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STRUCTURAL ANALYSIS OF GLIDER WING FOR LIFT FORCE

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ABSTRACT: The paper deals with the Structural design and strength analysis of a glider wing is paramount importance in the glider system as structural failure of a wing may lead to failure of machine of the glider. The purpose of the present project is to structurally design and ensure that the wing has a sufficient strength with lowest weight possible. As the wing is complex 3-Dimensional aerodynamic profile theoretical stroke analytical structural design is quite difficult. An FEM technique is used for strength analysis of the wing. As the part of strength analysis static analysis is performed and will be ensured that the wing will be safe in the entire region of operation. The Geometry of the models is carried out in the CATIA V5 R20 Software and is designed in Generative shape Design. The structural analysis is done to show the structural deformations, Von-mises stress, Maximum principal stress and strains for the applied loading conditions. The objective of this project is to compare the results obtained for different models like Solid wing(AL), Hollow wing 5mm(AL), Hollow wing 3mm(AL) using analysis software. From the results we will conclude which model is having better properties

KEYWORDS: Glider, FEM, structural, Von-misses

INTRODUCTION

Glider wing is a heavier than air craft that is supported in flight by the dynamic reaction of the air against its lifting surface and whose free flight does not depend on an engine. Glider wing air craft to extending their flight when necessary small engines are used to take off. The NACA airfoils are airfoil shapes of aircraft wings developed by the National Advisory Committee for Aeronautics (NACA). The shape of the NACA airfoils is described using a series of digits following the word "NACA.". Glider wing is designed by combining NACA profiles. The wing must have sufficient strength with lower weight possible for that we used Solid Al, Hollow surface Al and Hollow Composite material bodes. The discussions were focused on the aerodynamics characteristics, lift coefficient CL, and lift-to-drag ratio L/D. In this investigation two Different wings are used: An Elliptical wing and a Long wing. The airfoil used in this investigation is NACA profiles with which both the wings are designed to gather to form an glider wing. The investigation aims to produce better aerodynamic performance with the implementation of the glider wing designs. One of the objectives of this work is reduce the induced drag formed on wing during the fight operation, thus improving the efficiency of the glider wing. The analysis part is done by using the ANSYS Software; flow parameters (like the lift and drag) are measured for different design configurations and are compared with the plane wing.

A wing is a surface used to produce an aerodynamic force normal to the direction of motion by traveling in air or another gaseous medium, facilitating flight. It is a specific form of airfoil. A wing is an extremely efficient device for generating lift. Its aerodynamic quality, expressed as a Lift-to-drag ratio. This means that a significantly smaller thrust force can be applied to propel the wing through the air in order to obtain a specified lift. The most common use of wings is to fly by deflecting air downwards to produce lift, but upside-down wings are also commonly used as a way to produce down force and hold objects to the ground.

DESIGN AND DETAILS OF MODEL

CONSTRUCTION IN CATIA V5: -

Glider wing design has four different NACA profiles. NACA profile is generated by using 42 points to construct the splain. In the same way draw other NACA profiles using them combined multi section surfaces contacted. Multi output symmetric them NACA design forms glider wing design. Sheet metal like structure Glider wing Skin is an essential part of the wing which is used to maintain an aerodynamic shape and is used to transfer different types of loads to the structural members of the wing. Skin is manufactured by the traditional methods of stretch forming for aircrafts.

EQUATION:

$$\pm y_t = \frac{t}{0.2}\left(0.2969\sqrt{x} - 0.1260x - 0.3516x^2 + 0.2843x^3 - 0.1015x^4\right)$$

NOMENCLATURE

Yt span length of a NACA profile
t Maximum thickness of airfoil
x change in thickness of NACA profile

NACA 3422	**NACA 3422**	**NACA 3418**	**NACA 2412**	**NACA 1412**

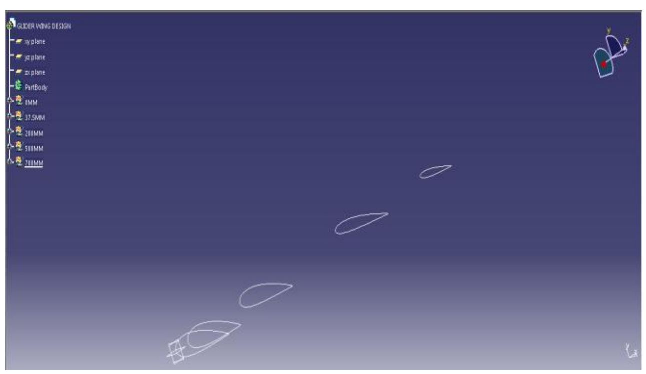

Figure 1: GLIDER WING NACA PROFILES

Wireframe geometry is the backbone on which the surface features of the model are created. You can use wireframe features to define construction elements, intersection, and common boundaries of the surface that define the shape of the model. Wireframe geometry can consist of simple features such as sketches, points, lines, and planes, as well as more complex geometry, such as splines or helixes.

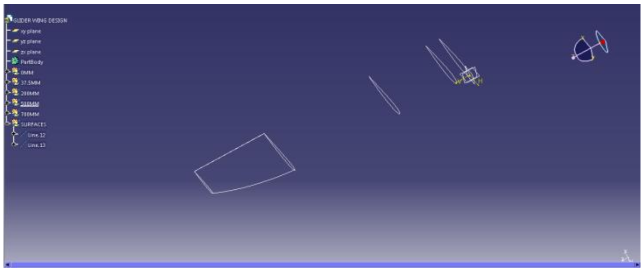

Figure 2: Elliptical and long wing

In this investigation two Different wings are used. An Elliptical wing and a Long wing. The airfoil used in this investigation is NACA profiles with which both the wings are designed. The investigation aims to produce better aerodynamic performance with the implementation of the winglet for both wing designs. One of the objectives of this work is reduce the induced drag formed on wing during the fight operation, thus improving the efficiency of the aircraft.

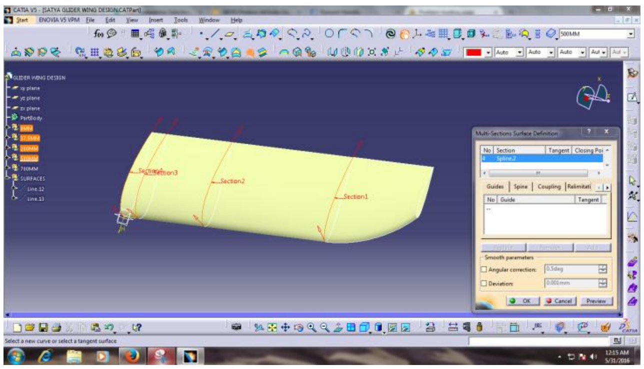

Figure 3: Multi-Section surface

This tool allows you to create lofted multi-section surfaces. The surface is created between the sections along the computed or user-defined spine. To create a multi-section surface, you first need to create sections and guide curves. Next, choose the Multisections surface button from the Surface toolbar.

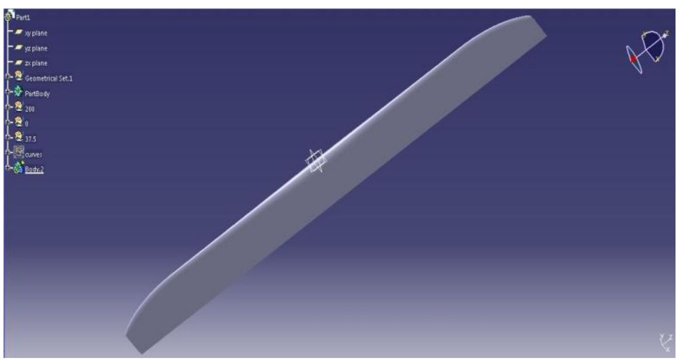

Figure 4: GLIDER WING DESIGN

ANALYSIS

<u>Material</u>: -Al

<u>Construction in ANSYS 14</u>: -

The "Advanced Meshing tools" available in the generative shape structural analysis workbench in ANSYS Workbench15 software is used for creating the entire glider wing and performing the structural analysis.

Before proceeding to the finite element analysis of the wing structure, it is good to obtain an solid and hollow wing thickness of the components through analytical calculus. At a first approximation, it is assumed that solid wing carries the total load acting on the wing. This assumption goes toward safety and leads to oversize the thickness, since Stress distribution due to the lift. The length at which the force is applied is assumed to be the distance from the effective root airfoil to the mean aerodynamic chord. Since the two components have different module of elasticity, a stress discontinuity will occur at the interface between them. In fact, using the calculated value of the stress distribution as a function of the y coordinate is different for the two materials, and it is given by maximum stress occurs where y is maximum.

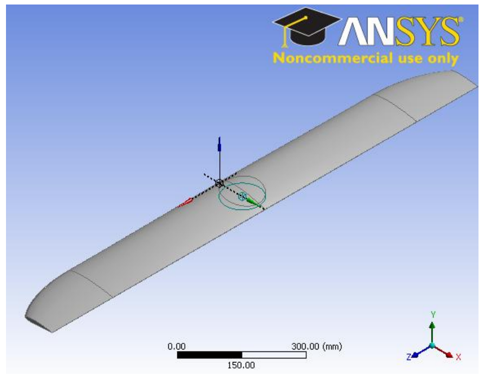

Figure 5: Glider Wing Imprint faces

Hear mainly glider wing imprint faces are created for fixing the wing to an aeroplain at the center of the axis for that we are using circle as a fixed support.The finite element mesh of the glider wing should be of good quality. This means that there are not any uneven or large angles in the mesh nodes. Furthermore, it is essential that the all the mesh elements of the wings are properly connected at the nodes. This means that the growth points of the mesh be properly controlled so that the mesh elements take into account the position and orientation of the glider wing panels. A global mesh size and tolerance parameter is defined which controls the size and characteristics of the mesh.

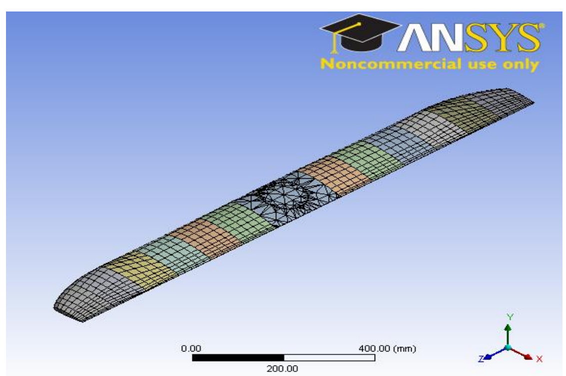

Figure 6: GLIDER WING ANSYS MESH

Wing needs section data specifications to simulate a three dimensional behavior. In the section data, a laminate composite can be also created, inputing for each layer the material, its thickness and its orientation with respect to the local coordinate system x axis. The sections that have been associated used to model the same thicknesses of the wing, and have been approximated as single-layer homogeneous sections.

LIFT RESULTS

We can perform the parametric analysis with the use of different parameters like Material properties, loading condition, boundary condition, mesh resizing by virtue of which we obtain some useful information without experimental cost and we can finally optimize our model.

It is only used in order calculations of deformation, stress and strains in each part of the glider wing and the shear flow. This will generate a table showing all the conditions of external force on the wing and for this it is necessary to establish the geometric characteristics of the cross section. Applying 1600N lift force on symmetric sections both surface which can be controlled by circular fixed support results will be obtained as shown in below.

1. **Structural analysis outputs for the Solid wing (AL) are as follows.**

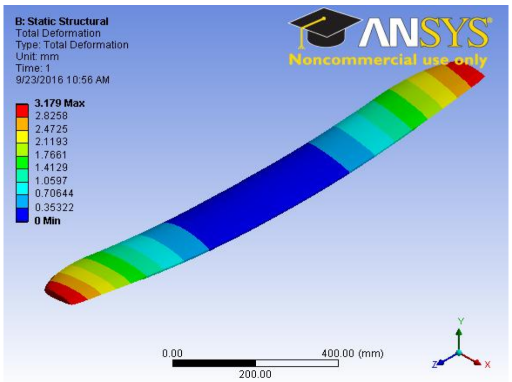

Figure 7: Total Deformation.

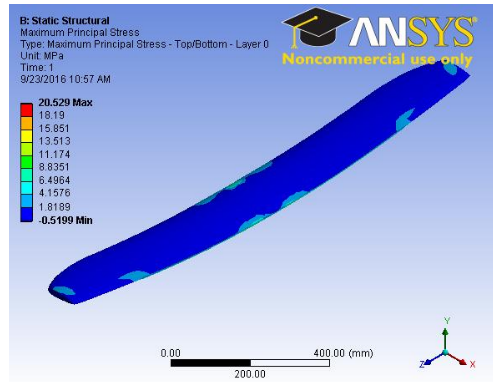

Figure 8: Maximum Principal Stress

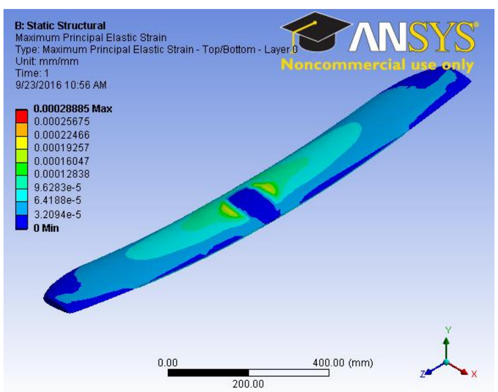

Figure 9: Maximum Principal Strain

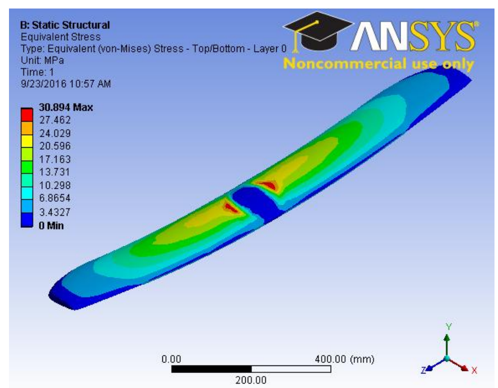

Figure 10: Equivalent Stress

2. Structural analysis outputs for the Hollow wing (AL) 5mm are as follows.

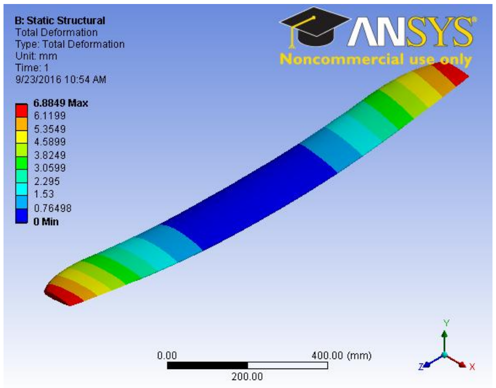

Figure 11: Total Deformation

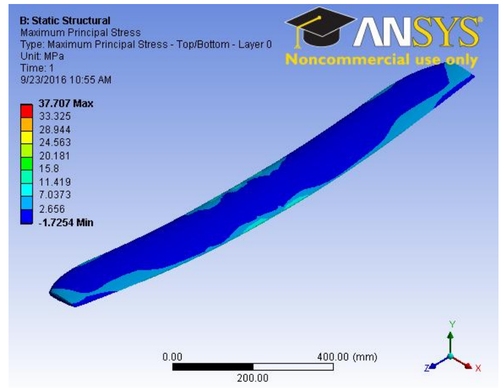

Figure 12: Maximum Principal Stress

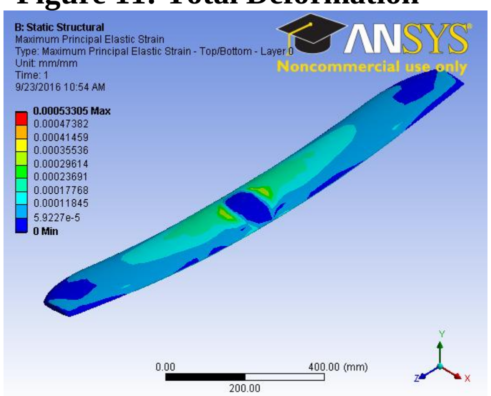

Figure 13: Maximum Principal Strain

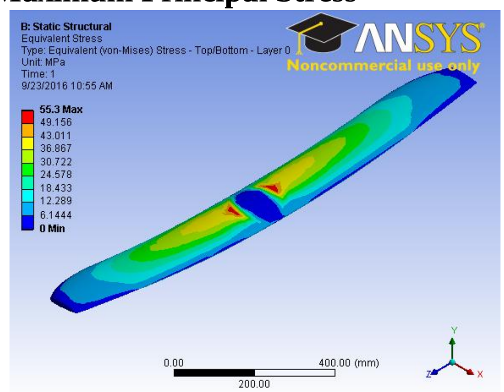

Figure 14: Equivalent Stress

3. Structural analysis outputs for the Hollow wing (AL) 3mm are as follows.

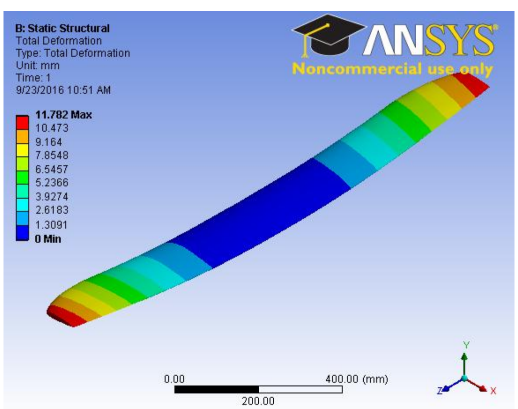

Figure 15: Total Deformation

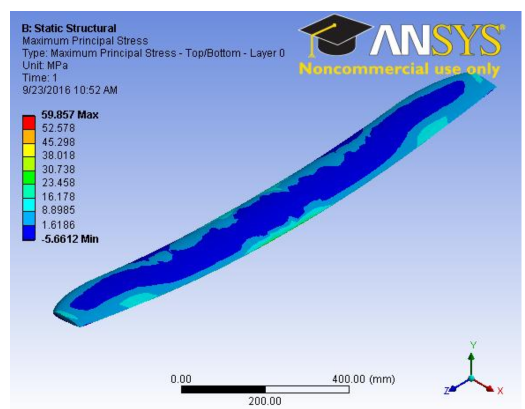

Figure 16: Maximum Principal Stress

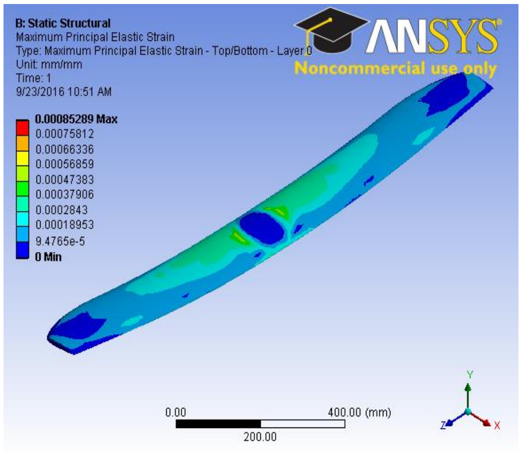

Figure 17: Maximum Principal Strain

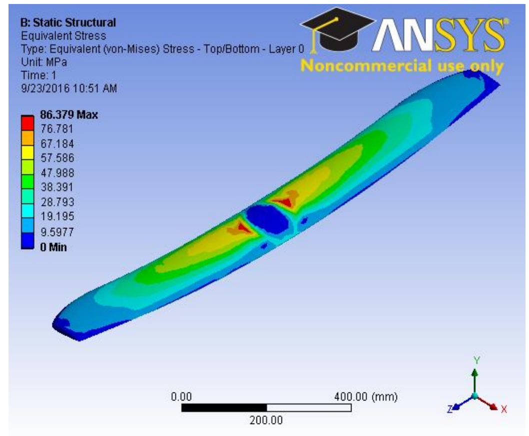

Figure 18: Equivalent Stress

Material	Weight (KG)	Total Deformation (MM)	Maximum Principal Stress (Mpa)	Maximum Principal Strain	VON-MISES Stress (Mpa)
SOLID WING (Al)	**8.9994**	**3.179**	**20.529**	**0.00028885**	**30.894**
HOLLOW WING (AL) (5MM)	**5.8241**	**6.8849**	**37.707**	**0.00053305**	**55.3**
HOLLOW WING (Al)(3MM)	**3.1391**	**11.782**	**59.857**	**0.00085289**	**86.379**

Table 1: Glider wings

CONCLUSION

As per the calculated design requirements, the modeling of wing is carried out with the help of software CATIA V5R20. The structural analysis of the wing section was carried out for material aluminum with help of ANSYS Static Structural and the results of lift at various sections of the solid and hollow wing are compared. From the comparisons it is concluded that hollow wing 3mm aluminum material has better structural characteristics than will reduction in weight of the wing. As the demand for lighter material with good structural characteristics is required in aerospace.

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