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Design and analysis of aero fins in aerospace vehicles

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Abstract

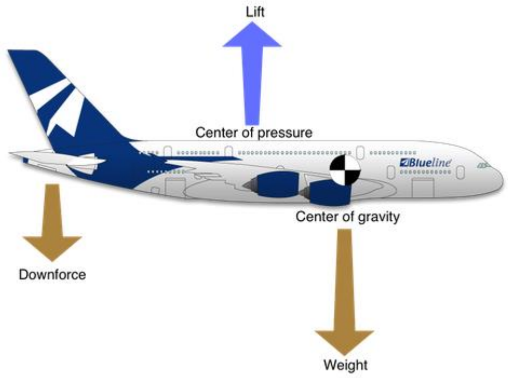
The fin is a main surface of the Aerospace vehicle. It is used to ensure the stability when it is subjected to aerodynamic forces. In general this fin used to move the vehicle in different directions. The static & dynamic analysis is performed to estimate deflections, stresses & natural frequencies.The wings are the most important lift- producing part of the aircraft. The design of wings may vary according to the type of aircraft and its purpose. Experimental testing of wing structure is more expensive and time consuming process. In this project detailed design of trainer aircraft wing structure made by using CATIA V5 R21.In this approach, here we are considering 3 different models with 4 different materials for analysis & the stresses & deformations in each case is obtained.

I. INTRODUCTION

The aeroplanes are designed for many uses on our nature, most of the people know aeroplanes are used for passenger purposes only, but only 1/3 rd of the percent only the aeroplanes are used for travelling of mankind, but most of the cargo flights run daily. Even there are many types of aeroplanes. These are even called by many names such as jets, flights, powered flights, army flights etc. As if you see the aeroplanes fly with the help of horizontal and vertical wings. As these are the main components which are used to move the flight towards up and towards down directions and the vertical wings help the flight to move the flight towards right or left directions. These vertical and horizontal wings are even called as the stabilizer for those wings. The vertical positioned stabilizer is the main part of the control surface of the wing. There can be a multiple vertical stabilizers for single aeroplanes.

LONGITUDINAL STABILITY

Longitudinal stability is achieved by having a **forward center of gravity**. Let's take a look at the forces on a typical airplane in straight and level flight:



The upward force of lift (acting from the center of pressure on the wings) is balanced by the downward forces of weight (acting from the center of gravity) and down force produced by the horizontal stabilizer. Without the down force applied by the horizontal stabilizer, the fact that the lift is behind the weight would cause the airplane to "want" to pitch down. The down force on the tail provided by the horizontal stabilizer is added to offset that downward pitching tendency.The amount of down force created by the (small) horizontal stabilizer is much smaller than the amount of lift generated by the (large) wings, but the horizontal stabilizer is much further aft of the center of gravity than the wings. This gives it a greater arm, and thus a greater torque (or moment). Thus, lift and down force are in balance and the plane remains level.

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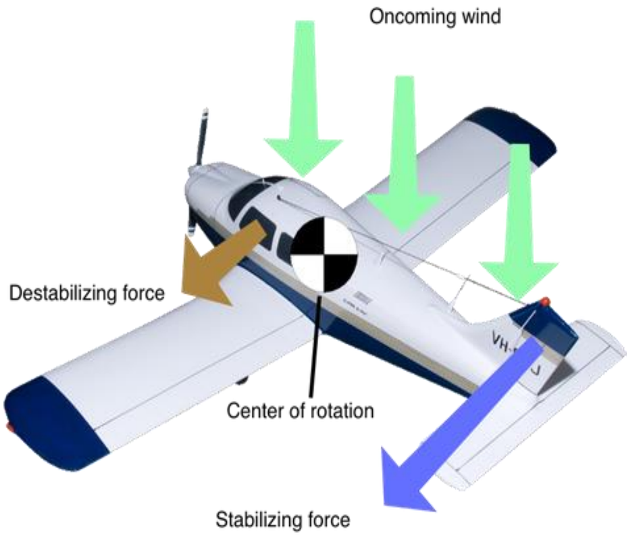
Vertical Stability

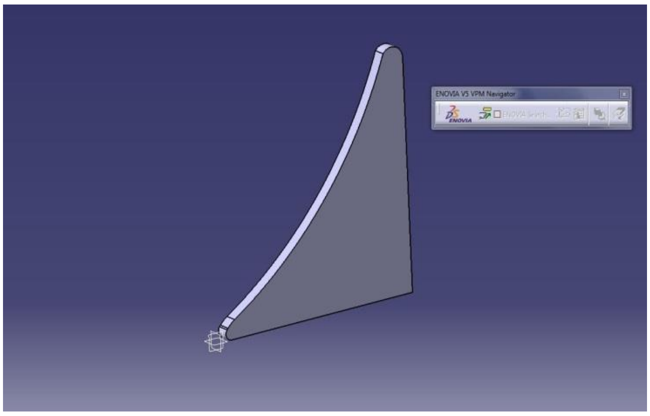
Vertical stability is achieved by **the vertical stabilizer**, or more particularly, by having more vertical surface area behind the center of gravity rather than ahead of it. This process is called the **keel effect.** Let's look at an airplane that's in a yaw:



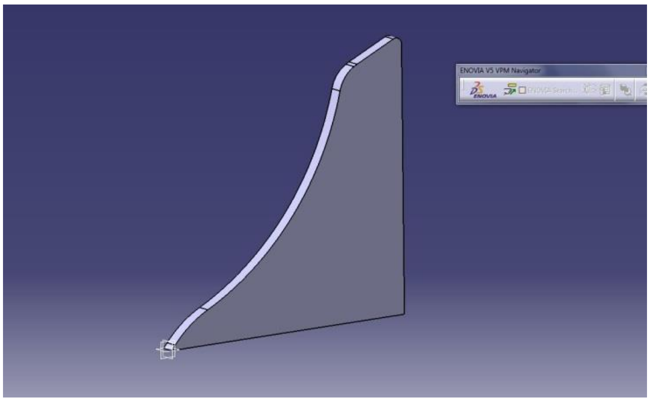
This airplane has yawed to the left, so oncoming wind is striking its right side. The wind strikes all parts of the aircraft's right surface, causing those parts of the aircraft to want to yaw left. The amount of yaw torque created is, once again, a function of the magnitude of the force and its distance from the center of rotation (center of gravity).Wind striking the cockpit and engine cowling wants to rotate the *front* of the aircraft left, which would decrease stability (since it has to go right to stabilize with the wind). However, notice that there is a nice big vertical stabilizer. It's got a lot of surface area, meaning a lot of wind is hitting it, and it's pretty far from the center of gravity, giving it a big arm and therefore lots of torque. When wind strikes the vertical stabilizer, it causes the *back* of the airplane to rotate left, making the *front* of the airplane rotate right, and the direction we want it to go. This is how the vertical stabilizer improves vertical stability. The larger the stabilizer (or just, the more surface area in general behind the center of gravity, as the wind is hitting all of it), the more vertical stability.

DESIGN DATA

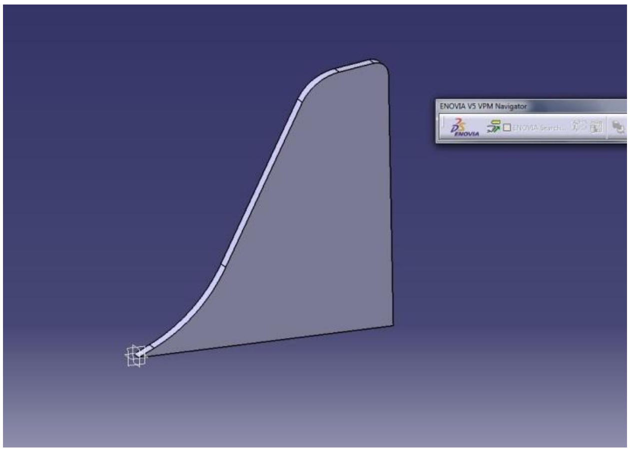
DESIGN OF AEROFIN WITH MODEL – 1



DESIGN OF AEROFIN WITH MODEL – 2



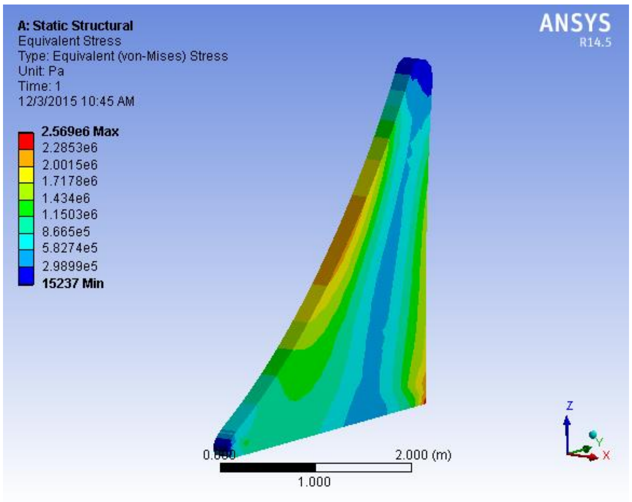
DESIGN OF AEROFIN WITH MODEL – 3



ANALYSIS

IMPORTED MODEL OF ORIGINAL MODEL OF WING WITH AL 7075 MATERIAL

STRESS



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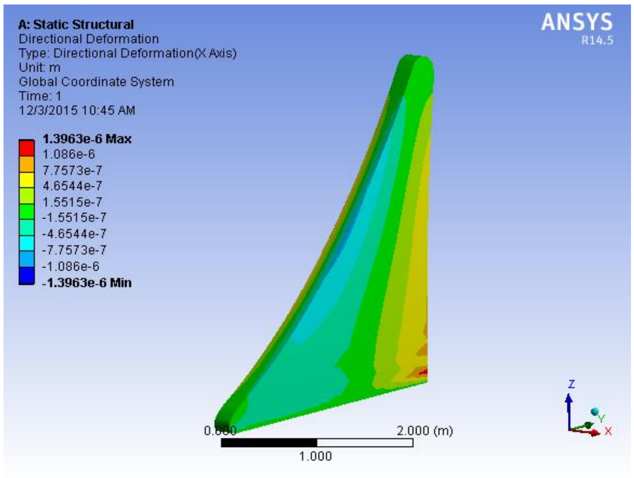
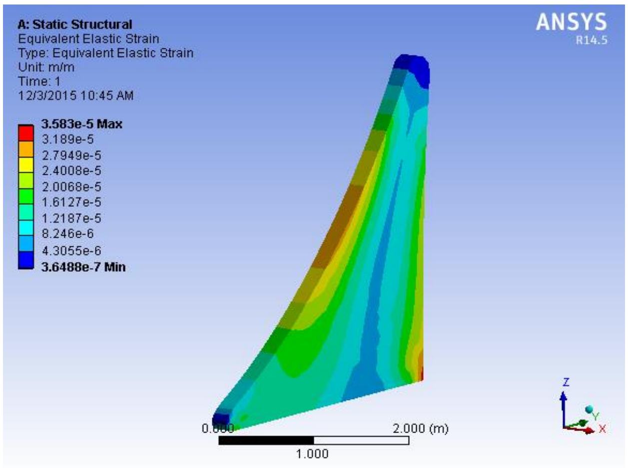


STRAIN



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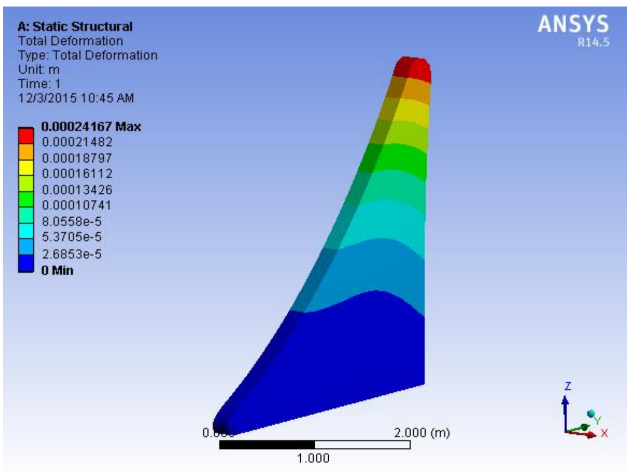

IMPORTED MODEL OF ORIGINAL MODEL OF WING WITH BORON MATERIAL

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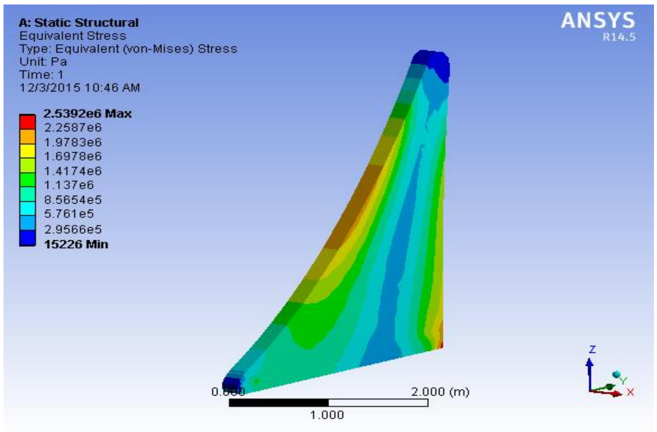

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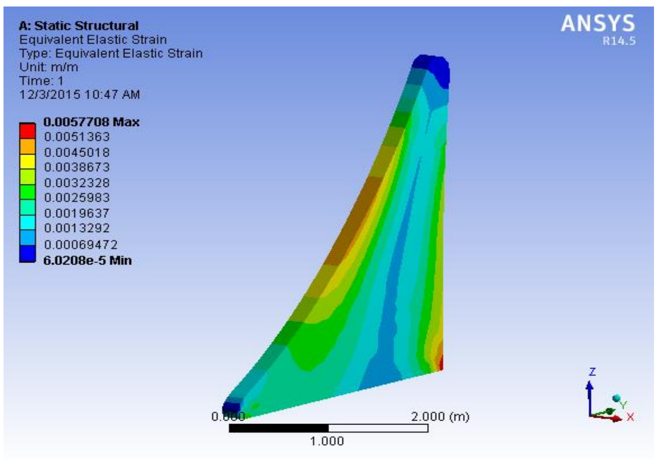

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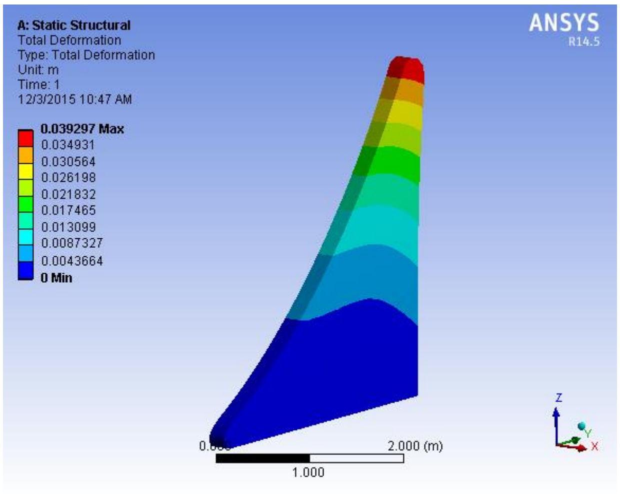

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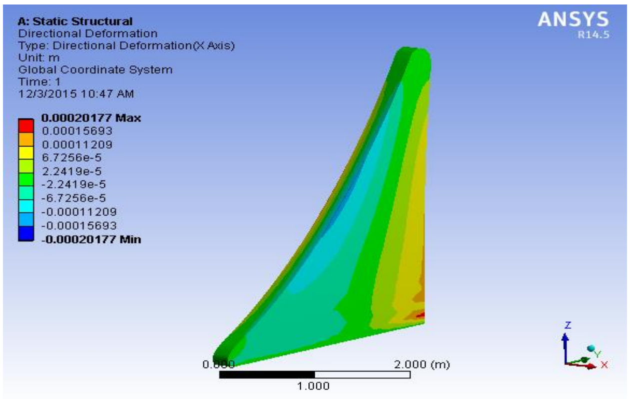

IMPORTED MODEL OF ORIGINAL MODEL OF WING WITH SILICON CARBIDE MATERIAL

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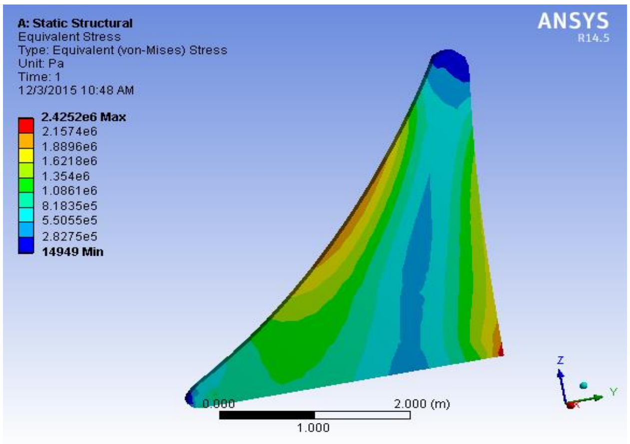

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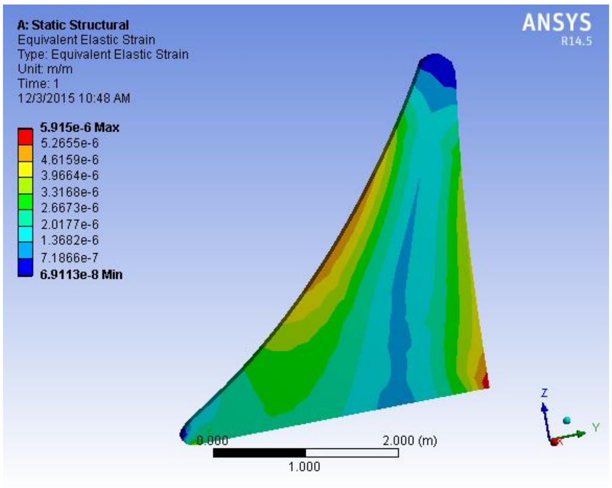

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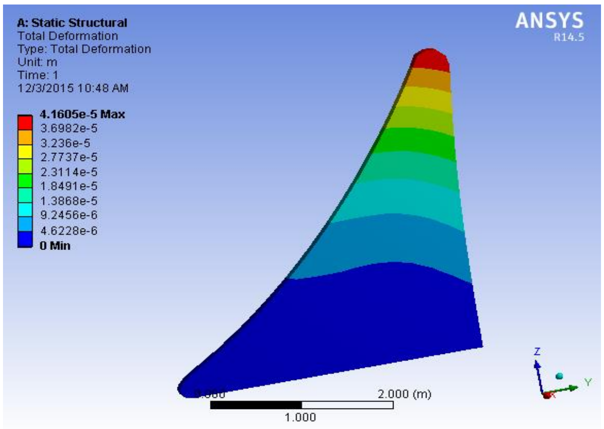

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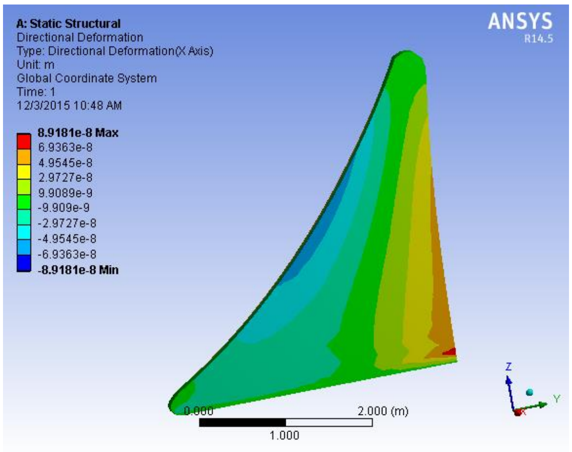

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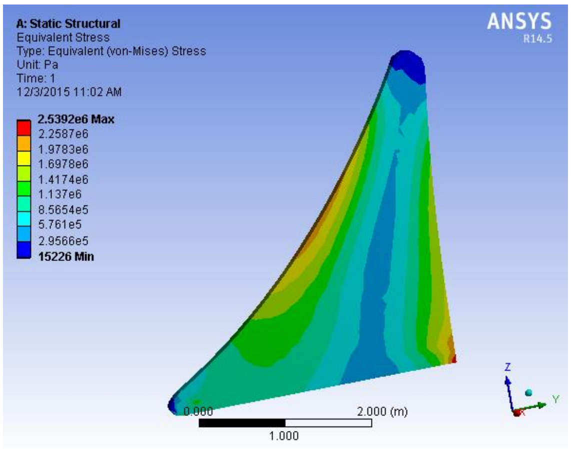

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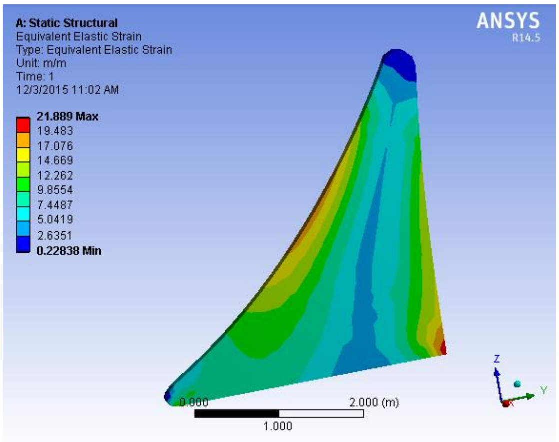

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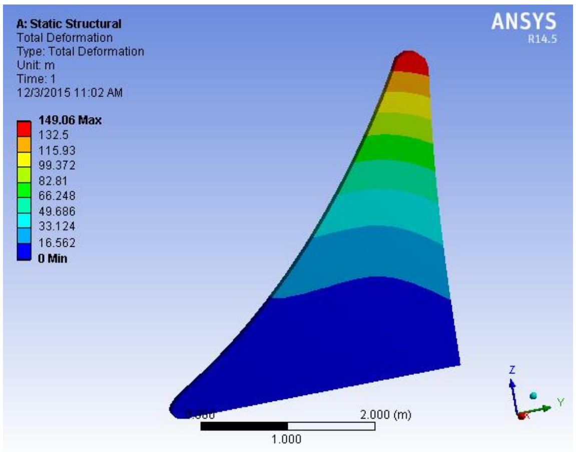

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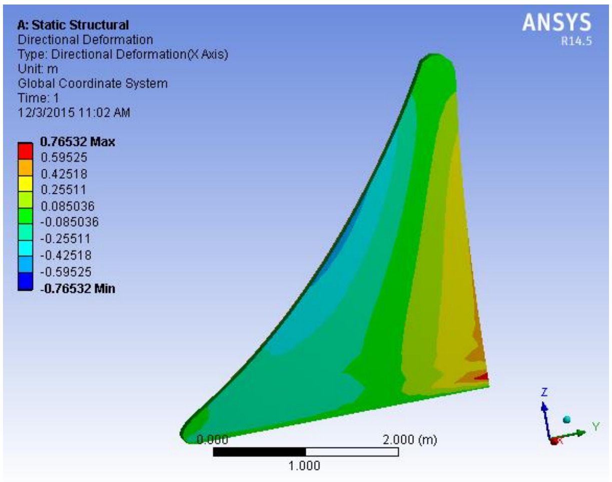

IMPORTED MODEL OF ORIGINAL MODEL OF WING WITH AL 7075 MATERIAL

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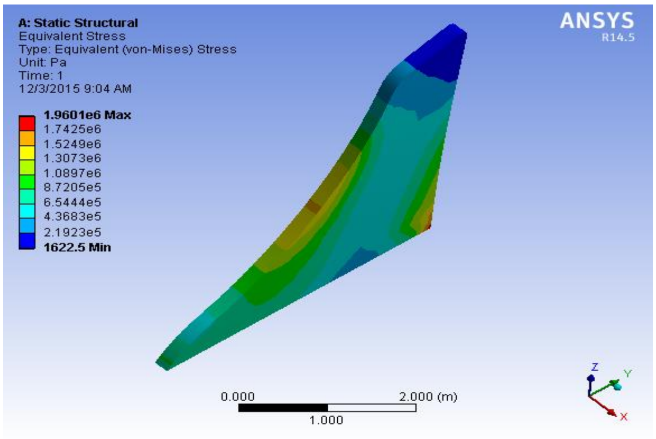

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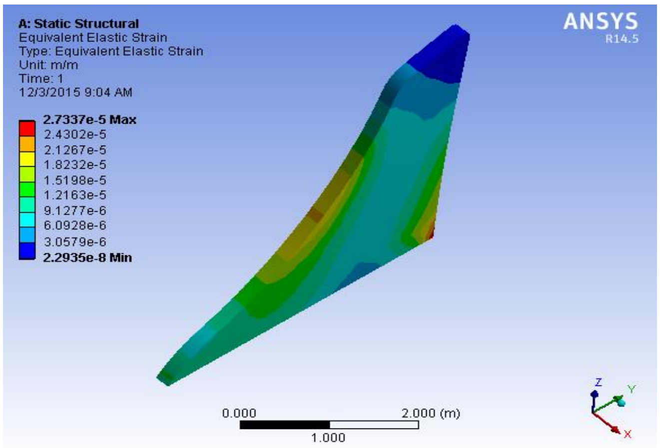

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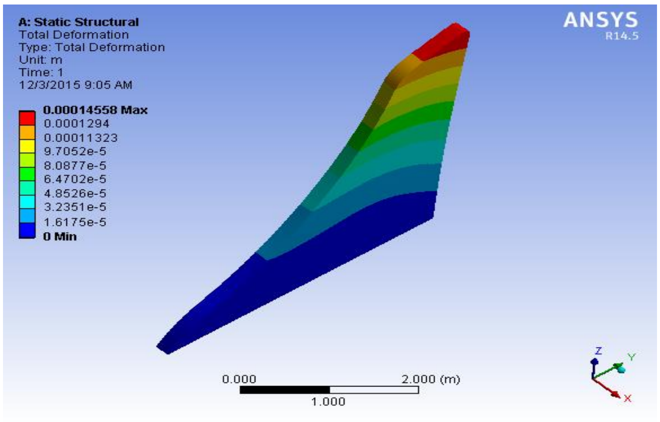

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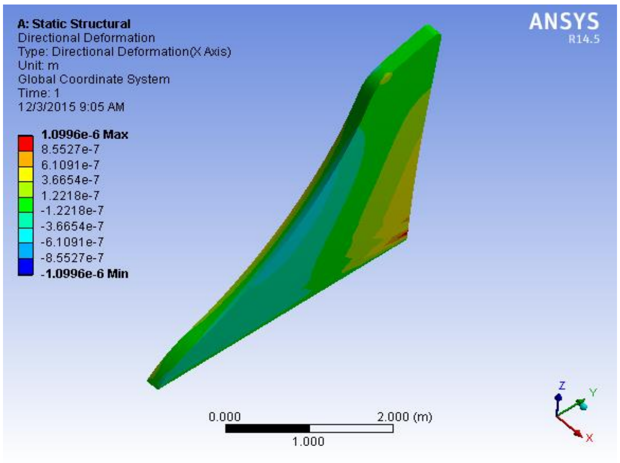

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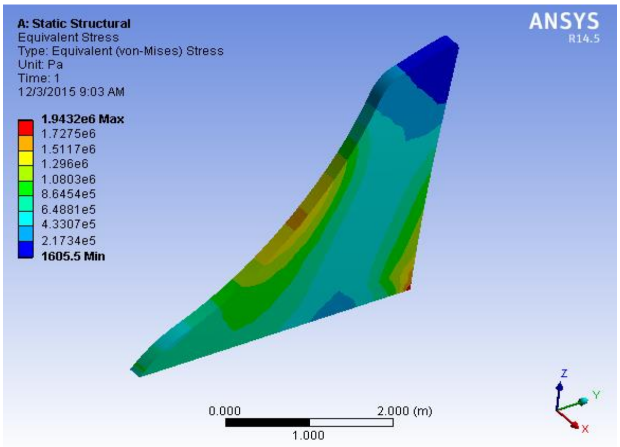

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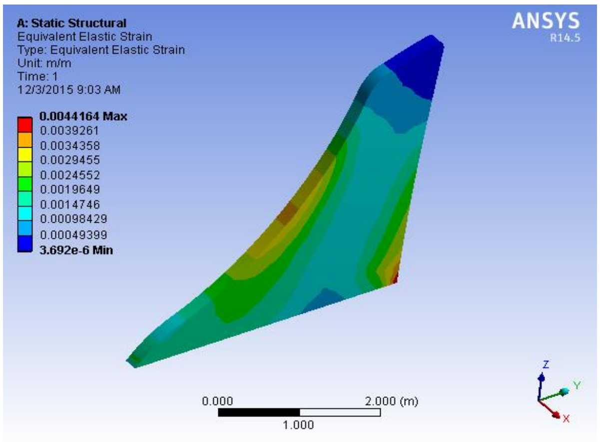

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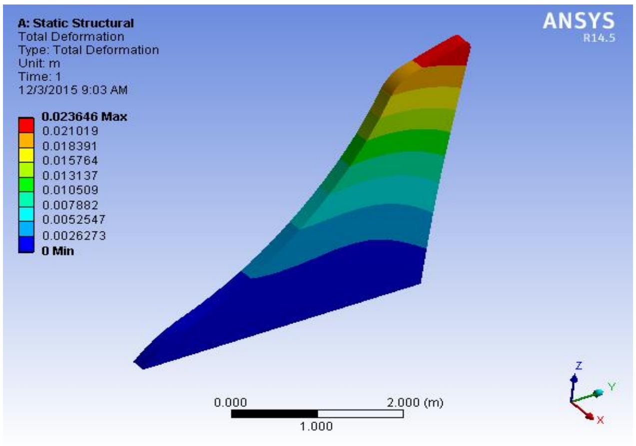

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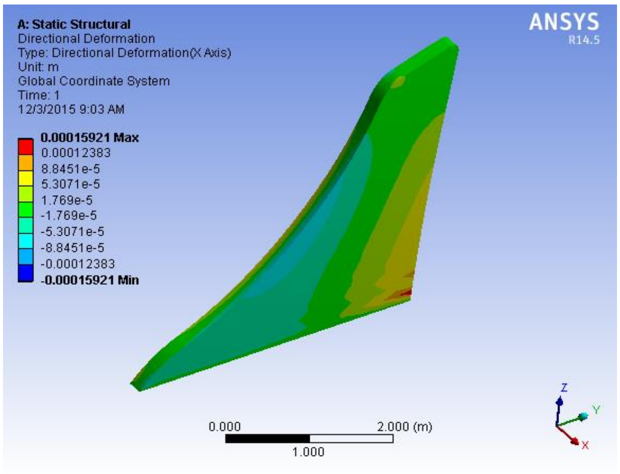

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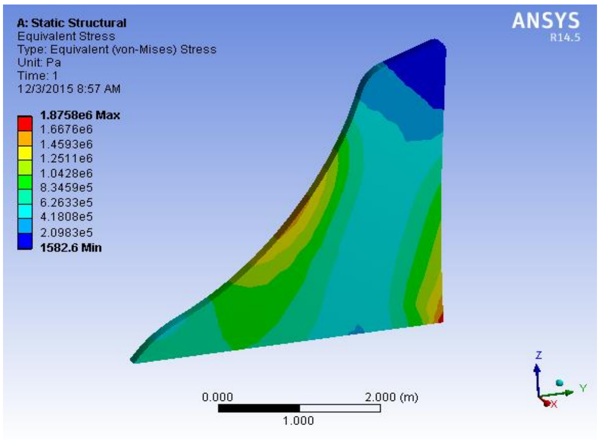

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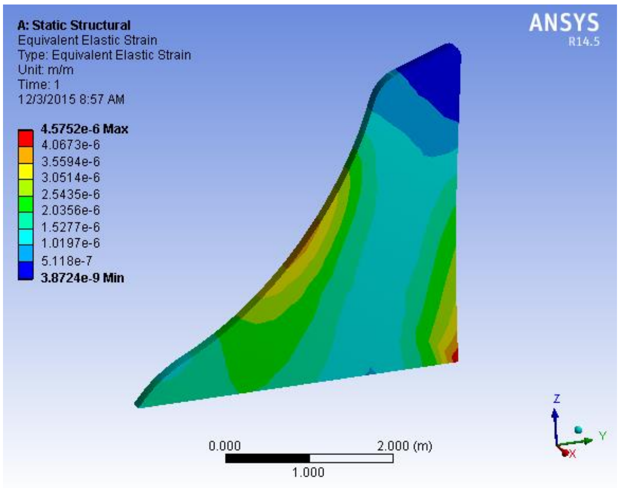

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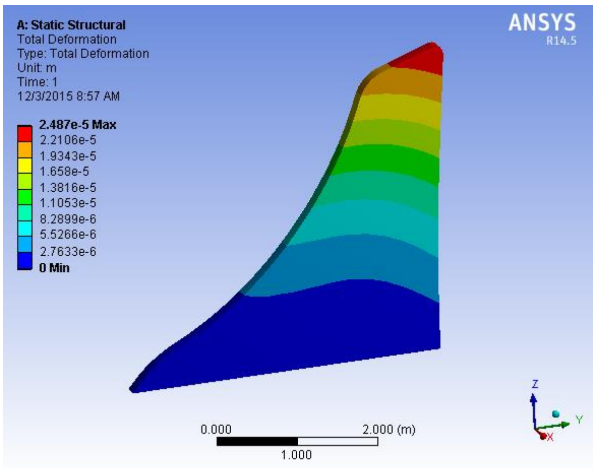

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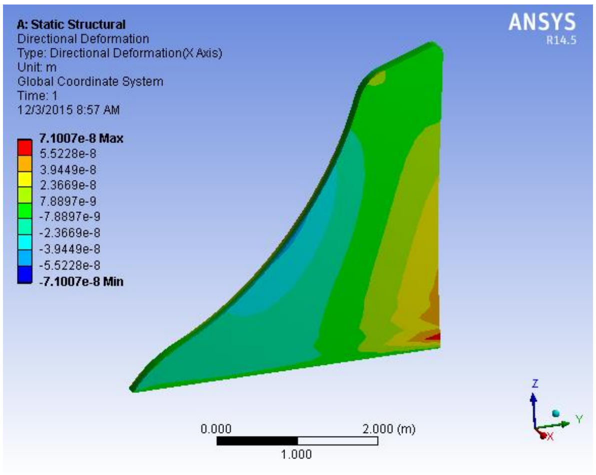

IMPORTED MODEL OF ORIGINAL MODEL OF WING WITH TITANUM 6 ALLOY MATERIAL

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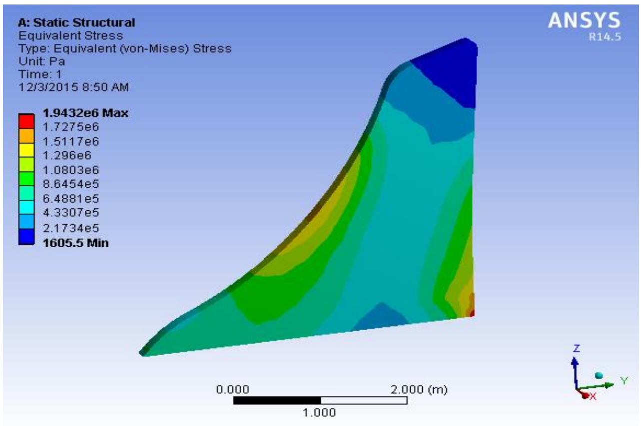

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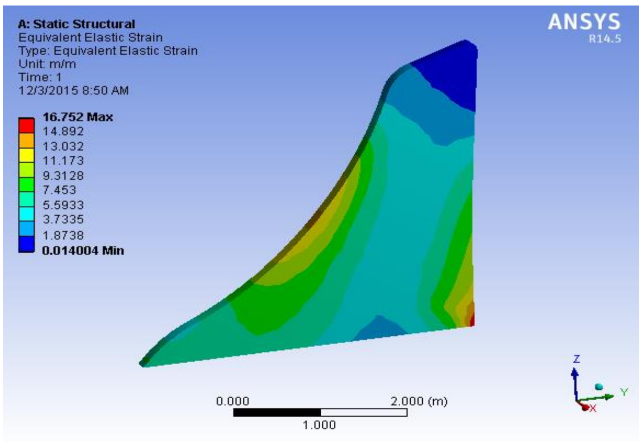

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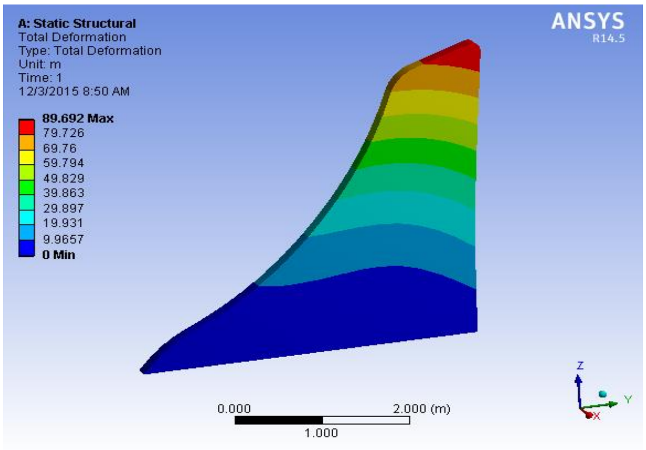

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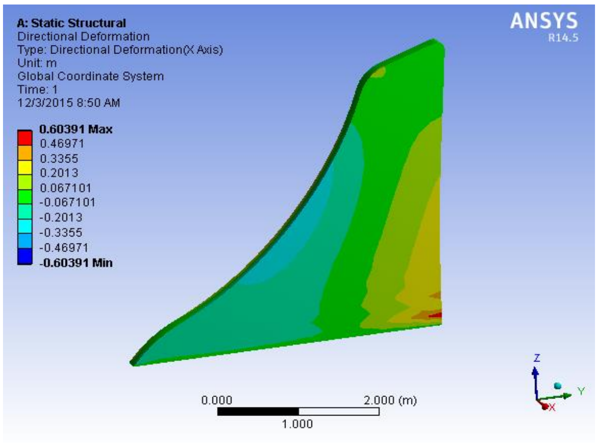

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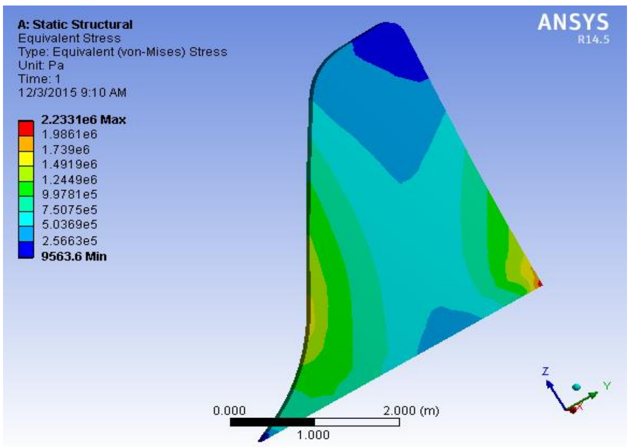

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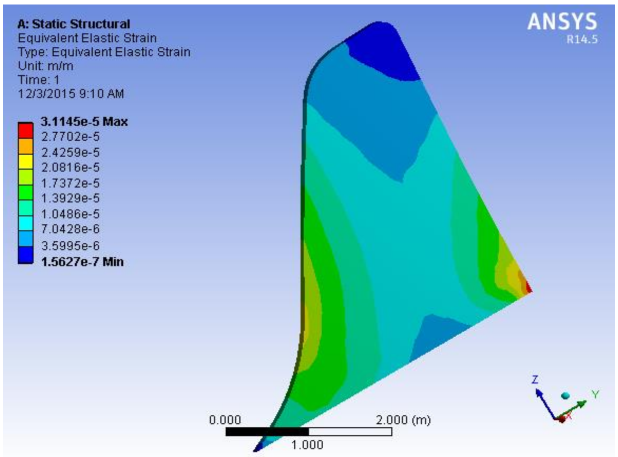

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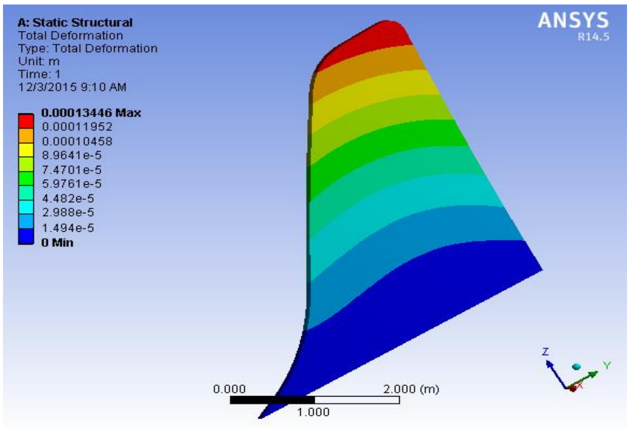

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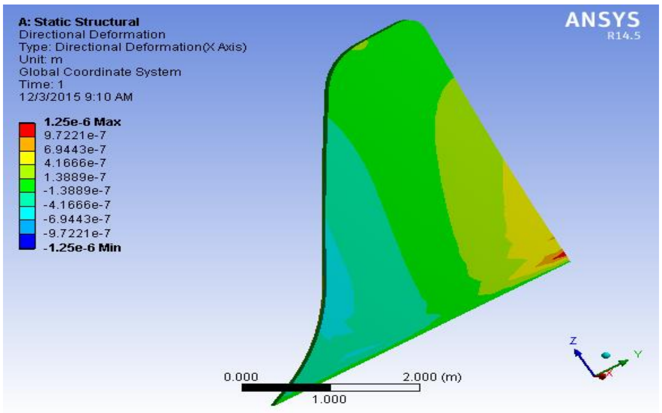

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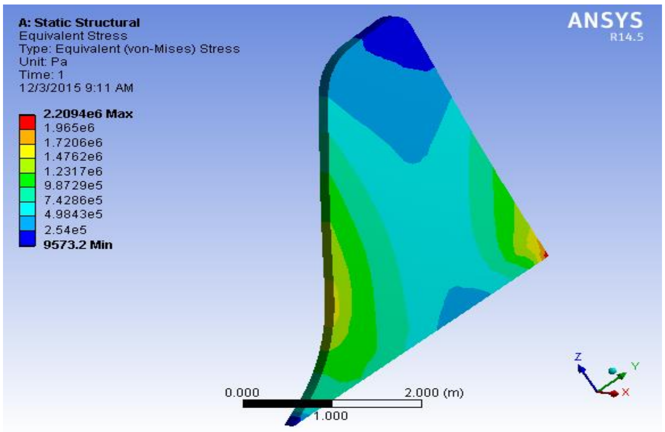

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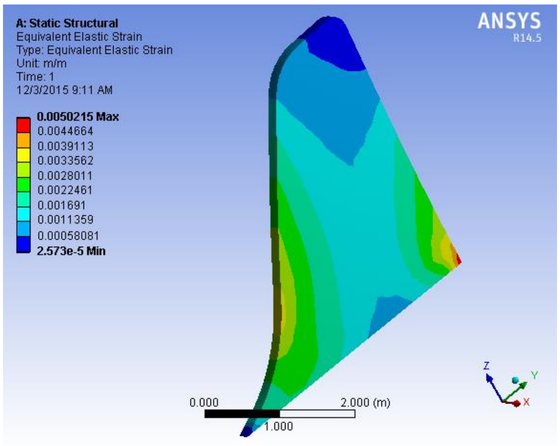

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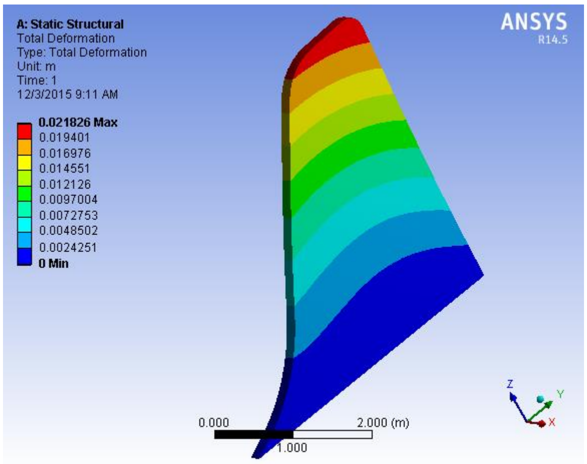

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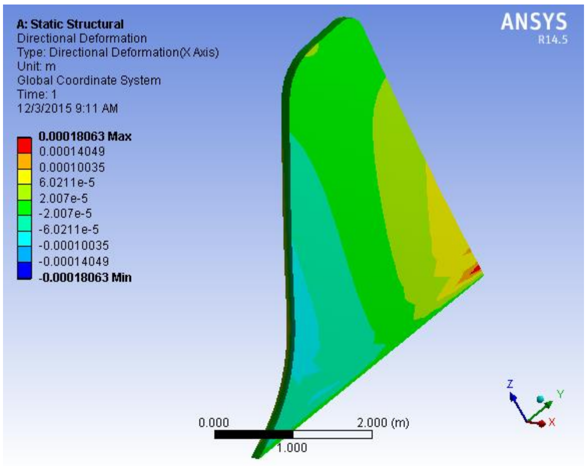

IMPORTED MODEL OF ORIGINAL MODEL OF WING WITH SILICON CARBIDE MATERIAL

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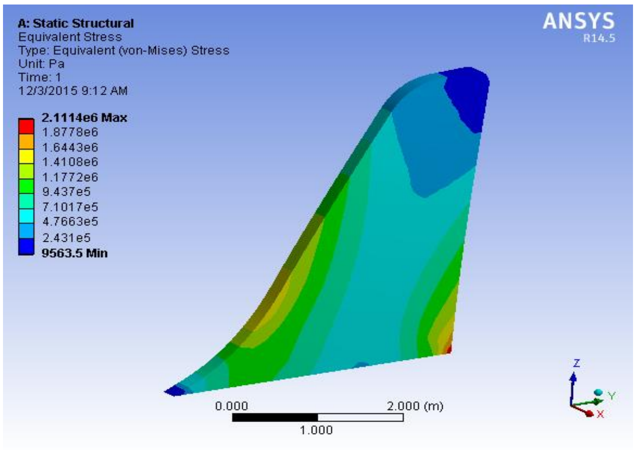

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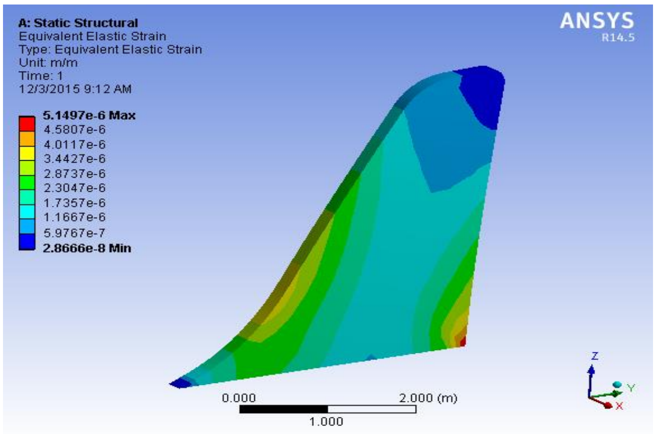

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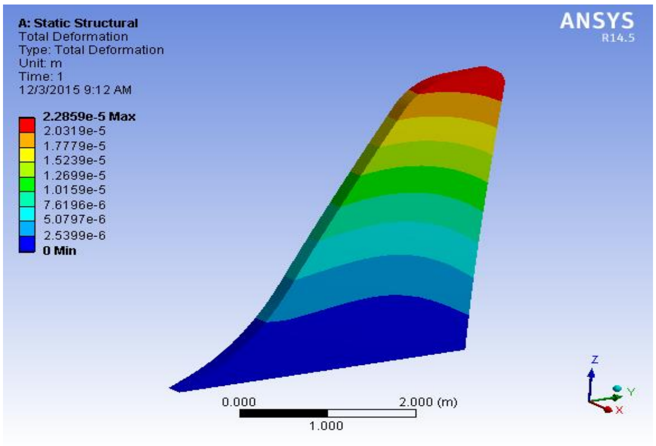

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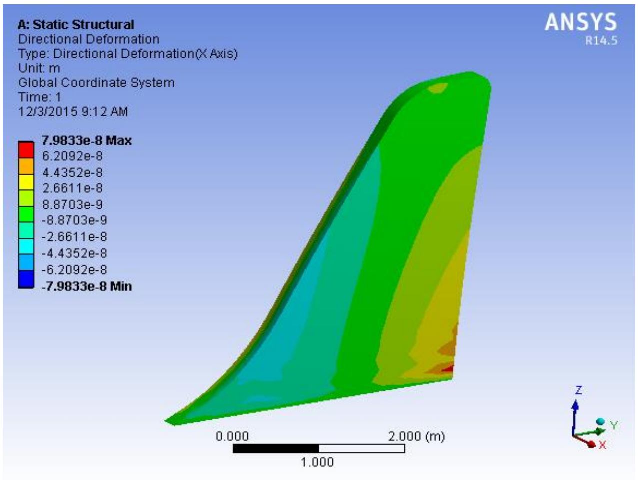

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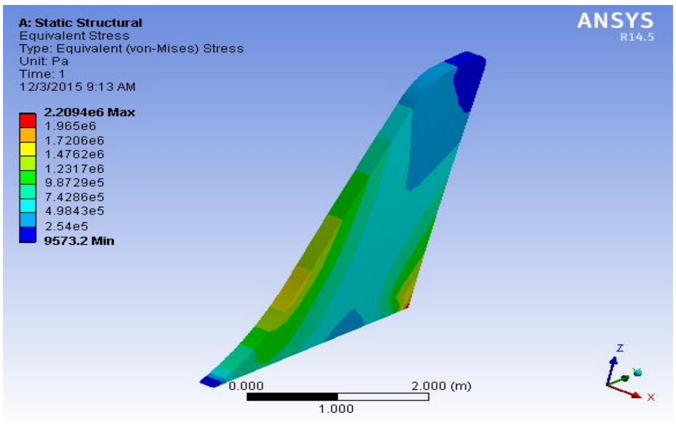

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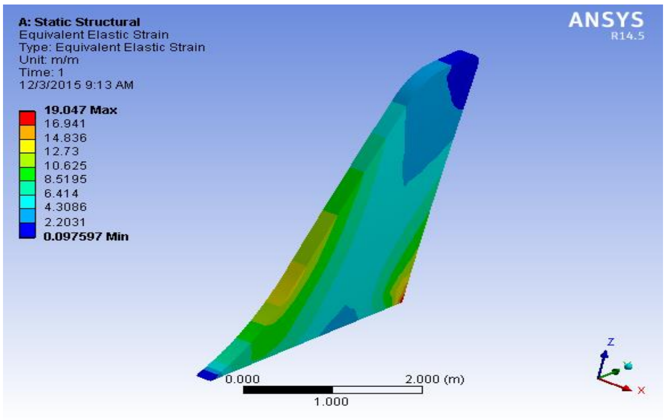

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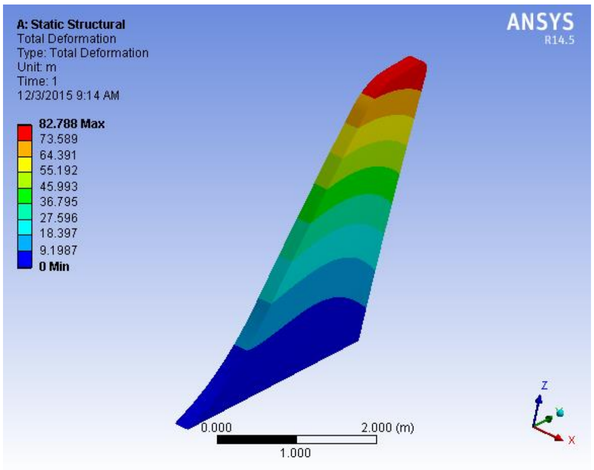

RESULTS AND DISCUSSIONS

MODEL 1

TABLE

	STRESS		STRAIN		TOTAL DEFORMATION		DIRECTIONAL DEFORMATION	
	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
AL 7075	15237	2.57E+06	3.65E-07	3.58E-05	0.00E+00	2.42E-04	-1.40E-06	1.40E-06
BORON	15226	2.54E+06	6.02E-05	0.005771	0	0.039297	-0.00020177	0.00020177
SIC	14949	2.43E+06	6.91E-08	5.92E-06	0.00E+00	4.16E-05	-8.92E-08	8.92E-08
T6	15226	2.54E+06	2.28E-01	21.889	0.00E+00	1.49E+02	-7.65E-01	7.65E-01

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MODEL 2

TABLE

	STRESS		STRAIN		TOTAL DEFORMATION		DIRECTIONAL DEFORMATION	
	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
AL 7075	1622 .5	1.96E+ 06	2.29E- 08	2.73E- 05	0.00E+ 00	1.46E- 04	-1.10E- 06	1.10E-06
BORO N	1605 .5	1.94E+ 06	3.69E- 06	0.00441 6	0	2.36E- 02	-1.59E- 04	1.59E-04
SiC	1582 .6	1.88E+ 06	3.87E- 09	4.58E- 06	0.00E+ 00	2.49E- 05	-7.10E- 08	7.10E-08
T6	1605 .5	1.94E+ 06	1.40E- 02	16.752	0.00E+ 00	8.97E+ 01	-6.04E- 01	6.04E-01

MODEL 3

TABLE

	STRESS		STRAIN		TOTAL DEFORMATION		DIRECTIONAL DEFORMATION	
	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
AL 7075	1622 .5	1.96E+ 06	2.29E- 08	2.73E- 05	0.00E+ 00	1.46E- 04	-1.10E- 06	1.10E-06
BORO N	1605 .5	1.94E+ 06	3.69E- 06	0.00441 6	0	2.36E- 02	-1.59E- 04	1.59E-04
SiC	1582 .6	1.88E+ 06	3.87E- 09	4.58E- 06	0.00E+ 00	2.49E- 05	-7.10E- 08	7.10E-08
T6	1605 .5	1.94E+ 06	1.40E- 02	16.752	0.00E+ 00	8.97E+ 01	-6.04E- 01	6.04E-01

CONCLUSION

The wings are the most important lift- producing part of the aircraft. The design of wings may vary according to the type of aircraft and its purpose. Experimental testing of wing structure is more expensive and time consuming process. In this project detailed design of trainer aircraft wing structure made by using CATIA V5 R21.

In this approach, here we are considering 3 different models with 4 different materials for analysis & the stresses & deformations in each case is obtained. In this thesis we have considered the original model as model – 1 and the 2 modification models are done to basis of original model.

As if we observe in the original model, by the results obtained in the analysis and those are plotted as graphs and tables. So from those results we can conclude that the stress (2.43E+06) and strain (5.92E-06) , total deformation (4.16E-05) and directional deformation (8.92E-08) has obtained the low results to the material silicon carbide, as here we can conclude that the material with SiC is the best material for the aero wing in the model - 1

As if we observe in the model - 2, by the results obtained in the analysis and those are plotted as graphs and tables. So from those results we can conclude that the stress (1.88E+06) and strain (4.88E-06) , total deformation (2.49E-05) and directional deformation (7.10E-08) has obtained the low results to the material silicon carbide, as here we can conclude that the material with SiC is the best material for the aero wing in the model – 2.

As if we observe in the model - 3, by the results obtained in the analysis and those are plotted as graphs and tables. So from those results we can conclude that the stress (2.11E+06) and strain (5.15E-06) , total deformation (2.29E-05) and directional deformation (7.10E-08) has obtained the low results to the material silicon carbide, as here we can conclude that the material with SiC is the best material for the aero wing in the model – 3.

So from all the above results the modified model which is named as model – 2 will be the best design and even SiC is the best material than any other design and material, so if we implement this design of aero wing, we could decrease the stress and the deformations obtained.

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GUIDE

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