


Fig-10: Force V/S Equivalent stress of all structures.

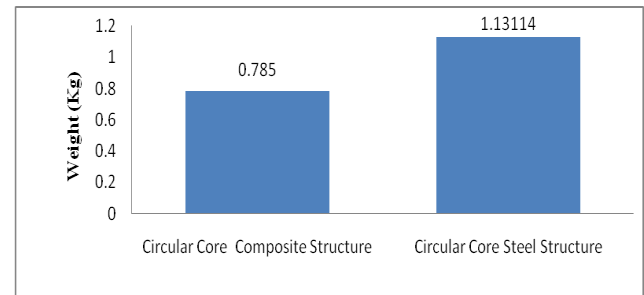


Fig-11: Weight comparison of All Structures

5. CONCLUSIONS

The circular core composite structure and circular core steel structure models in Pro-E are efficiently imported into ANSYS workbench and structural analysis is done and equivalent stress and total deformation is observed. In circular core composite structure the equivalent stress as well as weight is also reduced as compare to circular core steel structure. In circular core composite structure equivalent stress decreases by around 62% and weight is decreases by around 30% as compare circular core steel structure.

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