Received Date: 08/12/2021 Acceptance Date: 23/12/2021 Publication Date:31/12/2021

NUMERICAL INVESTIGATION OF A300 AIRCRAFT WING USING 6061Al- TiC-ALOEVERA POWDER

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Abstract: *The A300 is currently the largest aircraft on the market and one ahead Flights in the country. The design of the flight corresponds to their flying wings. The wing of the plane. The most complex aspects is aircraft design. For all of its short history, Aluminium alloy has been dominated by other materials in the aerospace industry; it was considered to be light-weight, inexpensive, and widely used in aircraft components. Obviously, it is observed that the mechanical properties of pure aluminium and its alloys can be improved by adding hybrid reinforcement. Therefore, in this review a new combination of Al alloy with reinforcing materials TiC and Aloe Vera powder is added then Modal and structural analysis to the A300 wing Section done.*

Key Words: *A300 aircraft, 6061 Aluminium, Titanium carbide, Aloe Vera powder, Structural analysis.*

1. INTRODUCTION:

In order to achieve the best performance in the wing of Airbus A300B4-600R the presence of reinforcing material in matrix must be the same and the bonding or chemical bonding integrity between the matrix and reinforcement is maintained. Using the hybrid composite in the wing design and thus, designing and analysis is done. The material used here is 6061Al-TiC-Aloevera powder. The Titanium carbide reinforced with aluminium metal matrix composite with different composition of fly ash as 8%, 16%, 24% collectively added then found mechanical properties such as improved up to composition 2 after that it is slightly decreased because using high content of fly ash and also it will increase the weight percentage of Titanium carbide and fly ash leads to porosity and cluster formation [1]. Aluminum with Titanium carbide reinforcement have increased wear resistance. On increasing of Titanium carbide with Aluminium matrix makes the surface cracks and porosities were observed [2]. Aluminium with fly ash and Aloe Vera powder was compared respectively as result we got to know that Aluminium with Aloe Vera powder will give better improvement of material such as hardness, tensile strength, impact strength than that of fly ash used [3]. The Aloe Vera powder is natural fibers [4]. To investigate flexural and impact properties of natural fiber are higher than the pure polyester, Aloe Vera has higher values of flexural [5]. The airplane wing is one of the most important and complex components of an airplane design. A wing is a type of wing that produces strong winds that fly through the air. When energy works in the body, the next will be the force of the air in the air. The first are the elevators. This force is directed upwards and controls the movement of the wing, and the latter is the resistance. It is used in a different direction from the movement of the aircraft. This type of wing is used with two materials, the AL alloy and the AL 7068 alloy. Due to its flexibility in many aircraft operations and conditions [6]. Aloe Vera can be affected by processing procedures that involve heat or cutting action [8]. If we increase Titanium carbide to the Aluminium matrix shows the significant improvement in mechanical properties [9]. Based on this approach, the structural analysis of wing is carried out.

2. MATERIAL SELECTION

The material for the wing is selected by considering many different factors such as mechanical properties, chemical properties, physical properties, electrical properties and cost. These must be weighed during the fabric material selection process.

Therefore, TiC and Aloe-vera powder are used as the reinforcing material which is added to the 6061 Al alloy to enhance the properties of the composite.

The properties of the respective materials are shown in the table below.

Materials	Density (g/cm3)	Young's modulus (GPa)	Poisson's ratio
6061 Al	2.70	68.9	0.33
TiC	4.93	400	0.18
Aloe-vera	1.0	3.91	0.2

Table 1 Properties of material

The materials are then fabricated using the stir casting process for uniform mixing and bonding integrity between the matrix and reinforcement. The properties obtained for the fabricated material is shown in the table which is then used for the static structural analysis of the wing.

Young's modulus	111GPa
Poisson's ratio	0.3
Density	2.58 g/cm^3

Table 2 Fabricated materials properties

3. DESIGN

To do the analysis, the initial step is to collect the details of A300B4-600R. The wing aspect ratio, span, thickness etc. are noted down as shown within the table below.

Aircraft type	**A 300B4-600R**
Airfoil	NACA 64-215
Wing area (m^2)	260
Wing span (m)	44.84
MAC (m)	6.44
Aspect ratio	7.73
Taper ratio	0.3
Average thickness	10.5
¼ Chord sweep angle	28
Rib thickness (mm)	100

Table 3 A300B4-600R aircraft details

Then the airfoil co-ordinates are collected and exported to the design software. The wing is designed using the software called SolidWorks 2020. The airfoil is the projected to different planes and ribs and spars are created accordingly. Also, the skin is developed over the structure.

Figure 1 Design of aerofoil using Catia V5

4. STEPS INVOLVED IN PREPROCESSING AND POST PROCESSING

- Importing CAD model
- Messing of Geometry
- Application of material properties
- Loads and Boundary conditions
- Model and Structural analysis submission
- Analysis results

INTERNATIONAL JOURNAL FOR INNOVATIVE RESEARCH IN MULTIDISCIPLINARY FIELD ISSN: 2455-0620 Volume - 7, Issue - 12, Dec – 2021
Monthly, Peer-Reviewed, Refereed, Indexed Journal with IC Value: 86.87 Impact Factor: 6.719
Received Date: 08/12/2021 Acceptance Date: 23/12/2021 Publication Date:31/12/2021

5. RESULTS AND ANALYSIS

In this review, the designed wing geometry is analyzed using the software MSC Patran and Nastran. The MSC Patran, where the pre and post processing works are done on the principle of finite elemental analysis. That provides solid modeling, meshing and analysis setup. It is then solved by using the solver MSC Nastran.

Some of the applied load condition required during analysis of the wing geometry is shown below:

Limit Load = TOWx Lift
= 163000 x 9.81 x 6 = 9,594,180

Design force= Limit Load x FOS
= 9,594,180 x 1.5 = 14,391,270
(FOS = 1.5)

Force on semi span = Design force/2
= 14,391,270 /2 = 7,195,635

Pressure force on wing = force on semi span / wing area
= 7,195,635 /260
= 27,675.5192x 10^-6 N/mm^2

6. MODAL ANALYSIS:

Modal analysis is the one in which the wing geometry is subjected to free-free conditions to determine the natural frequencies and the behaviour of wing.

The analysis results are shown below for first three modes.

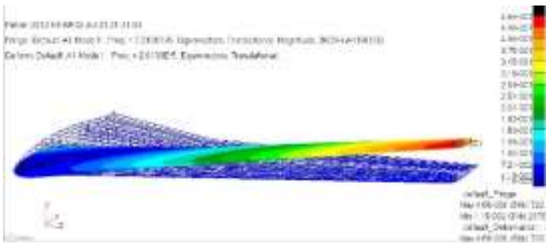


Figure 2: Model analysis at mode 1

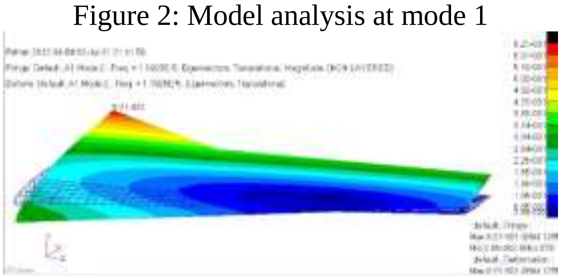


Figure 3: Model analysis at mode 2

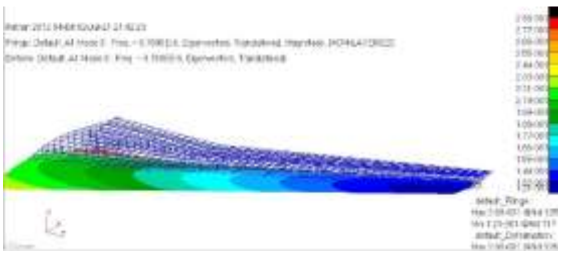


Figure 4: Model analysis at mode 3

Modes	Frequency (Hz)
Mode 1	2.0136E-5
Mode 2	1.1925E-5
Mode 3	9.7895E-6
Mode 4	3.7858E-6
Mode 5	8.3996E-6
Mode 6	1.3696E-5
Mode 7	6.7576

Table 4 Modal Analysis

Therefore, from the analysis it is inferred that the different modes of frequencies show that the stages of bending, tension, and twisting of the wing structure.

7. STRUCTURAL ANALYSIS:

The structural analysis is done for the wing geometry. The one end of the wing is arrested at the two spars. The applied boundary condition is shown in the figure below.

The meshed geometry of the wing, spar and ribs are separately are shown in figure 5, figure 6 and figure 7.

Figure 5: Meshed geometry of wing Skin

Figure 6: Meshed geometry of Spars

Figure 7: Meshed geometry of ribs

Then the pressure load is applied on the down side of the wing geometry as shown in figure 8

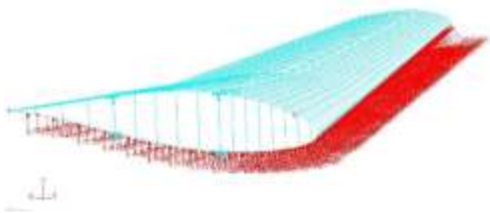


Figure 8: Pressure load applied

In static structural analysis we are interested in finding the total deformation, von mises stress which is also known as equivalent stress, shear stress and stress intensity included in the skeleton structure of the wing.

Figure 9: Principal stress on ribs

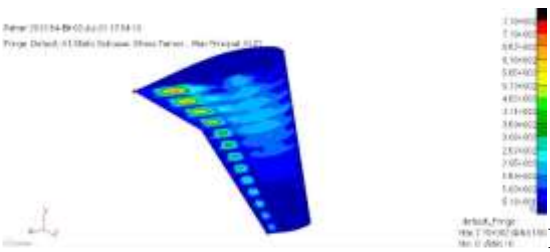
The above result shows the max. principal value of 172 MPa at ribs for an applied pressure load of 27,675.5192×10^{-6} N/mm^2 on the bottom side of the wing geometry.

Figure 10: Von-mises stress on ribs

The above figure 10 shows the von-mises stress on ribs. A maximum of 194 MPa von-mises stress is observed at the applied boundary condition. And a minimum of 6.74MPa at the trailing edge of the wing.

Figure 11: Shear stress on ribs

From the above figure 11 the max. shear stress 103 MPa and min. shear stress 3.52 MPa is obtained.



Figur

Fig 12: Principal stress on skin of the wing

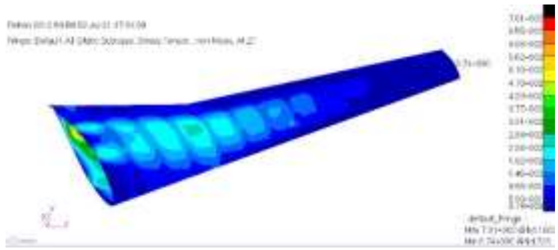


Figure 13: Von-mises stress on skin of the wing

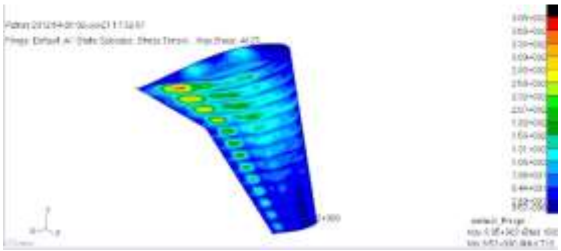


Figure 14: Shear stress on skin of the wing

The figure 12, 13, 14 shows the max. principal, von-mises and shear stress on the skin of the wing geometry. Where a max. value is obtained at the applied boundary condition, that is at the leading edge of the wing geometry.

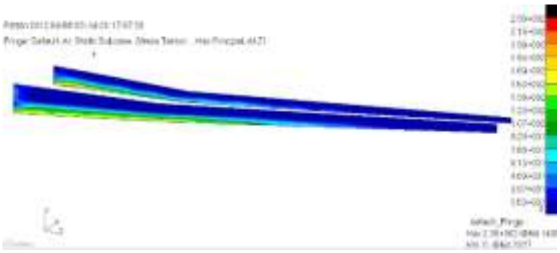


Figure 15: Principal stress on spar

The above figure shows the max. Principal stress on the spar. A maximum value of 230 MPa and a minimum of 0 MPa is seen.

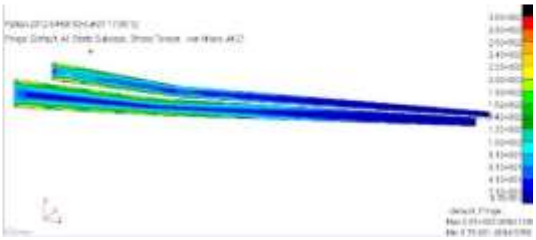


Figure 16: Von-mises stress on spar

From the above figure 16, it is inferred that a max. von-mises stress of 303 MPa and a min. of 0.878 MPa is observed.

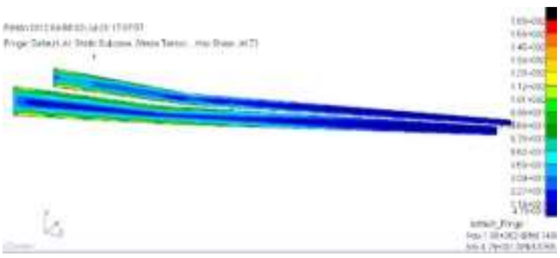


Figure 17: Shear stress on spar

INTERNATIONAL JOURNAL FOR INNOVATIVE RESEARCH IN MULTIDISCIPLINARY FIELD ISSN: 2455-0620 Volume - 7, Issue - 12, Dec – 2021
Monthly, Peer-Reviewed, Refereed, Indexed Journal with IC Value: 86.87 Impact Factor: 6.719
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The above figure shows the shear stress on spar. The max. shear value observed from above figure is 168 MPa and a min. value of 47.9 MPa.

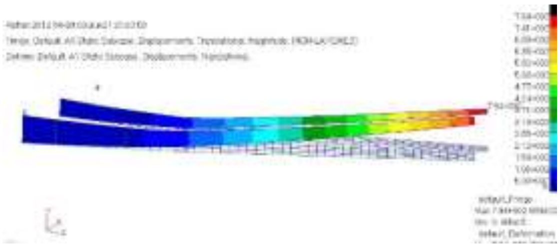

Figure 18: Spar deformation

The figure shows the deformation of the spar due to the applied pressure load. Since the structure is fixed at the leading edge, there is a max. deformation at the other end of the spar. A max. of 794 MPa and min. of 0 mm deflection is seen.

Figure 19: Deformed structure of ribs

The figure shows the deformed shape of ribs. A max. value of 822 mm is observed at the trailing edge of the wing and a min. value of 0 mm at the leading edge.

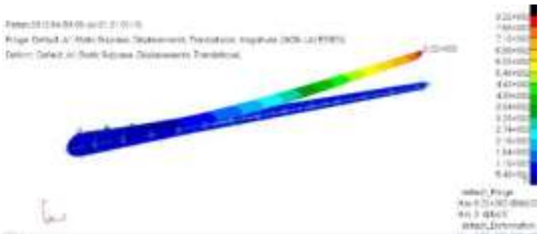

Figure 20: Deformed structure

The above figure shows the deformation of wing skin. We can see that there is a max. deformation of about 822 mm and a min. of 0 mm.

Finally summing up all the observed analysis values in the table x as shown below.

	Rib		Spar		Skin	
	Max	Min	Max	Min	Max	Min
Principal Stress (MPa)	172	0	230	0	770	0
Shear stress (MPa)	103	3.52	168	0.479	385	3.52
Von mises Stress (MPa)	194	6.94	303	0.878	701	6.74
Deformation (mm)	822	0	794	0	822	0

Table 5 Final results

8. CONCLUSION:

Obviously, it is seen that the mechanical properties of pure aluminium and its alloys can be improved to a significant level by adding a hybrid reinforcement. The Al alloy in the wing structure will generate a high stress and leads to failure of the component. But if we observe that the Al alloy reinforced with TiC have a good strength when compared with Al alloy. Based on the reference paper the ultimate tensile strength of Al MMC is 800MPa and in our result, the ultimate tensile strength is 770MPa which shows that it has got a better result. It can be concluded that, a better result is observed in the wing A300-600R after the addition of reinforcement TiC and Aloe-Vera powder with the Al alloy metal matrix composites.

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