# Design of an Air Craft Nose Cone and Analysis of Deformation under the Specified Conditions with Different Materials using ANSYS

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***Abstract*—The aim of this paper is to design and analysis of an aircraft nose cone and analysis made with some different materials which are having slightly different properties by using simulation of ANSYS software. They are Aluminium alloy, Structural steel, stainless steel and titanium alloy. And concentrated firstly on deformation of nose cone under the air pressure of 18700 (Pa) and secondly the comparison of the materials mentioned above with their capability to withstand for the deformation, when the cone section of aircraft travelling at a height of 40,000 (Ft). Which experiences the temperature around -45 $^0$C to -54 $^0$C through a compressible fluid medium.by using the ANSYS software, it is paved to analyze and created the replica of a nose cone section of aircraft as parabolic among many shapes because of less mean shear stress distribution, lowest tip temperature and Mach number having 0.8 to 1.0(which is very small and required for efficiency). Out of these materials the titanium material is having optimum deformation range of 49.674 (Min) and 238.14 (Max). Along with these materials titanium alloy having better properties which is now a days most popularly used in various fields is chosen for nose cone of an air craft for yielding good results.**

***Keywords*— ANSYS; Nosecone; Analysis; Air pressure; Deformation.***

## I. INTRODUCTION

The design of the nose cone section of aircraft to travel through a compressible fluid medium and important problem is the determination of nose cone geometrical shape and material used to it for optimum performance. Such tasks requires the definition of solid of revolution shape that experiences minimal resistance to rapid motion trough such a fluid medium, which consists of elastic particles.

The basic nose cone material majority of manufactures were more comfortable with the known life limitations of structural metal, in particular the aluminium alloys, primarily used by the US manufacturers, these alloys have a tensile strength in excess of mild steel, but the drawback is their susceptibility to corrosion, and to combat this, these materials are clad with a grades are commonly referred as ALCLAD. The 6061 grade is the common weldable grade, and not as bad as the others for corrosion other metals commonly used.

The composite materials, although being out standing in their strength to weight characteristic have some drawbacks in the cost of raw materials, storage and available data on structural life limitations in addition to requiring in many instances, expensive methods of non-destructive inspection.

In our study, to know the observable behavior of these materials, which are used for making cone nose of an aircraft model commonly there are many shapes like conical, elliptical, O-give (tangent), parabolic and sears hack. Among which we have chosen parabolic shape because of less mean shear stress distribution and lowest tip temperature. It is concentrated firstly on deformation of nose cone under the air pressure of 18700 (Pa) and secondly the comparison of the materials mentioned above with their capability to withstand when the cone section of aircraft travelling at a height of 40,000 (Ft), which experiences the temperature around -45 $^0$C to -54 $^0$C through a compressible fluid medium. Based on the shape the air intensity may be directed around the nose by balancing the force with whole body, when the air intensity exerts on the nose, it is subjected to some stresses, strains also along with the deformation it is keenly presented, when simulated with ANSYS in the static environment.

The analysis consists of two stages step1 and step2

Step 1: the model is first designed with CATIAv5 (Computer aided 3-Dinteraction application), the shape of model we use, it is taken care to obtain the replica with dimensions and shapes, then only the ANSYS can detect it to do the further analysis. The final shape which designed by using CATIAV5 is depicted in (fig1).

Step2: the model is investigated in the ANSYS for best result. By using ANSYSv11 and results is described in terms of different ranges of deformation with different materials under given conditions in the section (3)

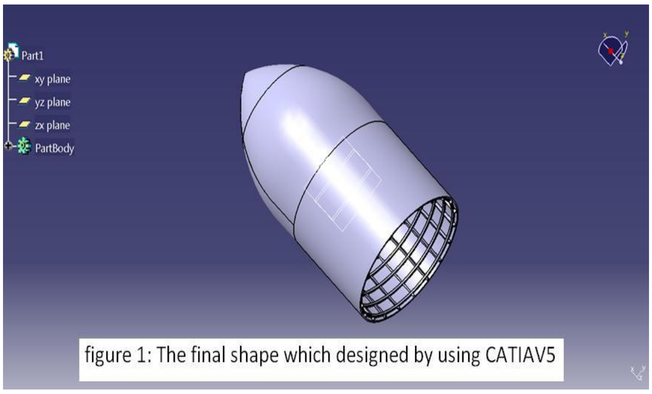


figure 1: The final shape which designed by using CATIAV5

## II. MODELING AND ANALYSIS

First we took CATIAv5 software (sketcher, part design) initially two base circles are drawn, which are similar using PAD options, making it to solid modeling by using 3D intersection. Then mark rectangles at centre of circles, again PADING and then the rectangular pattern we filled with parabolic shape and finally it is obtained full pledged model which is ready for detect by the ANSYSv11.then it is imported to the ANSYS workbench to do analysis of the model.

By using ANSYSv11, we can compute the response of a structural system computing the response of a structural system involves analyzing a wide range stresses, deformations, vibration characteristics, reaction forces and residual strains. The simulation must take into account on interactions between the various parts of product, its working environment and the effects of other forces such as electromagnetics and fluid Dynamics Structural mechanics solutions from ANSYS set the industry standard in engineering. Simulate every structural aspect including model analysis, time-varying, and load response. This incorporates Linear and non-linear transient dynamic analysis and spectrum analysis for random vibrations. Using the ANSYS results end to- end solution.

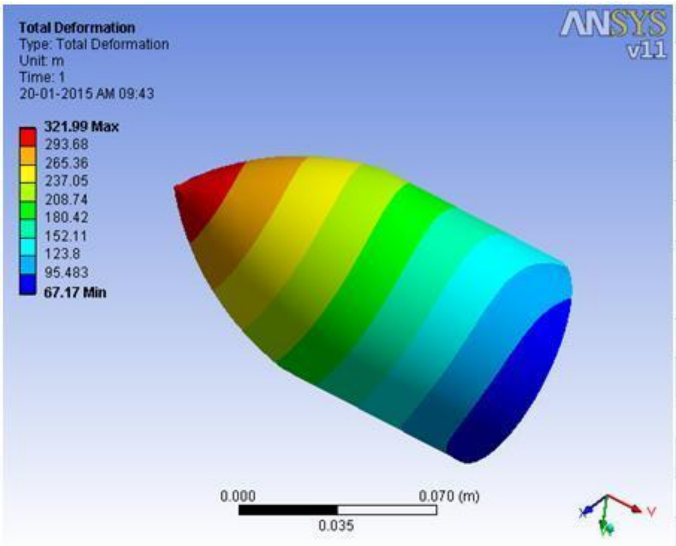
Our model once imported into the ANSYS we are choosing the materials like Aluminium alloy, Structural steel, stainless steel and titanium alloy by maintaining nose cone shape and size as constant initially, after choosing various materials, we generated mesh for all materials and then allowing for simulation.

In the simulation it consist static structural analysis in which it is specified the spot at which the fluid (mostly air) pressure 18700 Pa is supposed to be apply, and the behavior of various materials under this pressure is depicted through the print review of simulation.

## III. RESULTS

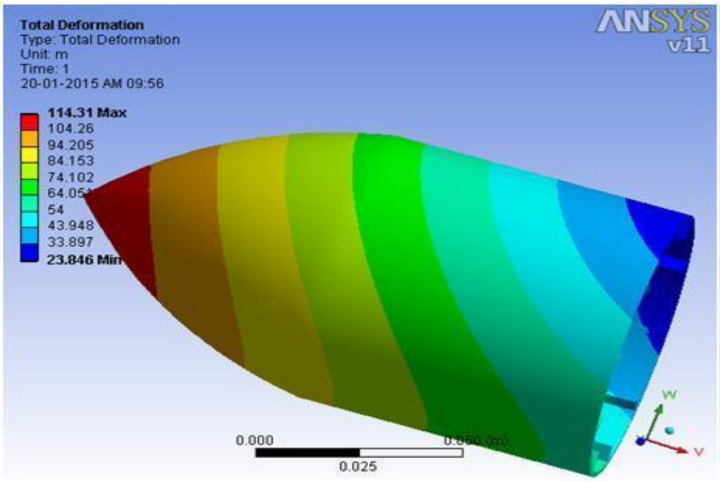
The following figures from (Figure 2 to Figure 5), explaining about the testing phase with air pressure of 18700(Pascal) at a height of 40,000(Feet) under the static condition by using ANSYSv11 software package, where the model of nose cone of aircraft which is made by the different materials like aluminium alloy, structural steel, stainless steel and titanium.

The left hand side of each figure represents the size of deformation changes from maximum range to minimum from extreme edge of nose (Tip) to contour towards back side of nose respectively. Also the size of deformation is clearly mentioned from max to min by different colors on the cone, it gives a lucid understanding about the deformation which occurs at various spots at various magnitudes, then it bring proper idea to compare the materials under constant air pressure and constant height in the static position of the nose cone in the ansysv11. And right hand side of each figure represents the material essential properties of each material which are very different from one material to another.



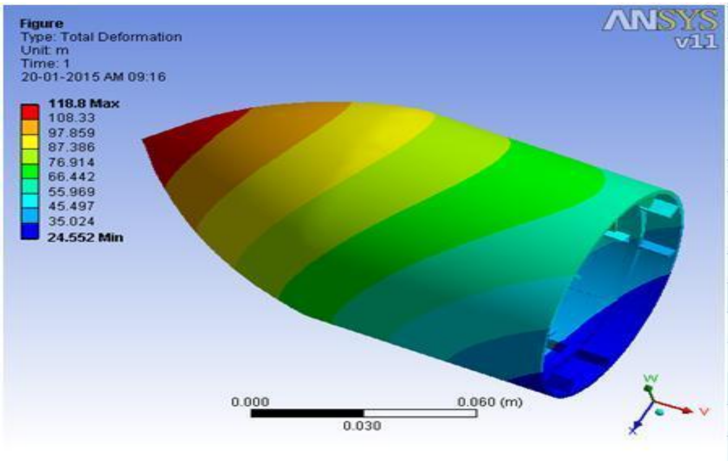

| Aluminum alloy | |
|---|---|
| Young's Modulus | 7.1e+010 Pa |
| Poisson's Ratio | 0.33 |
| Density | 2770. kg/m³ |
| Thermal Expansion | 2.3e-005 1/°C |
| Tensile Yield Strength | 2.8e+008 Pa |
| Compressive Yield Strength | 2.8e+008 Pa |
| Tensile Ultimate Strength | 3.1e+008 Pa |
| Compressive Ultimate Strength | 0. Pa |
| **Thermal** | |
| Specific Heat | 875. J/kg·°C |
| **Electromagnetic** | |
| Relative Permeability | 1. |
| Resistivity | 5.7e-008 Ohm·m |

Figure 2: Ansys results deformation of aluminium nose cone under given conditions



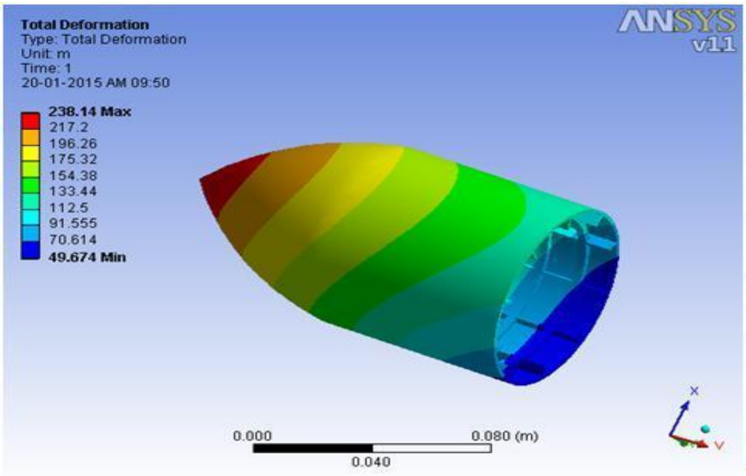

| Structural steel | |
|---|---|
| Young's Modulus | 2.e+011 Pa |
| Poisson's Ratio | 0.3 |
| Density | 7850. kg/m³ |
| Thermal Expansion | 1.2e-005 1/°C |
| Tensile Yield Strength | 2.5e+008 Pa |
| Compressive Yield Strength | 2.5e+008 Pa |
| Tensile Ultimate Strength | 4.6e+008 Pa |
| Compressive Ultimate Strength | 0. Pa |
| **Thermal** | |
| Thermal Conductivity | 60.5 W/m·°C |
| Specific Heat | 434. J/kg·°C |
| **Electromagnetics** | |
| Relative Permeability | 10000 |
| Resistivity | 1.7e-007 Ohm·m |

Figure 3: Ansys results deformation of structural steel nose cone under given conditions




| Stainless steel | |
|---|---|
| Young's Modulus | 1.93e+011 Pa |
| Poisson's Ratio | 0.31 |
| Density | 7750. kg/m³ |
| Thermal Expansion | 1.7e-005 1/°C |
| Tensile Yield Strength | 2.07e+008 Pa |
| Compressive Yield Strength | 2.07e+008 Pa |
| Tensile Ultimate Strength | 5.86e+008 Pa |
| Compressive Ultimate Strength | 0. Pa |
| **Thermal** | |
| Thermal Conductivity | 15.1 W/m·°C |
| Specific Heat | 480. J/kg·°C |
| **Electromagnetics** | |
| Relative Permeability | 10000 |
| Resistivity | 7.7e-007 Ohm·m |

Figure 4: Ansys results deformation of stainless steel nose cone under given conditions




| Titanium alloy | |
|---|---|
| Young's Modulus | 9.6e+010 Pa |
| Poisson's Ratio | 0.36 |
| Density | 4620. kg/m³ |
| Thermal Expansion | 9.4e-006 1/°C |
| Tensile Yield Strength | 9.3e+008 Pa |
| Compressive Yield Strength | 9.3e+008 Pa |
| Tensile Ultimate Strength | 1.07e+009 Pa |
| Compressive Ultimate Strength | 0. Pa |
| **Thermal** | |
| Thermal Conductivity | 21.9 W/m·°C |
| Specific Heat | 522. J/kg·°C |
| **Electromagnetics** | |
| Relative Permeability | 10000 |
| Resistivity | 1.7e-006 Ohm·m |

Figure 5: Ansys results deformation of titanium alloy nose cone under given conditions

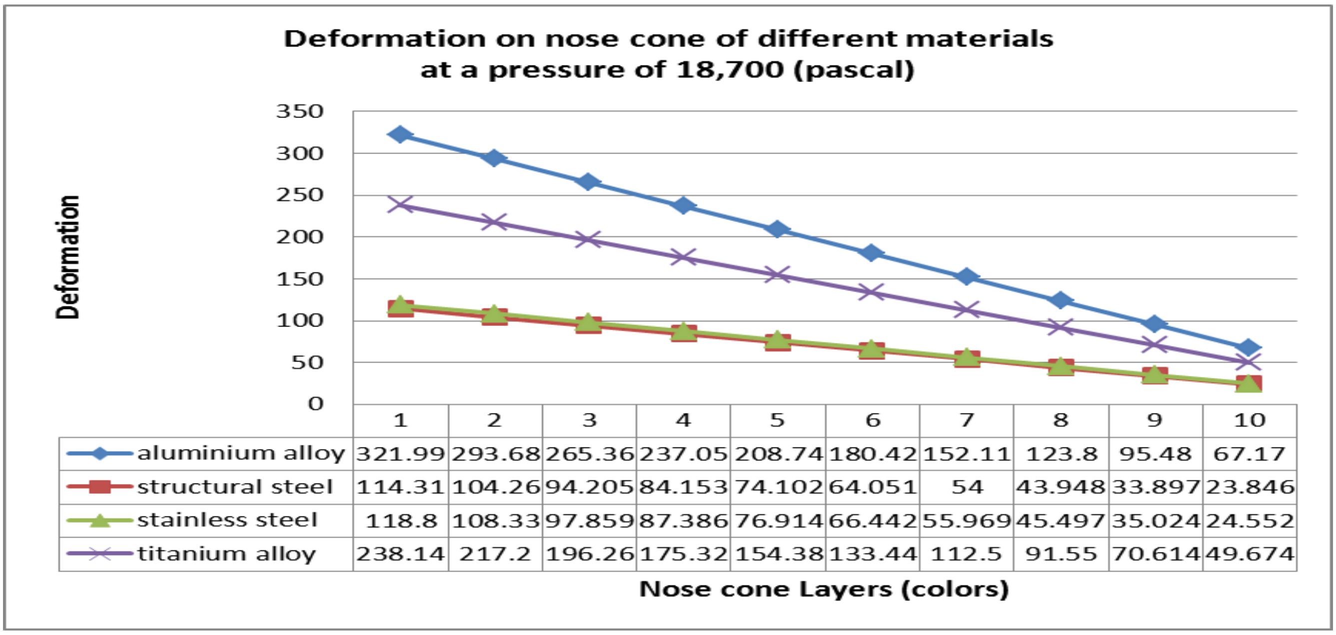
The nose cone when it is tested in the static condition under a given air pressure of 18700(Pa) by the ANSYSv11 software, it is subjected to the various ranges of deformation. The maximum value and minimum value as per above mentioned four materials listed in the following table.

| alluminium alloy | structural steel | stainless steel | titanium alloy |
|---|---|---|---|
| 321.99 | 114.31 | 118.8 | 238.14 |
| 293.68 | 104.26 | 108.33 | 217.2 |
| 265.36 | 94.205 | 97.859 | 196.26 |
| 237.05 | 84.153 | 87.386 | 175.32 |
| 208.74 | 74.102 | 76.914 | 154.38 |
| 180.42 | 64.051 | 66.442 | 133.44 |
| 152.11 | 54 | 55.969 | 112.5 |
| 123.8 | 43.948 | 45.497 | 91.55 |
| 95.48 | 33.897 | 35.024 | 70.614 |
| 67.17 | 23.846 | 24.552 | 49.674 |

Table gives the deformation values for deifferent materials

From the table we can make analysis of the behavior of deformation for the materials. from the **Graph** it is understand that the aluminium alloy is subjected to more deformation and titanium alloy is subjected to next more deformation and both structural steel and stainless steel subjected to same kind of deformation. Coming to these two which are much intended to corrosion compared to other materials of aluminium and titanium alloys. But strength point of view structural and stainless steels are strong (in terms of deformation) than the aluminium and titanium alloys.

Compared to other properties, which are mentioned right hand side of the figures 2, 3, 4 and 5, the titanium alloy is having moderate features among the other three of the materials and beyond this deformation (max range of value) the materials cannot withstand.



## IV. CONCLUSION

In the present study, the nose cone is prepared by the CATIA and ANSYS software. Applied the flow field of air pressure of 18700 (Pa) on the nose cone at the height of 40,000(Ft) is investigated for different materials like aluminium alloy, structural steel, stainless steel and titanium alloy. And analysis made to know the behavior of the deformation in the static environment. It says that the aluminium alloy is subjected to more deformation and titanium alloy is subjected to next more deformation and both structural steel and stainless steel subjected to same kind of deformation. Out of these materials the titanium material is having optimum deformation range of 49.674 (Min) and 238.14 (Max). Along with these materials titanium alloy having better properties which is now a days most popularly used in various fields is chosen for nose cone of an air craft for yielding good results.

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