Proceedings of **“National Conference on Recent Trends in Science and Advances in Engineering”**
Organized by Fabtech Technical Campus, College of Engineering & Research, Sangola
International Journal of Innovations in Engineering Research and Technology [IJIERT]
ISSN: 2394-3696, Website: www.ijiert.org, June, 2022

DESIGN, ANALYSIS AND WEIGHT OPTIMIZATION OF LIFT PANEL BY USING COMPOSITE STRUCTURE

1. Prof. J. P. Gavade
Department of Mechanical Engineering, Fabtech Technical Campus College Of Engineering & Research, Sangola, Maharashtra, India
gavadejay@gmail.com

2. Mr. Bibhu Mohapatra
3D Printing Mumbai.
bibhu@3idea.in

3. Prof. S.G.Mane
Department of Mechanical Engineering, Sanjay Bhokre Group of Institutions Miraj, Maharashtra, India
Shrikant_mane3665@rediffmail.com

Abstract

The need for bigger, briskly and lighter moving vehicles, similar as vessels, trains, exchanges and motorcars has increased the significance of effective structural arrangements. The two approaches live to develop effective structures either operation of new accoutrements or and minimal weight can be attained. The sandwich structures have implicit to offer a wide range of seductive design results. To attained weight reduction, these results can frequently bring space savings, fire resistance, noise control and bettered heating and cooling performance. Ray- welded metallic sandwich panels offer a number of outstanding parcels allowing the developer to develop light and effective structural configurations for a large variety of operations. These panels have been under active examinations during the last 15 times in the world. The structural models in CATIA can be efficiently imported into ANSYS. Structural analysis is done, outside stress and total deviation is observed.

Keyword: Deformation, Stress, ANSYS, FEA Analysis.

Introduction

This construction has frequently used in feather light operations similar as Lift, EOT crane ray, vehicle body, aircrafts, marine operations, wind turbine blades. In principle two approaches live to develop effective structures either operation of new structural design. A proven and well- established result is the use of sandwich structures. In this way high strength to weight rate and minimal weight can be attained. The sandwich structures have implicit to offer a wide range of seductive design results. In addition to the attained weight reduction, these results can frequently bring space savings, noise control. Use of Ray- welded metallic sandwich panels offers a number of outstanding parcels allowing the developer to develop light and effective structural configurations for a large variety of operations. These panels have been under active examinations during the last 15 times in the world. Outokumpu has been sharing in several cooperative systems in this area. In Finland the exploration related to all steel sandwich panels was initiated in 1988 in the Ship Laboratory of Helsinki University of Technology. Since also in a considerable number of exploration systems in Finland, similar as Shipyard 2000, Weld 2000 and the Kenno – Light Structures Technology Program, manufacturing, design and optimization of steel sandwich panels have been delveloped. The work is grounded on several R&D systems driven concertedly with VTT Industrial Systems, specialized universities in Finland, pristine steel manufacturer Outokumpu Stainless as well as finish sandwich panel manufacturers. In this composition the results of the before mentioned R&D work in steel sandwich structures and operations is epitomized from the pristine steel material point of view.

Sandwich panels may be generally two types as composite sandwich and metallic sandwich panels. Composite sandwich panels correspond to non-metallic factors similar as FRP, PU and are generally applied as cargo carrying structures in non-military vessels and rest yachts, and substantially as non-load carrying essentials on trafficker and large voyage vessels. For metallic sandwich panels there are principally two types of panels with metallic face plates and clicked core similar as SPS panels and panels with both metallic face plates and core welded together. The essence material can be either regular, high tensile or pristine steel, or aluminium blends. This paper emphasis on steel sandwich panels welded by lasser ray. The steel sandwich panels can be constructed with colourful types of cores. The choice of the core depends on the operation under consideration. The standard cores similar as Z-, tube- and hat profiles are easier to get and they are generally accurate enough for the demanding ray welding process. The special cores, similar as corrugated core (V- type panel) and I- core, need specific outfit for product, but they generally affect with the lightest panels. During the product process or after welding of faceplates plates and core together, the steel sandwich panels are filled with some polymer, mineral or gemstone hair, concrete. All kinds of sandwich panels have a number of common benefits, like good weight to stiffness rate, high pre-manufacturing accuracy and problems, e.g. integration in a boat structure, while the colourful variants also show a number of specific advantages and disadvantages. Steel sandwich is fairly light and the total costs are veritably competitive to other light structures results. Generally, normal strength steel is used with steel sandwich panels as buckling or relegation is the dominating failure criteria, thus high strength steel doesn't generally give any major benefits. For areas with high demands for erosion protection or easy conservation pristine steel can be also applied. Ray welding bear fairly high investment costs, therefore the price of the panels is explosively related to the volume of the product. Still, as the material costs are lower due to the dropped weight, generally the price of the steel sandwich panels unit area is about the same magnitude as that of conventionally strengthened steel panels.

Finite Element Analysis Validation

A composite structure typically consists of two thin face sheets made up from stiff and strong relatively dense material such as metal bonded to a thick lightweight material called core. The face sheets supports bending loads and the core transfers shear force between the faces in a panel under load. Face sheets used in structure are in three forms flat, lightly profiled and profiled. The face sheet of composite structure provides structural stiffness and protects the core against damage and weathering. During loading the face sheets takes compressive and tensile loads and core transforms shear loads between the faces.

FEA Analysis

Fixed Support

In ANSYS the STP format is imported and materials properties are given to the individual part i.e., All structure are selected and steel properties are given to them. Now meshing the geometry as free mapped mesh and structural analysis is done by fixing the plate at bottom and force is applied at top face of the plate as shown in below figures.

Rectangular cross section model

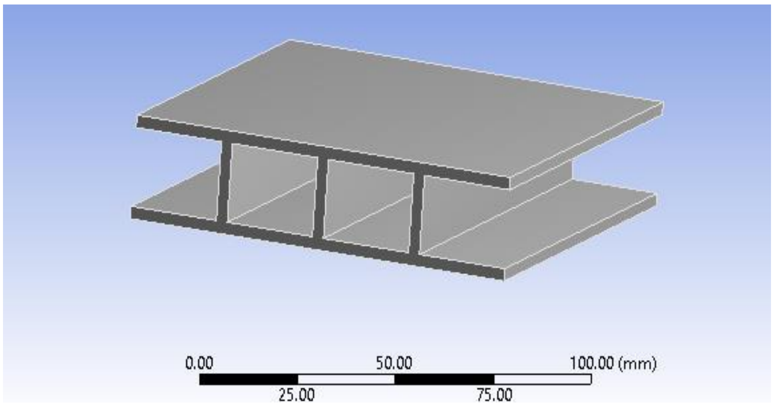

Photo1 Imported model of rectangular cross section in ANSYS

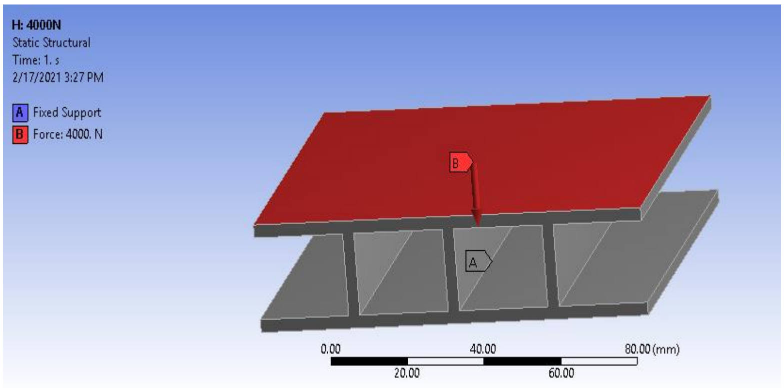

Photo2 Boundary Condition (4000N) applied on rectangular cross section in ANSYS

Triangular cross section model

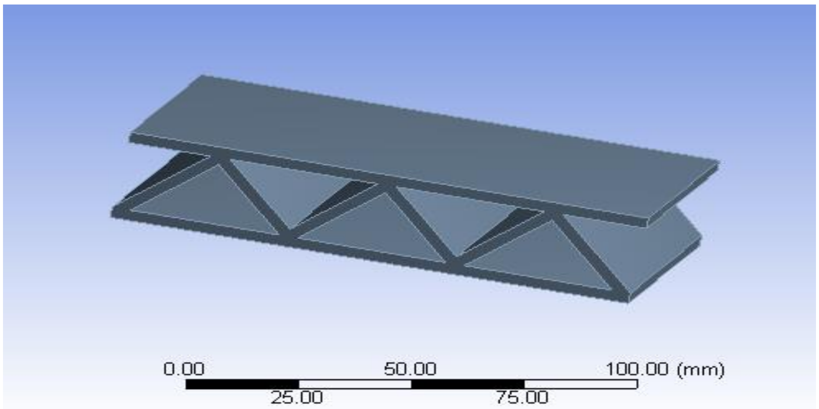

Photo3 Imported model of Triangular cross section in ANSYS

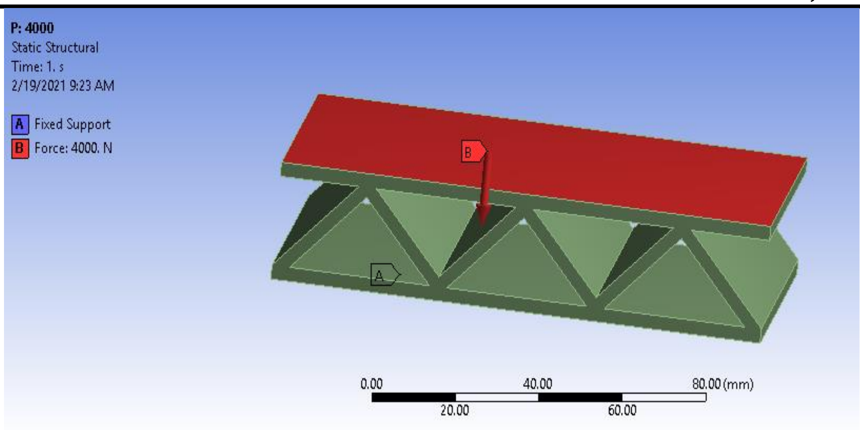

Photo4 Boundary Condition (4000N) applied on Triangular cross section in ANSYS

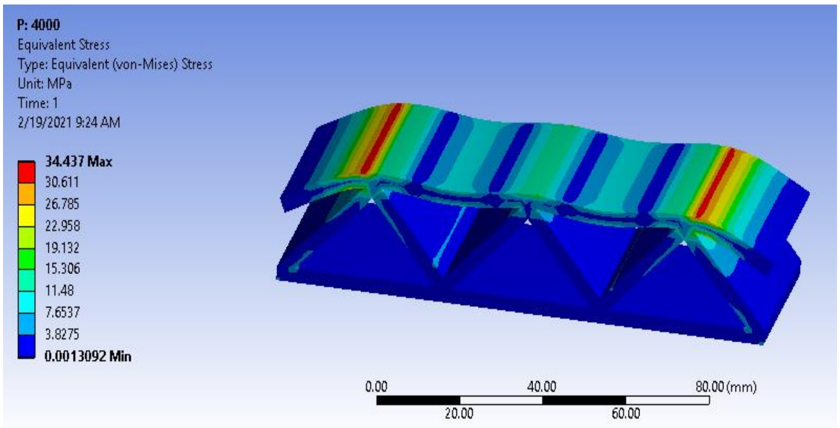

Photo5 Stress due to applied load of 4000N on Triangular cross section in ANSYS

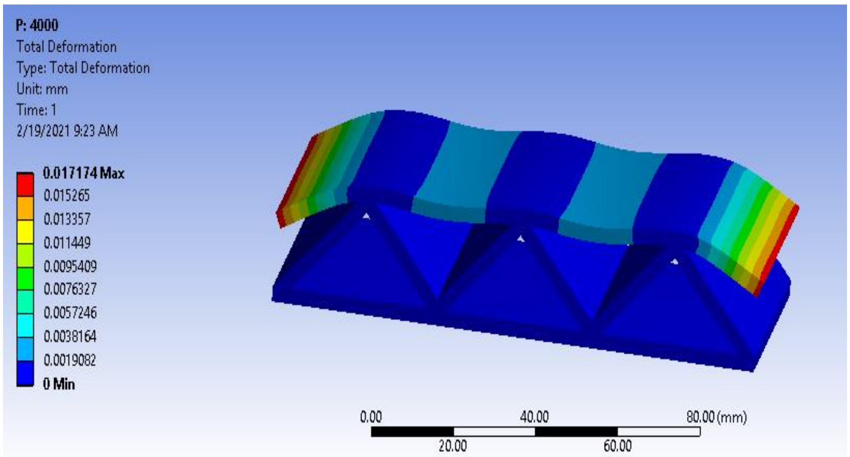

Photo6 Deformation due to applied load of 4000N on Triangular cross section in ANSYS

Circular cross section model

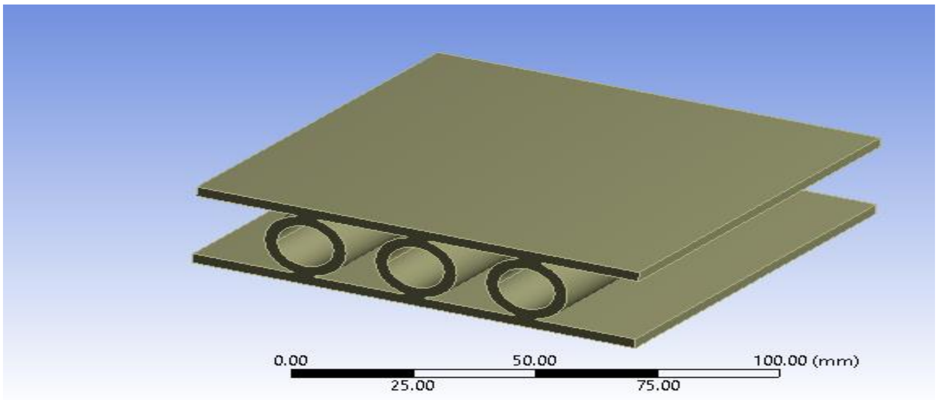

Photo7 Imported model of Circular cross section in ANSYS

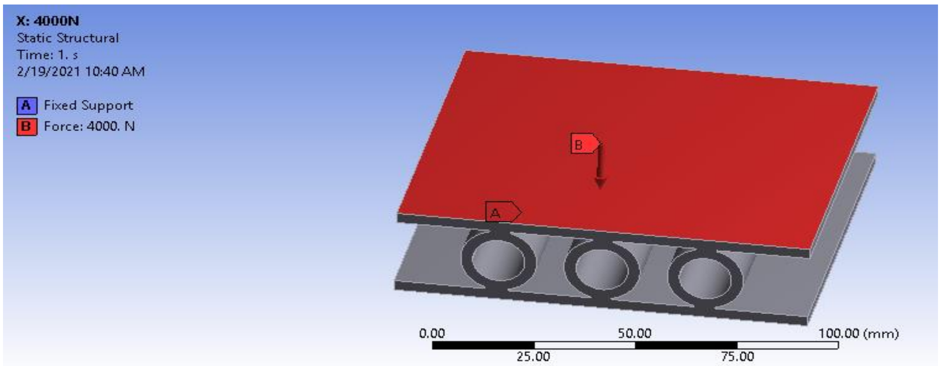

Photo8 Boundary Condition (4000N) applied on Circular cross section in ANSYS

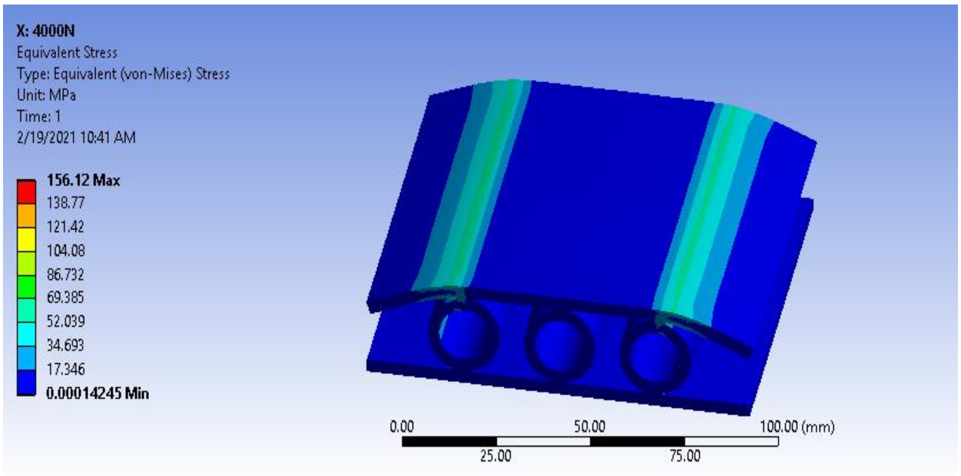

Photo9 Stress due to applied load of 4000N on Circular cross section in ANSYS

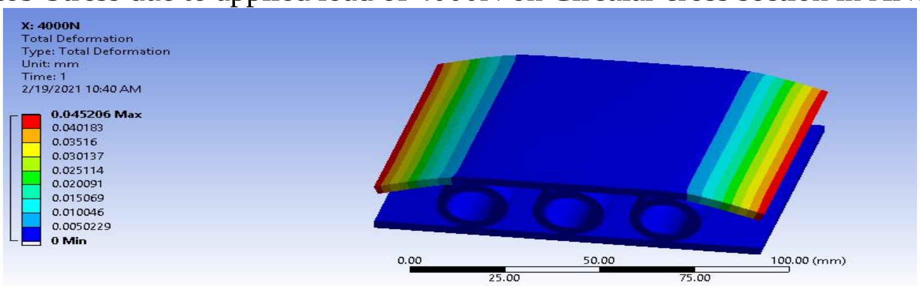

Photo10 Deformation due to applied load of 4000N on Circular cross section in ANSYS

Result and Discussion

ANSYS Result Of All Structure Compare Between The Total Weight, Total Deformation And Equivalent Stress.

Table1 Applied force and obtained value of design characteristics using FEA for Rectangular Steel Structure

Rectangular Steel Structure				
Sr.No.	**Force (N)**	**Equivalent Stress (Mpa)**	**Deformation (mm)**	**Weight (Kg)**
1	500	7.8382	0.0059418	0.63795
2	1000	15.676	0.011884	
3	2000	31.353	0.023767	
4	3000	47.029	0.035651	
5	4000	62.706	0.047535	

Table2 Applied force and obtained value of design characteristics using FEA for Triangular Steel Structure**.**

Triangular Steel Structure				
Sr.No.	**Force (N)**	**Equivalent Stress (Mpa)**	**Deformation (mm)**	**Weight (Kg)**
1	500	4.3838	0.002225	0.94672
2	1000	8.7676	0.0044499	
3	2000	17.535	0.0088999	
4	3000	25.828	0.01288	
5	4000	34.437	0.017174	

Table3 Applied force and obtained value of design characteristics using FEA for circular Steel Structure

Circular Steel Structure				
Sr. No.	**Force (N)**	**Equivalent Stress (Mpa)**	**Deformation (mm)**	**Weight (Kg)**
1	500	0.59117	0.0056488	0.86869
2	1000	39.029	0.011301	
4	2000	78.058	0.022603	
6	3000	117.09	0.033904	
8	4000	156.12	0.045206	

Weight comparisons of all structure:

Table4 Weight comparisons of all structure

Sr. No.	**Name of Structure**	**Weight (Kg)**
1	Circular Steel Structure	0.86869
2	Triangular Steel Structure	0.94672
3	Rectangular Steel Structure	0.63795

Deformation comparison of all steel structure:

Table5 Deformation comparison of all steel structure in ANSYS

Sr. No.	Force (N)	Circular steel Structure (Deformation)	Triangular steel Structure (Deformation)	Rectangular steel Structure (Deformation)
1	500	0.0056488	0.002225	0.0059418
2	1000	0.011301	0.0044499	0.011884
3	2000	0.022603	0.0088999	0.023767
4	3000	0.033904	0.01288	0.035651
5	4000	0.045206	0.017174	0.047535

Equivalent Stress comparison of all steel structure:

Table6 Equivalent Stress comparison of all steel structure in ANSYS

Sr. No.	Force (N)	Circular steel Structure Equivalent Stress (Mpa)	Triangular steel Structure Equivalent Stress (Mpa)	Rectangular steel Structure Equivalent Stress (Mpa)
1	500	0.59117	4.3838	7.8382
2	1000	39.029	8.7676	15.676
3	2000	78.058	17.535	31.353
4	3000	117.09	25.828	47.029
5	4000	156.12	34.437	62.706

In above table shows the deflection, equivalent stress and self-weight of investigated Triangular, Rectangular and Circular composite structure. The weight of composite structure is 0.785 kg is small as compare to the steel structure (weight of Mild steel plate of same thickness is 2.08 kg.) The Equivalent Stresses, Total deformation of Rectangular steel structure is also small as compare to Triangular, circular steel structure. From above table it is observed that the minimum stress and minimum deformation is observed in rectangular composite structure when it is compare with Triangular, Circular composite structure.

Original Lift Analysis

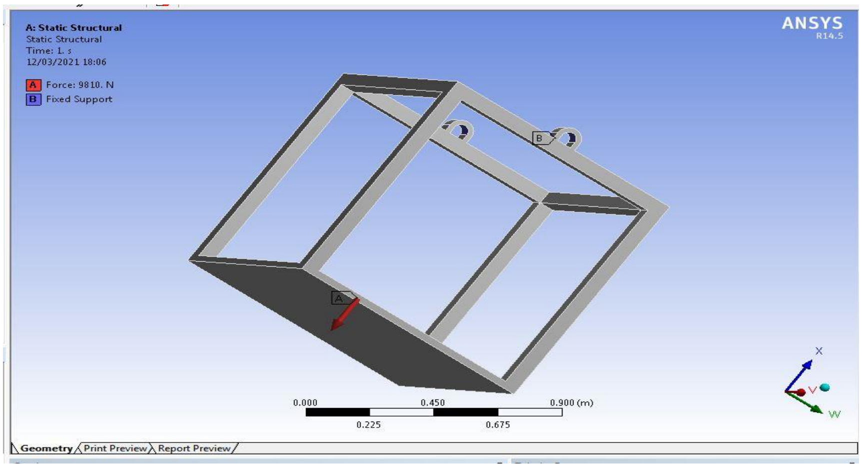

Photo11 Boundary Condition (9010N) applied on original section in ANSYS

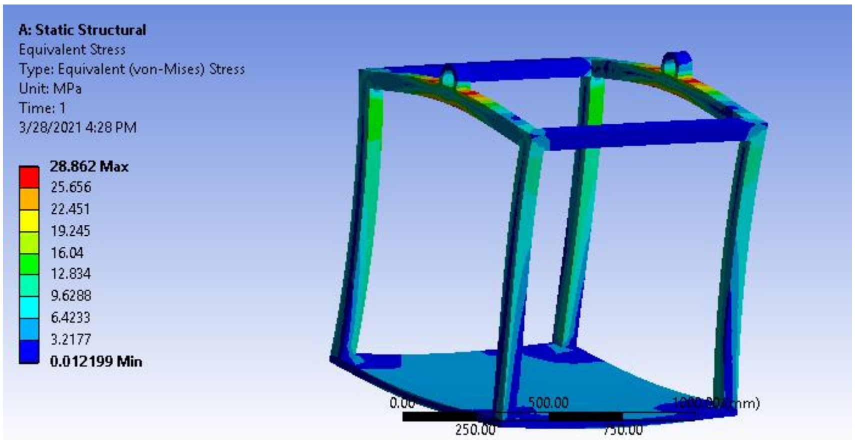

Photo12 Stress due to applied load of 9010N on original section in ANSYS

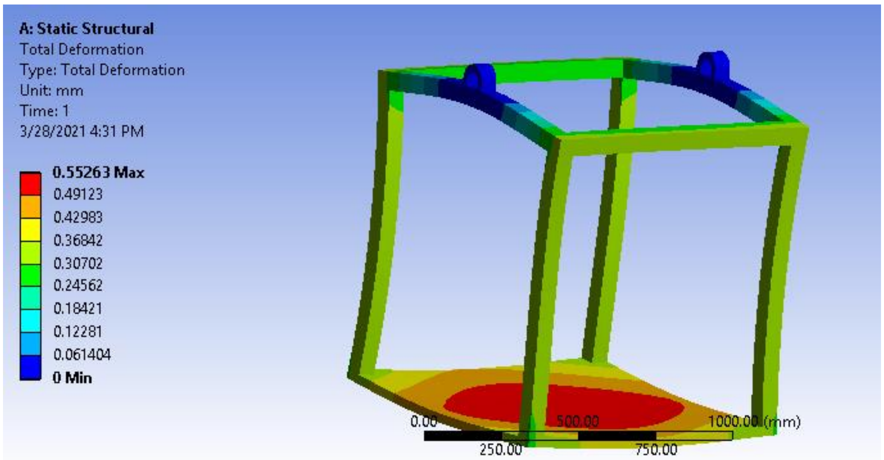

Photo13 Deformation due to applied load of 9010N on original section in ANSYS

Optimized Lift Analysis

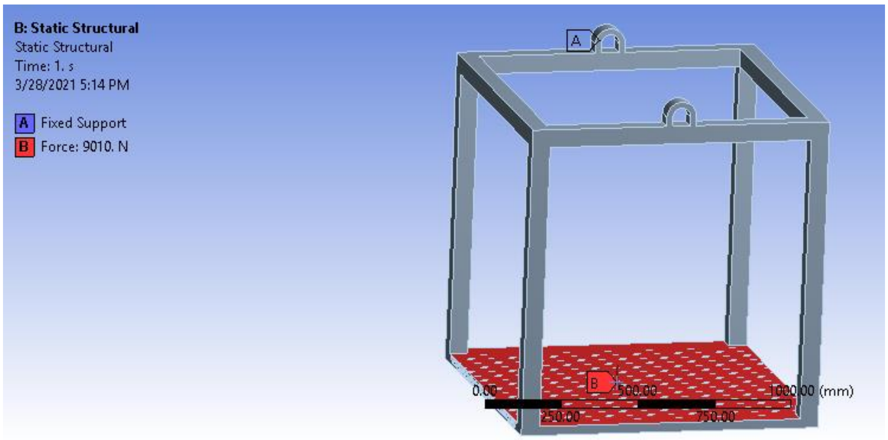

Photo14 Boundary Condition (9010N) applied on optimized section in ANSYS

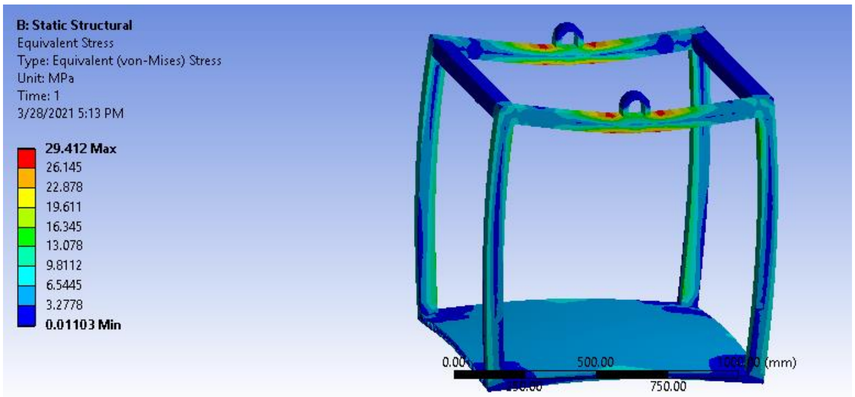

Photo15 Stress due to applied load of 9010N on optimized section in ANSYS

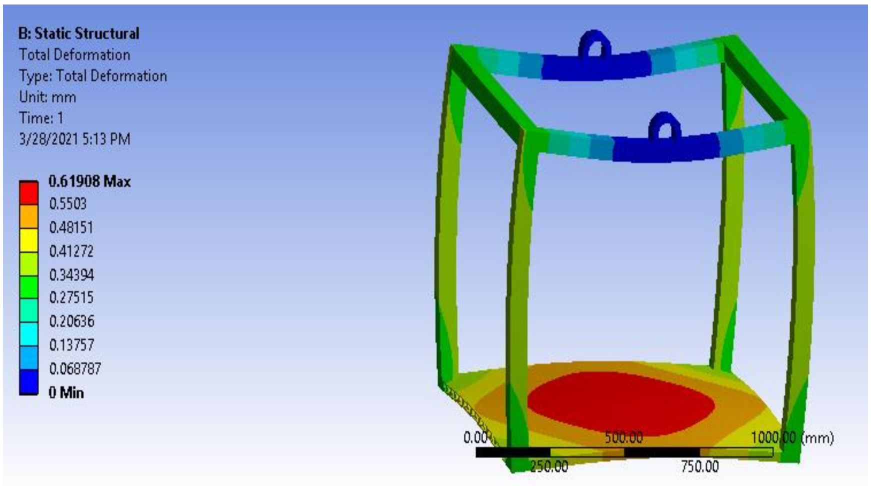

Photo16 Deformation due to applied load of 9010N on optimized section in ANSYS

Conclusion

The composite structure models built in CATIA are efficiently imported into ANSYS platform structural analysis is done and max. stress and total deflection is observed.

For given span of the structure, decreasing the weight of composite structure, strength increases strength and weight is reduces. The weight of composite structure decreases of 19-40% as compares to steel structure. It also increases the strength of composite structure as compare to steel structure.

By comparing Triangular composite structure with Rectangular and Circular composite structure, it is observed that Triangular composite structure have minimum stresses and have minimum deflection. As per maximum principal stress theory we get that all structure we select having within the limit of allowable stress so we take a structure with minimum weight is rectangular. So, rectangular structure is the perfect replacement for the traditional industrial crane base platform.

References

[1] A.Gopichand, Dr.G.Krishnaiah, B.Mahesh Krishna, Dr.Diwakar Reddy. 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.

[2] Kamlesh G. Ambule,Dr. Kishor P. Kolhe, "FEM and Experimental Analysis of Stainless Steel Sandwich Panels for Weight Reduction"," IJIRST –International Journal for Innovative Research in Science & Technology| Volume 3 | Issue 02 | July 2016 ISSN (online): 2349-6010.

[3] Francois Cote , Russell Biagi b, Hilary Bart-Smith b, Vikram S. Deshpande, "Structural response of pyramidal core sandwich columns," International Journal of Solids and Structures 44 (2007) 3533–3556.

[4] A.Gopichand, Dr.G.Krishnaiah, D.Krishnaveni, Dr.Diwakar Reddy.V, "Numerical simulation of steel sandwich plate system (sps) floor," International Journal of Innovative Research in Science, Engineering and Technology (An ISO 3297: 2007 Certified Organization) Vol. 2, Issue11, November 2013.

[5] Jukka Säynäjäkangas and Tero Taulavuori, Outokumpu Stainless Oy, Finland, "A review in design and manufacturing of stainless steel sandwich panels," Automotive, Stainless Steel World O K T O B E R 2 0 0 4.

[6] Narayan Pokharel, and Mahen Mahendran, "Finite Element Analysis and Design of Sandwich Panels Subject to Local Buckling Effects,".

[7] Prof. V. B.Ghagare, Mr. Jayesh Patil, Mr. Rohan Patil, Mr. Rupesh Patil , Mr. Radhay Patil, "Design and Analysis of Corrugated Aluminum Sandwich Structures Using Ansys Workbench," Volume 5 Issue VI, June 2017 IC Value: 45.98 ISSN: 2321-9653 International Journal for Research in Applied Science & Engineering Technology (IJRASET).