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DESIGN & ANALYSIS OF VEHICLE PLATFORM USING COMPOSITE STRUCTURE TO FIND THE OPTIMUM SOLUTION.

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ABSTRACT

In this project Catia is used as CAD software while ANSYS is used for analysis of equivalent stress and total deformation. This study conducts an analysis of Platform sharing has the ability to be used in too many different models. However, in the mind of the consumers, the products may be too similar and more expensive products may be perceived to be cheaper. The two elements of platforms are constant and non-constant. If the non-constant elements are not designed to be easily integrated into the constant elements of the platform, extensive and expensive changes will have to be made in order to make the elements compatible again. Failure to do so negates the purpose of platform sharing in that it increases costs as opposed to reducing them. The propensity for a higher number of recalls is greatly increased with platform sharing. If a defect is found in one model and that model shares its platform with ten other models, the recall would be magnified by ten thus costing the manufacturer more time and money to fix. The analysis has been performed keeping in mind that usefulness and the necessity of using composite structure. This allows for the use of composite structure within the available space resulting in versatility and economy. A vehicle platform is a general term, the needs of operation vary by the conditions of operation. i. e. the transport fluid properties, operating temperature, operating pressure, etc. The conditions of operation dictate the design of the optimization whereas the environment dictates the material and maintenance requirements. the deflection, equivalent stress and self-weight of investigated Triangular, Rectangular and Circular composite structure and Triangular, Rectangular and Circular Aluminum Alloy structure. The Equivalent Stresses total deformation of Rectangular Aluminum Alloy structure is also small as compare to Triangular, circular Aluminum Alloy structure. The minimum stress and minimum deformation is observed in rectangular composite structure when it is compare with Triangular, Rectangular composite structure.

KEY WORDS - versatility and economy, optimization

INTRODUCTION

The demand for bigger, faster and lighter moving vehicles, such as ships, trains, trucks and buses has increased the importance of efficient structural arrangements. In principle two approaches exist to develop efficient structures either application of new materials or the use of new structural design. A proven and well-established solution is the use of composite materials and sandwich structures. In this way minimum weight can be obtained. The sandwich structures have potential to offer a wide range of attractive design solutions. In addition to the obtained weight reduction, these solutions can often bring space savings, noise control. Aluminum Alloy sandwich panels can offer 10-25 % weight savings compared to the conventional steel structures. The work carried out includes development of design formulations for the ultimate and impact strength, analysis of strength for the joints, and development of solutions to improve the behavior under fire. A number of research projects both at the national and European level have been ongoing. A summary of the applications, main benefits and problem areas of the panels as well as available design tools are given. For weight and cost optimization is also presented proving some of the described benefits of all steel sandwich panels. This construction has often used in lightweight applications such as Lift, EOT crane beam, vehicle body, aircrafts, marine applications, wind turbine blades. In principle two approaches exist to develop efficient structures either application of new materials or the use of new structural design. A proven and well-established solution is the use of composite materials and sandwich structures. In this way high strength to weight ratio and minimum weight can be obtained. The sandwich structures have potential to offer a wide range of attractive design solutions. In addition to the obtained weight reduction, these solutions can often bring space savings, noise control. Laser-welded metallic sandwich panels offer a number of outstanding properties allowing the designer to develop light and efficient structural configurations for a large variety of applications.

LITERATURE REVIEW

1) "Noor, Burton and Bert" state that the concept of sandwich construction dates back to Fairbairn in England in 1849. Also in England, sandwich construction was first used in the Mosquito night bomber of World War II which employed plywood sandwich construction. Feichtinger states also that during World War II, the concept of sandwich construction in the United States originated with the faces made of reinforced plastic and low density core. In 1951, Bijlaard studied sandwich optimization for the case of a given ratio between core depth and face thickness as well as for a given thickness. An experimental and analytical investigation is carried out to examine the in-plane compressive response of pyramidal truss core sandwich columns. The identified failure mechanisms include Euler buckling, shear buckling and face wrinkling. The operative mechanism is dependent on the properties of the bulk material and geometry of the sandwich columns and analytical formulae are derived for each of these modes... Finally, optimal single layer and multi-layer pyramidal sandwich column designs that minimize the weight for a given load carrying capacity are calculated using the developed analytical models for the failure of the sandwich columns.

2) "In addition local strength of sandwich panels has been analysed under concentrated loads (Naar, 1997, Kunjala and Naar, 1998". The design methods for all steel sandwich panels were further developed in the research project carried out during the years 1996-1997. The project covered e.g. Development of composite coatings for Preserved sandwich panels under wheel loading planned to be used on a railway cargo wagon (Kunjala and Mantilla, 1997, Kunjala, 1998b), strength analysis of laser welded crane structures (Remes and Kunjala, 1997) and design and fatigue testing of longitudinal joints for sandwich panels planned to be used as deck structures on a cruising ship (kotisalo, 1998, kunjala, 1998a, kunjala et al., 1998).

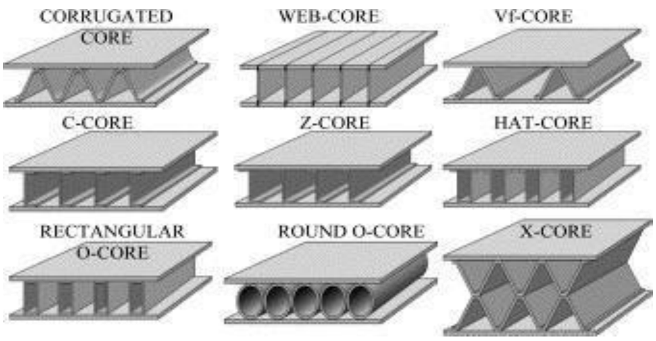
3) "The Thereafter the applications of all Aluminum Alloy sandwich panel deck and bulkhead structure of cruising ship was studied (Kujala et al., 1995, kujala and Tuhkuri, 1995)".The studies include development of design methods with optimization, ultimate and testing under hydrostatic loading and fire and noise testing of the panels. The steel sandwich deck and bulkhead structure found to be 30 to 50 % lighter than the conventional steel grillages. These studies where continued by conducting fatigue test of the all steel sandwich panels used as a longitudinal bulkhead also the application of all steel sandwich panels is crane structure is studied by conducting static test for laser welded beams (Kujala et al., 1996).

4) Aluminum Alloy Sandwich Plate Systems have been used for commercial applications during the last 15 years. Stairs & staircase landings, bulkheads and decks are the main application areas of metallic sandwich panels in cruise ships and in other marine applications. In recent years a wide variety of applications of stainless steel sandwich panels are used in civil and mechanical engineering as well as in other industrial sectors. These include floors of buses, walls and floors of elevators, working platforms in industrial applications and balconies of shipyard. The sandwich structures have potential to offer wide range of attractive design solutions. The steel sandwich structure offer high strength to weight ratio, noise control, high stiffness etc if compared to traditional steel plate flows. In this work numerical simulation of SPS floor with all edges clamped, subjected to uniform pressure loading is carried out in ANSYS workbench.

5) Studies related to the all-Aluminum Alloy sandwich panels were initiated at HTU / ship laboratory in 1988 when the application of all steel sandwich panels as shelf structure of an icebreaker was analysed (Tuhkuri, 1991, Tuhkuri, 1993)... The research related to ultimate strength of all steel sandwich panels at the ship laboratory of HUT is reviewed in this paper. The studies include laboratory strength testing, numerical FEM analysis and development of design formulation for this panels the ultimate strength is analysed under the hydrostatic loading and under local point Loading. Three cases be classified for the collapse mode for large loading areas and for small core plate thickness elastic buckling of the core plate is dominating collapse modes for thicker plate core welding and buckling are causing the failure the third type of collapse mode occurs when the face plate is thin, then the applied ultimate load causes high compressive bending stress on the face plate causing face plate buckling before the collapse of the core plate. The demand for bigger, faster and lighter moving vehicles such as sheep trians has increased the demand for the efficient structural arrangement sandwich construction offer one possibility for efficient utilisation of materials the present interest in steels sandwich structure has been awakened by the developments in laser welding technology enabling efficient production of this panels.

CONCEPT OF PROJECT

This project is to increase equivalent stress strength of composite structure and also reduction of weight of composite structure as compare to conventional Aluminum Alloy structure. For that various methods available to increase.



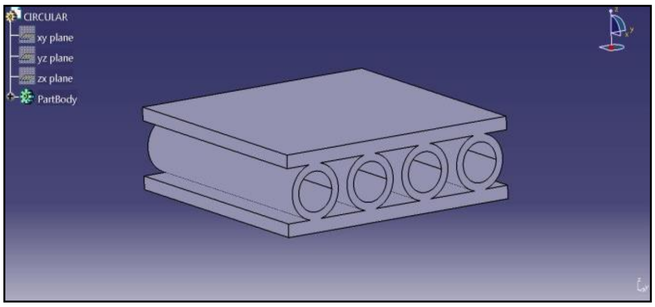
Strength and reduction of weight but in this project we considered only two major parameters that have major influence on strength and reduction of weight. The objective is to increase strength by varying parameters and find the best to suit requirement and that have maximum strength and having minimum weight as compare to other conventional structure. A composite structure typically consists of two thin face sheets made from stiff and strong relatively dense material such as metal bonded to a thick lightweight material called core. Where the face sheets support bending loads and the core transfers shear force between the faces in a panel under load. Face sheets used in structure are mainly in three forms flat, lightly profiled and profiled. The face sheets of composite structure provide structural stiffness and protect the core against damage and weathering. During loading the face sheets take compressive and tensile loads and core transforms shear loads between the faces. The demand for bigger, faster and lighter moving vehicles, such as ships, trains, trucks and buses has increased the importance of efficient structural arrangements. In principle two approaches exist to develop efficient structures either application of new materials or the use of new structural design. A proven and well-established solution is the use of composite materials and sandwich structures. In this way minimum weight can be obtained. The sandwich structures have potential to offer a wide range of attractive design solutions. In addition to the obtained weight reduction, these solutions can often bring space savings, noise control. Aluminum Alloy sandwich panels can offer 10-25 % weight savings compared to the conventional steel structures. The work carried out includes development of design formulations for the ultimate and impact strength, analysis of strength for the joints, and development of solutions to improve the behavior under fire. A number of research projects both at the national and European level have been ongoing. A summary of the applications, main benefits and problem areas of the panels as well as available design tools are given. For weight and cost optimization is also presented proving some of the described benefits of all Aluminum Alloy sandwich panels.

WORKING

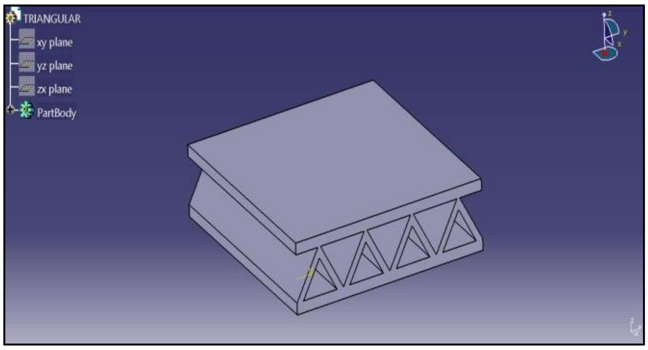
In this project Catia is used as CAD software while ANSYS is used for analysis of equivalent stress and total deformation. The value of total deformation and equivalent stress which is getting from ANSYS software. A composite structure typically consists of two thin face sheets made from stiff and strong relatively dense material such as metal bonded to a thick lightweight material called core. Where the face sheets support bending loads and the core transfers shear force between the faces in a panel under load. Face sheets used in structure are mainly in three forms flat, lightly profiled and profiled. The face sheets of composite structure provide structural stiffness and protect the core against damage and weathering. During loading the face sheets take compressive and tensile loads and core transforms shear loads between the faces. CATIA enables the creation of 3D parts, from 3D sketches, sheet metal, composites, and molded, forged or tooling parts up to the definition of mechanical assemblies. The software provides advanced technologies for mechanical surfacing & BIW. It provides tools to complete product definition, including functional tolerances as well as kinematics definition. CATIA provides a wide range of applications for tooling design, for both generic tooling and mold & die. In Catia I had done all modeling work. Then this model is converted in to STP file. This STP files will be input for ANSYS.

CATIA MODELING

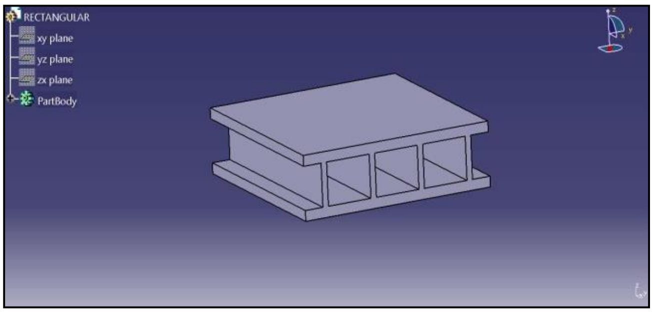
CATIA enables the creation of 3D parts, from 3D sketches, sheet metal, composites, and molded, forged or tooling parts up to the definition of mechanical assemblies. The software provides advanced technologies for mechanical surfacing & BIW. It provides tools to complete product definition, including functional tolerances as well as kinematics definition. CATIA provides a wide range of applications for tooling design, for both generic tooling and mold & die. In Catia I had done all modeling work. Then this model is converted in to STP file. This STP files will be input for ANSYS.



Circular Aluminum Alloy structure view in Catia



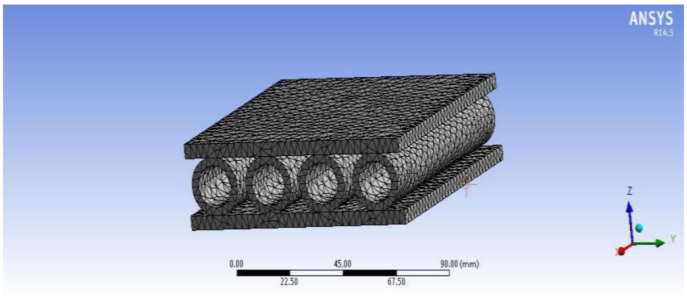
Triangular Aluminum Alloy structure view in Catia



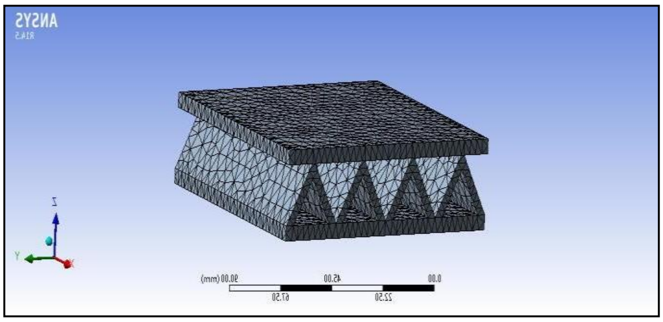
Rectangular composite structure view in Catia

MESHING IN ANSYS

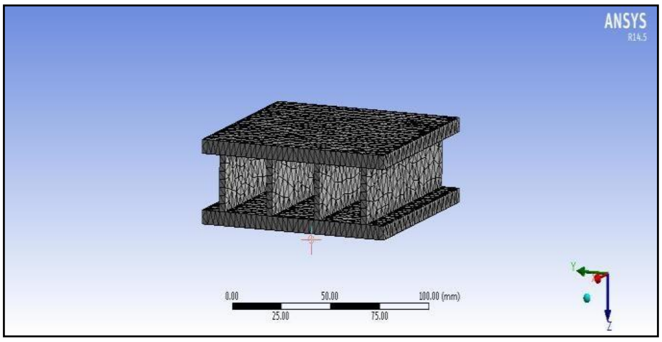
Meshing of all parts done in ANSYS. Mesh generation is one of the most critical aspects of engineering simulation. ANSYS Meshing technology has been built on the strengths of stand- alone, class-leading meshing tools. For meshing of parts element size selected is 3mm for better results and edges selected for fine tune meshing purpose at critical area. Because too many cells may result in long solver runs, and too few may lead to inaccurate results. ANSYS Meshing technology provides a means to balance these requirements and obtain the right mesh for each simulation in the most automated way possible. This is the most important step in analysis because meshing generally affects the accuracy & economy of analysis.



Meshing view of circular Aluminum Alloy structure



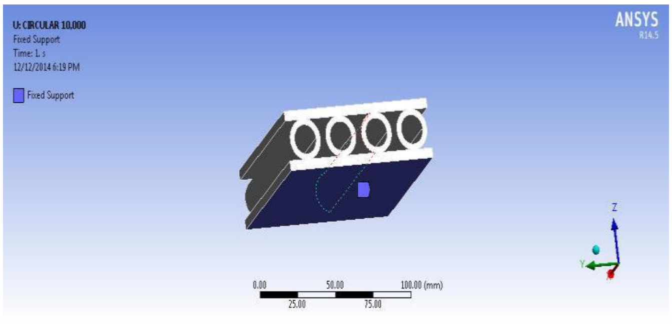
Meshing view of Triangular Aluminum Alloy structure

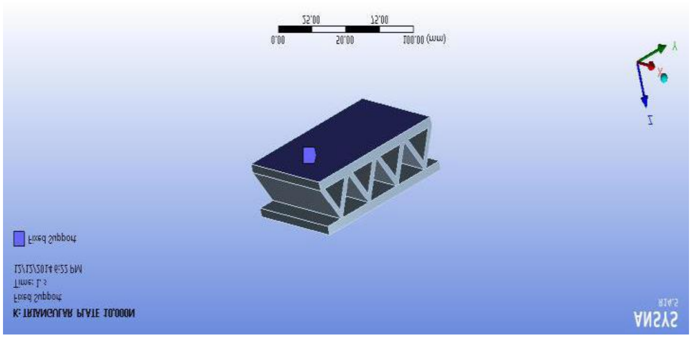


Meshing view of Rectangle Aluminum Alloy structure

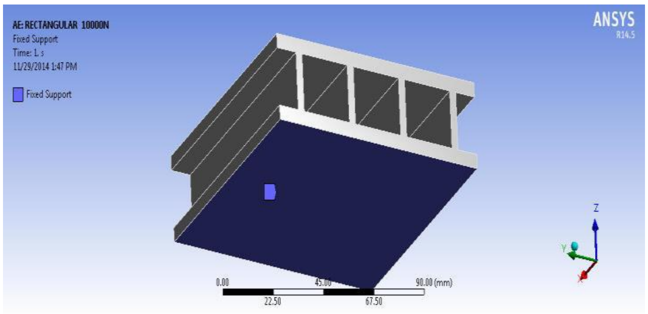
FEA RESULT

In ANSYS Workbench the STP format is Imported and Materials properties are given to the individual part i.e., top and bottom plates are selected and steel properties are given to them. Now core is selected and E-Glass/Epoxy properties are given. Now mesh 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 fig.



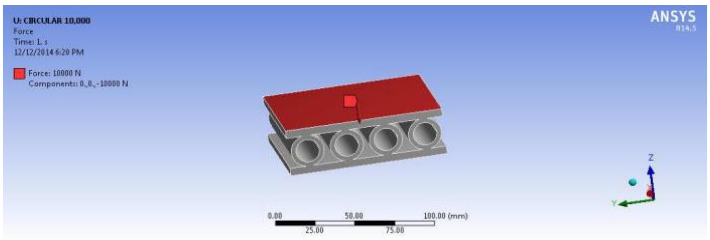


Fixing bottom plate in Triangular Aluminum Alloy structure.

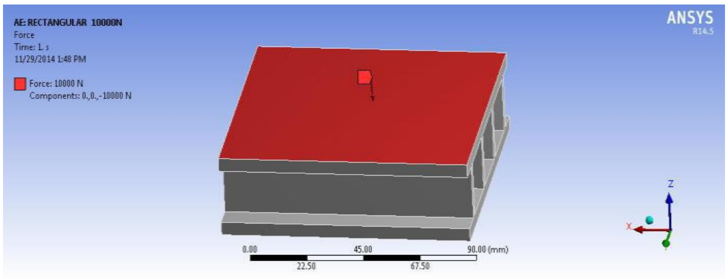


Fixing bottom plate in Rectangular Aluminum Alloy structure.

POSITION OF APPLYING FORCE: structural analysis is done by fixing the plate at bottom and 10000N force is applied at top face of the plate in both composite and Aluminum Alloy structure as shown in below fig.

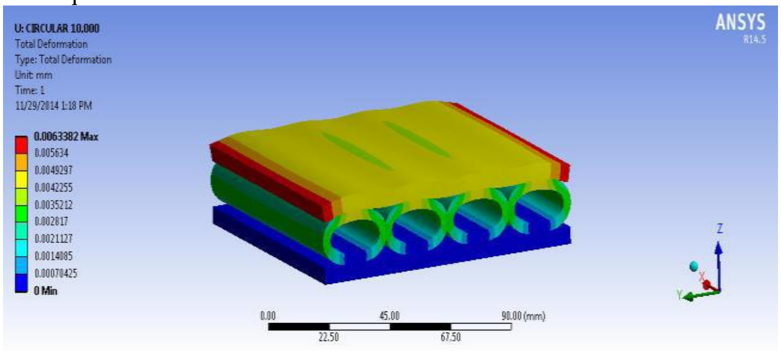


Position of applying force on circular Aluminum Alloy structure

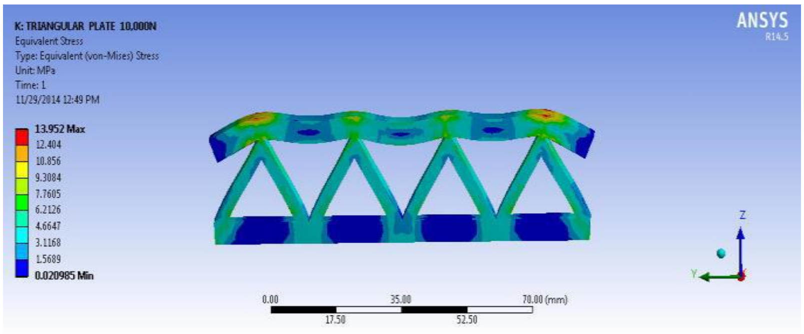


Position of applying force on Rectangular composite structure.

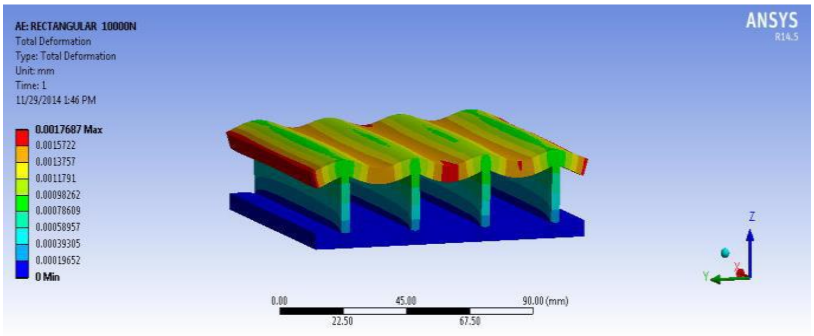
Total deformation and Equivalent stress of all structure:



Circular Aluminum Alloy Structure



Triangle Aluminum Alloy Structure



Rectangle Aluminum Alloy Structure

RESULTS AND DISCUSSIONS

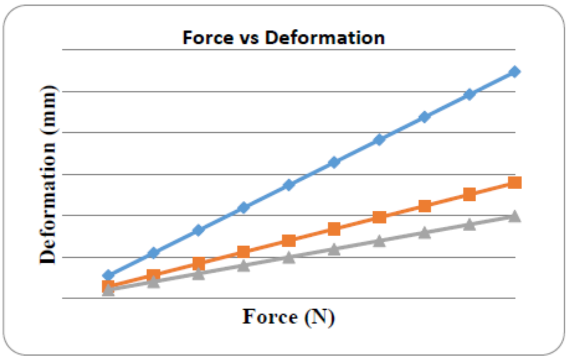
Rectangular Aluminum Alloy Structure				
Sr. No.	Force (N)	Deformation (mm)	Equivalent Stress (Mpa)	Weight (Kg)
1	1000	0.00017687	0.99194	0.97717
2	2000	0.00035374	1.9839	
3	3000	0.00053061	2.9758	
4	4000	0.00070748	3.9677	

Triangular Aluminum Alloy Structure				
Sr. No.	Force (N)	Deformation (mm)	Equivalent Stress (Mpa)	Weight (Kg)
1	1000	0.00030044	1.3952	1.1879
2	2000	0.00060088	2.7904	
3	3000	0.00090131	4.1856	
4	4000	0.0012018	5.5809	

Circular Aluminum Alloy Structure				
Sr. No.	Force (N)	Deformation (mm)	Equivalent Stress (Mpa)	Weight (Kg)
1	1000	0.00063382	2.7377	1.3114
2	2000	0.0012676	5.4754	
3	3000	0.0019015	8.2132	
4	4000	0.0025353	10.951	

Deformation comparison of all Aluminum Alloy structure:

Sr. No.	Force (N)	Circular Aluminum Alloy Structure (Deformation)	Triangular Aluminum Alloy Structure (Deformation)	Rectangular Aluminum Alloy Structure (Deformation)
1	1000	0.00063382	0.00030044	0.00017687
2	2000	0.0012676	0.00060088	0.00035374
3	3000	0.0019015	0.00090131	0.00053061
4	4000	0.0025353	0.0012018	0.00070748



Equivalent Stress comparison of all Aluminum Alloy structure:

Sr. No.	Force (N)	Circular Aluminum Alloy Structure Equivalent Stress (Mpa)	Triangular Aluminum Alloy Structure Equivalent Stress (Mpa)	Rectangular Aluminum Alloy Structure Equivalent Stress (Mpa)
1	1000	2.7377	1.3952	0.99194
2	2000	5.4754	2.7904	1.9839
3	3000	8.2132	4.1856	2.9758
4	4000	10.951	5.5809	3.9677

In above table shows the deflection, equivalent stress and self- weight of investigated Triangular, Rectangular and Circular composite structure and Triangular, Rectangular and Circular Aluminum Alloy structure. The weight of composite structure is 0.785 kg is small as compare to the Aluminum Alloy structure. The Equivalent Stresses, Total deformation of Rectangular steel structure is also small as compare to Triangular, circular Aluminum Alloy 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, Rectangular composite structure.

CONCLUSION

The composite structure models in CATIA are efficiently imported into ANSYS workbench structural analysis is done and max stress and total deflection is observed. For given span of the structure, decreasing the weight of composite structure also the strength increases and weight is reduced. The weight of composite structure is decrease of 19-40% as compares to Aluminum Alloy structure. And also increases the strength of composite structure as compare to Aluminum Alloy structure. By comparing rectangular Aluminum Alloy structure with triangular and circular structure it is observed that rectangular structure have minimum stresses and also have minimum deflection.

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