Design and analysis of Al6063 T6 and glass fiber reinforced composite material

Parthasarathy Garre* and Gooty Rohan[1]

*Assoc. Professor, Dept. of Aeronautical Engineering, MLR Institute of Technology, Hyderabad-500043. India, 9396965153, gps.mlrit@gmail.com

[1] M.Tech Scholor, Aerospace Engineering, Dept. of Aeronautical Engineering, MLR Institute of Technology, Hyderabad-500043. India

Abstract. Composite materials are used for aerospace structural component because of its good tensile strength. An attempt is made by the previous author with the sandwich composite as AL6063 T6 with E-glass fiber layers by fabricating and testing. In this paper we are validating the results of same material with the help of ANSYS. The finite element analysis as done on ANSYS by taking the specific orientation of the composite material. The final results obtained in FEA are validated with the previous test results and found in good comparison.

Keywords: Orientation, MWPS, CSM, UD, SW

1. Introduction

The combination of two or more distinct materials to obtain desired combined properties is named as composite material. Such material used for structural applications like aerospace and mechanical industry. In aerospace light weight composite structures used are like housing of the aircraft's satellite radio receiver, transmitter to achieve good or higher mechanical properties than conventional alloys.
Composites materials exhibit superior properties compared to conventional alloys or materials. The following are various properties to look upon. Mechanical properties like shear, tension, hardness, corrosion resistance, high strength to weight ratio; lightweight, fire retardant, fire resistant, electrical properties, chemical & weathering resistance, This project deals with the design and analysis of the sandwich panel i.e. by using aluminum and composite. Sandwich (SW) panel is consisting of three layers: one is core which present in middle and remaining two are thin skin layers which covers the core. These panels are used in applications where high structural rigidity and low weight are required. In this analysis we consider the core as glass fiber (Composite) and skin as aluminum AL6063 T6. The testing that are carried in the sandwich panel are: Tensile, Compression and shear through ANSYS software. This papers is on selection, fabrication and strength evaluation for AL6063 T6 and glass fiber reinforced composite material [1]. This paper review on fiber-reinforced polymer composite materials which is the present technology mostly using in construction of aircraft and spacecraft. Mechanical behavior of composite and special problems are also reviewed [2]. Addition of 10wt% of steel dust with the AL6063 alloy results the improvement in mechanical property has been studied [3]. This paper review on the classification, mechanical properties and applications of each type of glass fiber reinforced composite [4]. By using vacuum bagging technique for fabrication and mechanical properties evaluated for carbon fiber and glass fiber hybrid composite material as per ASTM standards. There is increase in mechanical properties with increase in fiber reinforce content in matrix material [5].

2. Methodology

The design and analysis of sandwich panel is made by using two materials i.e. glass fiber and aluminum in a standard dimension form. Specimen is designed along the gauge length, depending on the standard used. The figure 1 is designed with the help of AutoCAD and considering of ASTM standards. Element looks like rectangular plate consist has two ends with large area and a gauge section with smaller area. The actual element is designed and analyzed in ANSYS Mechanical APDL as shown in figure 2. For analyzing the sandwich panel we need to lay up the aluminum with glass fiber. The figure 3 shows the detail orientation of composite material layup. ANSYS is a finite element modelling software for numerically solving a wide variety of mechanical problems. It can perform structural analysis (linear and non-linear), thermal analysis, electromagnetic problems, Fluid analysis etc. Finite element solution can be divided into 3 main stages: Namely, Pre-processing stage, where we design the composite element in ANSYS based on the ASTM standards shown in figure 1. The aluminium Al6063 T6 and glass fiber composite material is made as 12 glass fibre layers and 2 aluminium layers. The glass fiber is layered by mat with plus shape (MWPS), unidirectional, chopped strand mat and standard level glass. These layered glass fiber is sandwiched by aluminium Al6063 T6. Mechanical structural properties of aluminium are: Young's Modulus 69000 MPa, Poisson ratio 0.3, Rigidity Modulus 26000 MPa and Density $2.7*10^{-6}$ kg/m^3. Mechanical structural Properties of glass fiber listed are, Mat with plus shape (MWPS): Young's Modulus 9000 MPa, 9000 MPa, 8500 MPa, Poisson ratio 0.2, Rigidity Modulus 4000 MPa, 4000 MPa, 3500 MPa and Density $2.6*10^{-6}$ kg/m^3, Chopped Strand Mat (CSM): Young's Modulus 8500 MPa, 8000 MPa, 7500 MPa, Poisson ratio 0.2, Rigidity Modulus 3500 MPa, 3000 MPa, 2500 MPa and Density $2.6*10^{-6}$ kg/m^3, Unidirectional (UD): Young's Modulus 8000 MPa, 7500 MPa, 7500 MPa, Poisson ratio 0.2, Rigidity Modulus 3000 MPa, 2500 MPa, 2500 MPa and density $2.6*10^{-6}$ kg/m^3 and Glass fiber: Young's Modulus 85000 MPa, Poisson ratio 0.23, Rigidity Modulus 36000 MPa and Density 2.6 $*10^{-6}$ kg/m^3. Shell type element are chosen for analysis of composite material. In shell type element we can layup the different layers of the element with different orientation. This composite material is layered as follows Aluminium- 1.2, glass-0.3, MWPS-0.4, unidirectional-1.1, chopped strand mat-0.75, MWPS-0.4, unidirectional-1.1, chopped strand mat-0.75, MWPS-0.4, unidirectional-1.1, chopped strand mat-0.75, MWPS-0.4, glass-0.3 and Aluminium- 1.2 these orientation is indicated in figure 3. The above data is complete orientation of composite material with respective thickness. Before analysis the composite material fine mesh has been performed as shown below figure. The boundary condition are fixed support at one end (all directional displacements are zero) and, other end load (P) is applied. These boundary conditions are the acts as tensile load to the element as shown in figure 4. Solution, in this stage the solution has been resulting in the evaluation of nodal variables. This evaluation of nodal values and results will viewed in the post-processing stage. Post-processor, one of the most important step is to view the results of an analysis in order to understand how the applied loads affects our design. General processor is used to review the results, by using this post processor we can see contour displays as shown in figure 5, deformed shapes, element forces and moments, nodal displacements, stress contour, vonmises stresses, principal stresses etc.

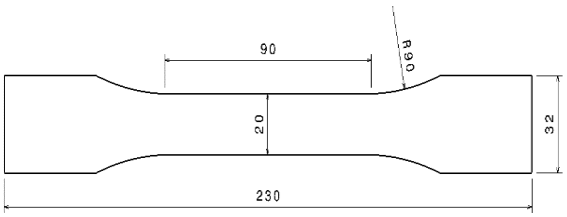

Figure 1: Dimensions of composite material

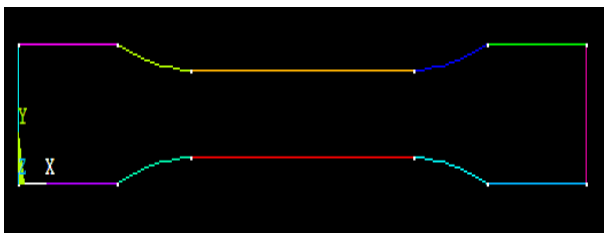

Figure.2: Design in ANSYS

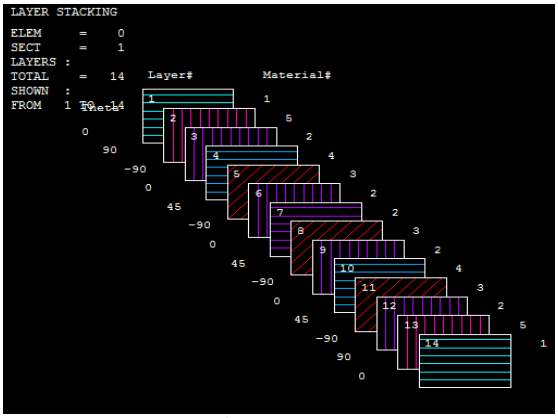

Figure.3: Layers of composite material

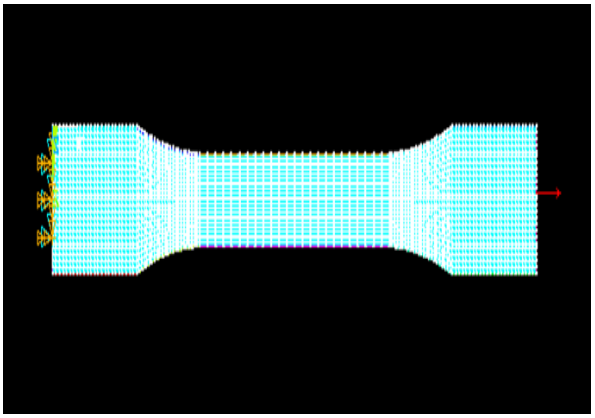
Figure.4: Meshing and boundary condition

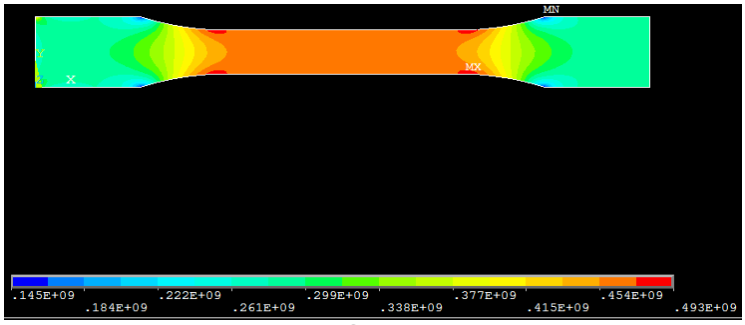

Figure.5: Stress contour

3. Results

Results obtained are plotted in the figure 6 as shown below between stress and strain.

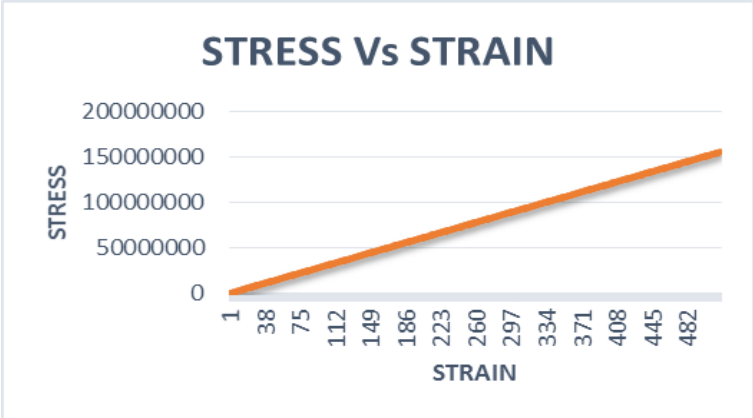

Figure 6: Linear Stress Vs. Strain graph

.

4. Conclusion

Tensile strength of sandwich composite material is analyzed in ANSYS by taking specific orientation 0, 90, -90, 0, 45, -90, 0, 45, -90, 0, 45, -90, 90, 0 degrees and boundary condition are one end fixed and other end tensile load is 77 GPa on it. The results were obtained for this sandwich composite in finite element analysis is 87 GPa which is in better comparison with ultimate strength observed in fabrication test is 90 GPa.

References

[1] Parthasarathy Garre, Dr.M.Sathyanarayana Gupta, 2017, International Journal of Civil Engineering and Technology, 8, Pp. 363-367.
[2] Nikhil V Nayak, 2014, International Journal of Scientific and Research Publications, 4.
[3] S. O. Adeosun, E. I. Akpan, O. I. Sekunowo, W. A. Ayoola, and S. A. Balogun, 2012, ISRN Mechanical Engineering.
[4] T P Sathishkumar, S Satheeshkumar, J Naveen, 2014, Journal on Reinforced Plastics and Composites, 33.
[5] T D Jagannathal and G Harish, 2015, International Journal of Mechanical Engineering and Robotics Research, 4.