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Composite Section Design for Minimum Weight in Structural Application

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Abstract: ***Reducing weight while increasing or maintaining strength of products is getting to be highly important research issue in this modern world. The rectangular steel sandwich structure which is used in application of aircrafts, wind turbine blades, marine, space and also in other industrial sectors. Steel sandwich structure with top and bottom plates as well as core made up of steel called as steel sandwich structure. In this paper replacement of core of Rectangular steel sandwich structure with core which glass fiber reinforced polymer (E-glass/epoxy) and top and bottom plates made up of mild steel is used due to high strength to weight ratio and good corrosion resistance. In this paper analysis of rectangular steel structure and rectangular composite structure is done in Ansys work bench and Total deformation and equivalent stress is analyzed. The model of composite structure is generated in CATIA. Result shows that, the rectangular composite structure has stresses much lower than rectangular steel structure and weight of rectangular composite structure is reduced.***

Key words: E-Glass/Epoxy, CATIA V5R20, Composite structure, Ansys 14.5, Mild steel

1. Introduction and Literature Review

Sandwich panels or structures with top and bottom plates as well as the core made up of steel are called steel sandwich Panels or structures. The core structures which are divided into different types i.e. I core, O- core with rectangular beams, Vf/V- core with hat or corrugated sheets as a core, web core, round O-core and X core with two hats as a core as shown in Figure 1. In this paper Rectangular 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).

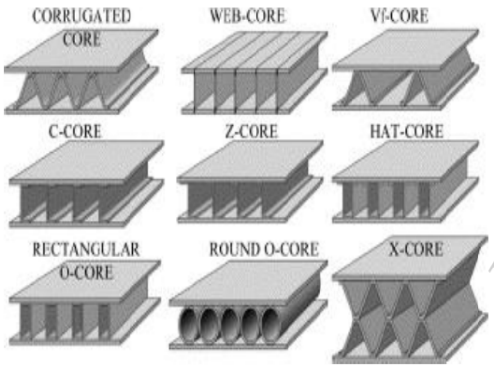

Figure 1: Different steel sandwich structure with Various cores.

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% [11]. Jukka Säynäjäkangas made a design and analysis on steel sandwich panel and conclude that austenitic stainless steel grade 1.4301 (AISI 304) can be used in laser welded sandwich panels offering good mechanical properties and corrosion resistance[4]. 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 composite structure and also reduction of weight of composite structure as compare to conventional steel structure. For that various methods available to increase strength and reduction of weight but in this paper we considered only two major parameters that have major influence on strength and reduction of weight. The objective is to increase strength by varying parameters and find the best to suit requirement and that have maximum strength and having minimum weight as compare to other conventional structure.

Following are the major objectives of work.

1) The major objective of the proposed research work is to minimize equivalent stress at minimum weight.
2) To propose a material which sustain maximum possible strength at minimum weight.
3) Analyze Effect of equivalent stress on composite structure.
4) Analyze Effect of weight on composite structure.

3. Design and Analysis of Composite Structure

Composite structure model as well as steel structure model which is generated in CATIA and this model is saved in STP format and then it is imported into the ANSYS workbench. In ANSYS workbench geometry shows three contact pairs. Material properties are given to the 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 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 composite structure and 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.

Table 1: Material properties of E-Glass/epoxy

Properties	*Value*
Tensile modulus along X-direction (Ex)	34000 MPa
Tensile modulus along Y-direction (Ey)	6530 MPa
Tensile modulus along Z-direction (Ez)	6530 MPa
Tensile strength of the material	900 MPa
Compressive strength of the material	450 MPa
Shear modulus (Gxy)	2433 MPa
Shear modulus (Gyz)	1698 MPa
Shear modulus (Gzx)	2433 MPa
Poisson ratio along XY-dirction(μxy)	0.217
Poisson ratio along YZ-direction (μyz)	0.366
Poisson ratio along ZX-direction (μzx)	0.217
Mass density of the material (ρ)	2.6*106 kg/mm3
Flexural modulus of the material	40000
Flexural strength of the material	1200

3.1 Rectangular Steel Structure

Top and bottom side plate of structure - 100mmx100mm5mm.
Core shape –Rectangular.
Core Height – 20.5 mm.
Core structure – 100mmx20.5mmx3mm.

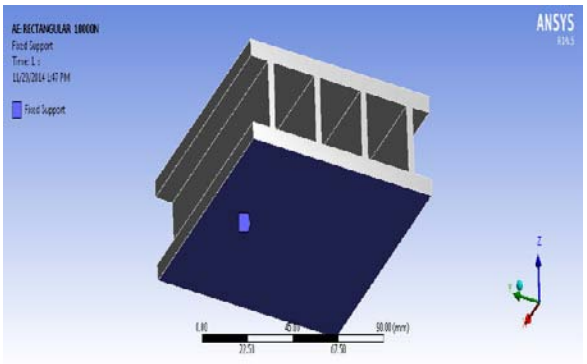

Figure 2: Position of fixing bottom plate in Rectangular steel structure

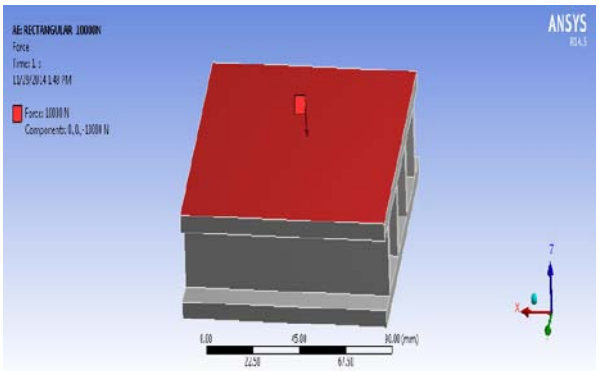

Figure 3: Position of applying force (10000N) on Rectangular steel structure

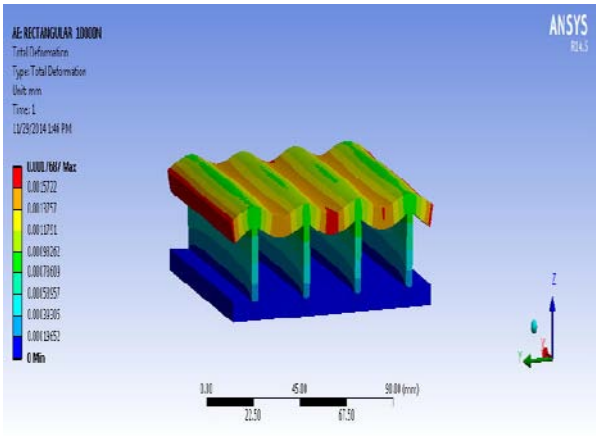

Figure 4: Total deformation of rectangular steel structure

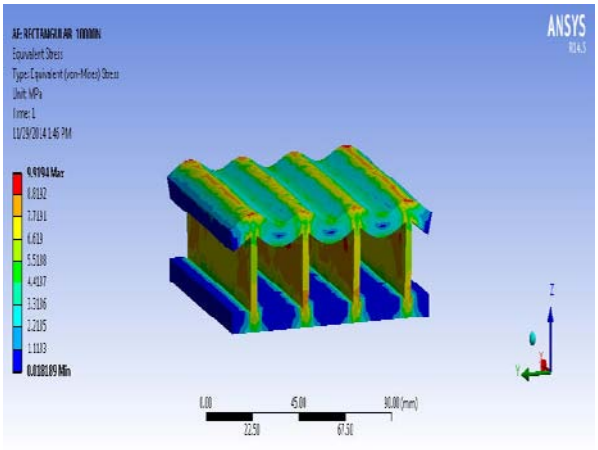

Figure 5: Equivalent stress of rectangular steel structure.

By applying a load 10000N on rectangular steel structure it is observed that the equivalent stress is 9.9194Mpa and total deformation is 0.00017687mm.

3.2 Rectangular Composite Structure

Top and bottom side plate of structure - 100mmx100mmx5mm.
Core shape –Rectangular.
Core Height – 20.5 mm.
Core structure – 100mmx20.5mmx9mm.

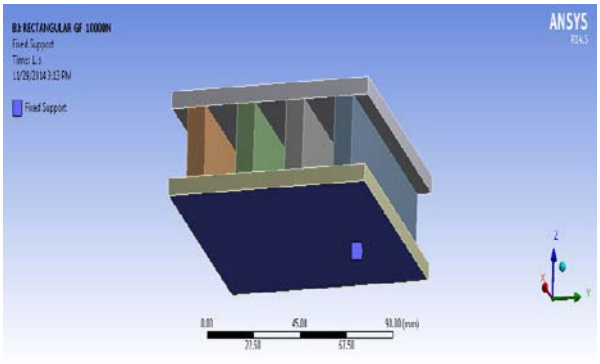

Figure 6: Position of fixing bottom plate in Rectangular composite structure.

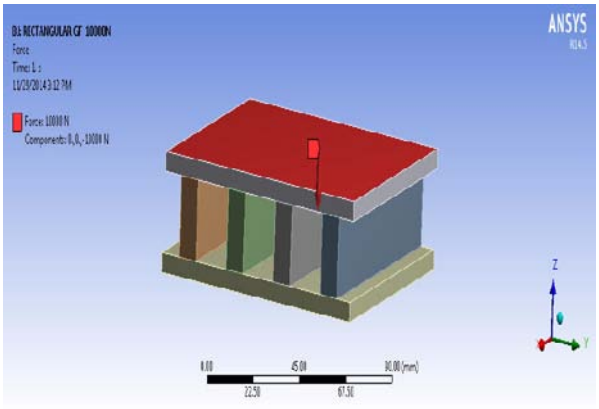

Figure 7: Position of applying force (10000N) on Rectangular composite structure.

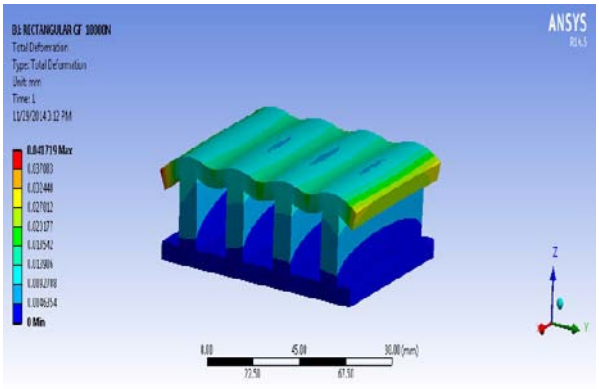

Figure 8: Total deformation of Rectangular composite structure.

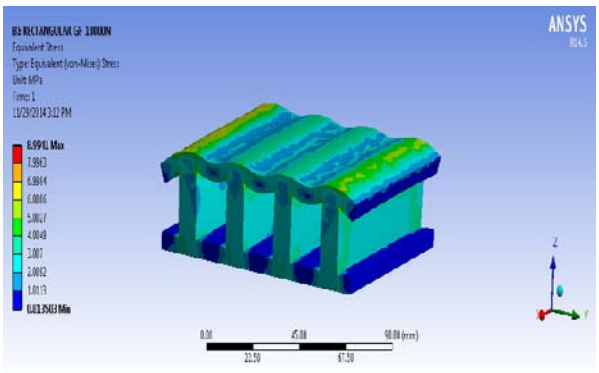

Figure 9: Equivalent stress of Rectangular composite structure.

By applying a load 10000N on rectangular composite structure it is observed that the equivalent stress is 8.994Mpa and total deformation is 0.0041719mm.

4. Result and Discussion

The table 2 shows the obtained value of total deformation of the Rectangular composite structures and Rectangular steel structure for an applied force of 1000N, 5000N, and 10000N. The table 3 shows the obtained value of equivalent stress of the Rectangular composite structure and Rectangular steel structure composite structures for an applied force of 1000N, 5000N, 10000N.

Table 2: Total deformation comparison of structures

Force (N)	Rectangular composite Structure Total Deformation (mm)	Rectangular steel Structure Total Deformation (mm)
1000	0.0041719	0.00017687
5000	0.020859	0.00088436
10000	0.041719	0.0017687

Table 3: Equivalent stress comparison of all structures

Force (N)	Rectangular composite Structure Equivalent stress (Mpa)	Rectangular steel Structure Equivalent stress (Mpa)
1000	0.89941	0.99194
5000	4.497	4.9597
10000	8.9941	9.9194

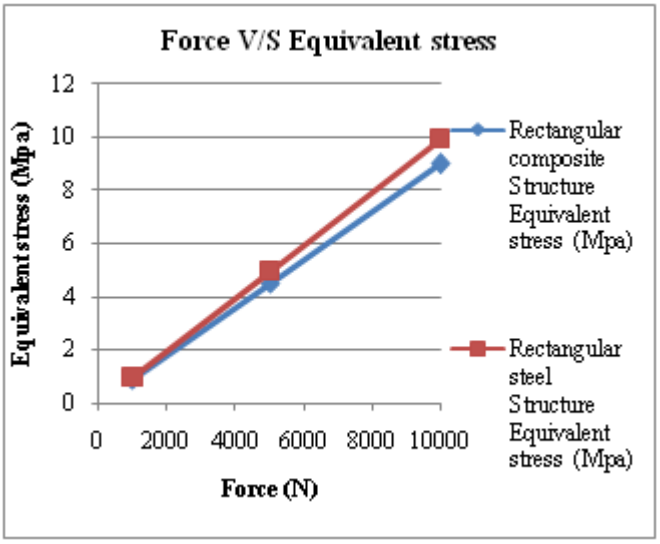

Figure 10: Force V/S Equivalent stress of all structures

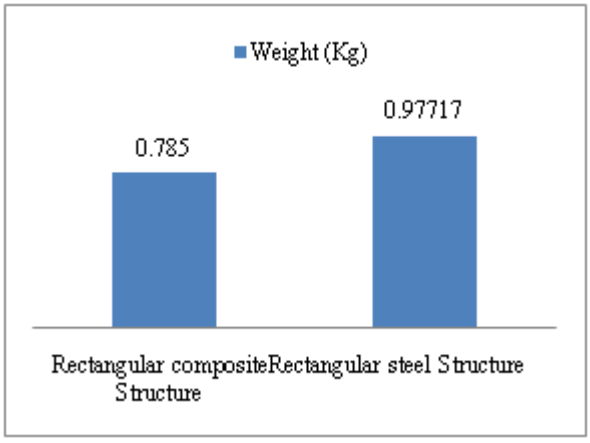

Figure 11: Weight comparison of All Structures

From figure 10 it is observed that the equivalent stress of rectangular composite structure is less than rectangular steel structure From figure 11 it is observed that the weight of rectangular composite structure is less than rectangular steel structure.

5. Conclusions

The composite structure and steel structure models in CATIA are efficiently imported into ANSYS workbench and structural analysis is done and equivalent stress and total deformation is observed. In rectangular composite structure the equivalent stress as well as weight is also reduced compare to Rectangular steel structure. In rectangular

composite structure equivalent stress decreases by around 10% and weight is decreases by around 20% as compare Rectangular steel structure.

References

[1] O.T. Thomson et al. (eds), sandwich structures 7; advancing with Sandwich Structure and materials, 3-12.
[2] Kevin J. Doherty, Aristedes Yiournas, Jordan A. Wagner, and Yellapu Murty, "Structural Performance of Aluminum and Stainless Steel Pyramidal Truss Core Sandwich Panels" ,ARL-TR-4867 July 2009.
[3] Aydıncak, İlke " investigation of design and analyses principles of honeycomb structures"
[4] Jukka Säynäjäkangas and Tero Taulavuori, Outokumpu Stainless Oy, Finland "A review in design and manufacturing of stainless steel sandwich panels" stainless steel world oktober 2004
[5] Tomas Nordstrand," Basic Testing And Strength Design Of Corrugated Board And Containers" Division of Structural Mechanics, LTH, Lund University, Box 118, SE-221 00 Lund, Sweden.
[6] Pentti kujala, Alan Klanac," Steel Sandwich Panels in Marine Applications" PrihvaÊeno, 2005-05-05
[7] Jani Romanoff "Bending Response of Laser- Welded Web-Core Sandwich Plates"ISSN (printed)1795-2239
[8] Pentti Kujala "Steel Sandwich Panels – From Basic Research To Practical Applications" 2Vol. 16/ISSN 0784-6010 2002
[9] Narayan Pokharel and Mahen Mahendran "Finite Element Analysis and Design of Sandwich Panels Subject to Local Buckling Effects"
[10] Pentti kujala "ultimate strength analysis of all steel sandwich panels"Rakenteiden Makaniikka,vol.31 Nrot 1-2,1998,s. 32-45
[11] A. Gopichand, Dr.G.Krishnaiah, B.Mahesh Krishna, Dr.Diwakar Reddy.V, A.V.N.L.Sharma "Design And Analysis Of Corrugated Steel Sandwich Structures Using Ansys Workbench", International Journal of Engineering Research & Technology (IJERT) Vol. 1 Issue 8, October – 2012.

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