NEW AERODYNAMIC DESIGN AND STRUCTURAL ANALYSIS OF MISSILE NOSE CONE USING DIFFERENT MATERIALS

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ABSTRACT:

A new nose cones concept that guarantees an addition in act over existing ordinary nose cones is talked about in this paper the term nose cone is utilized to allude to the forward most area of a rocket, guided rocket or air ship. The cone is shaped to offer least aerodynamic resistance. The aerodynamic structure of the nose cone area of any vehicle or body intended to go through a compressible fluid medium, (for example, a rocket or airplane rocket or projectile), a vital issue is the assurance of the nose cone geometrical shape for ideal execution. This undertaking assesses the rocket nose cone analysis by utilizing the accompanying materials, for example, Titanium Grade-I, Ti-6Al-4V and Ti-6Al-6v-2Sn. These are essentially more grounded than industrially unadulterated titanium. A cone display is taken from the concepts of obtuse nose cone and structured in the CAD programming catia. Further this nose cone configuration is imported to the Analysis programming named as Ansys and plays out the Structural analysis. At long last the outcomes are thought about and classified.

I.INTRODUCTION:

In current use, a rocket is a self-impelled accuracy guided ammo framework, instead of an unguided self-moved ammo, alluded to (in that these too can likewise be guided). Rockets have four framework segments: focusing on or potentially rocket direction, flight framework, motor, and warhead.

Nose cone:

The term nose cone used to insinuate the forward most fragment of a rocket, guided rocket or flying machine. The cone is shaped to offer least streamlined obstacle. Nose cones furthermore expected for development in and submerged and in quick land vehicles

In a satellite vehicle, the nose cone may change into the satellite itself in the wake of pulling back from the last time of the rocket or it may be used to shield the satellite until the point that orbital speed is expert, by then disconnecting from the satellite

Nose cone design:

Given the issue of the streamlined plan of the nose cone area intended to movement liquid medium, (for example, flying machine, rocket or projectile), an essential issue is the assurance ideal execution. For some applications, such an errand requires a strong of transformation shape that encounters insignificant protection from fast movement through, which comprises of versatile particles.

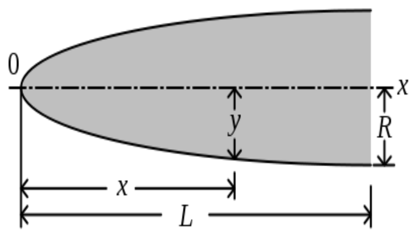
Generally regarding to the shapes the nose cones are classified into four types as follows :

- Conical
- Bi-conical
- Spherically Blunted
- Elliptical

According to the above classification of the shapes of nose cone, here we are considering the both Conical (they can scatter the air to one side with its tip than others) and Elliptical (less mean shear stress distribution and lowest tip temperature) shaped nose cones than Spherical and Bi-conical shaped nose cones with different materials and performing the structural analysis by ansys software.

General dimensions

In the majority of the accompanying nose cone shape conditions, L is the general length of the nose cone and R is the scope of the base of the nose cone. y is the range at whatever point x, as x shifts from 0, at the tip of the nose cone, to L. The conditions depict the 2-dimensional profile of the nose shape. The full exhibit of progress of the nose cone is formed by pivoting the profile around the centerline (C/L). Note that the conditions delineate the 'ideal' shape; sound nose cones are every now and again collecting or streamlined reasons.



II.THEORETICAL BACKGROUND

A.TITANIUM ALLOY

Titanium composites are metals that contain a mix of titanium and manufactured parts. Such composites have high flexible and sturdiness (even at phenomenal temperatures). They are light in weight, have extraordinary disintegration restriction withstand incredible temperatures. Titanium alone is a strong, light metal. It is more grounded than typical, low-carbon steels, anyway 45% lighter. It is also twice as strong as fragile aluminum mixes anyway simply 60% heavier. Titanium has excellent disintegration insurance from sea water, and is used in propeller shafts, military applications, carrier, rocket. Coming up next are the distinctive titanium materials used to do the structural analysis:

➢ **Ti-6Al-4V:**

Ti-6Al-4V is an alpha-beta titanium compound highlighting high quality, low weight proportion and great erosion obstruction. It is champion among the most customarily used titanium composites and is connected different from utilizations where low thickness and great erosion resistance.

➢ **Ti-6Al-6V-2Sn :**

6AL-6V-2SN is an alloyed Grade of alpha-beta Titanium. 6AL-6V-2SN is similar to 6AL-4V in many ways, but exhibits higher strength properties due to additional Vanadium, Iron, and Copper.

➢ **Titanium Grade-l :**

Titanium offering optimum ductility and cold formability with useful strength, high impact toughness, and excellent weldability. Highly corrosion resistant in oxidizing and mildly reducing environments, including chlorides.

III. LITERATURE REVIEW

A writing review of numerous papers were investigated and a few edited compositions from it are exhibited here

➢ A examine on Re-passage case at Mach 3 by **Siva Prasad** et.al thought about. The paper is on investigation of Re-section cases at speeds. The US FIREII and OREX cases were examined. The essential plan is that if the model is round shape it will build the streamlined drag (great amid the barometrical Reentry) and a short body. A choppiness model of KE was picked in it. This paper demonstrates mach number an incentive when stun plans.

➢ A investigation of hypersonic case into Titan's air by **Karthik Sundarraj** et.This paper centers around and flow nose amid passage into Titan's air about Mach 19.

- An investigation on stream examination over air plate at Mach 6 was completed by **Mehta** et.al Aero spike circle extraordinarily diminishes streamlined delay the limit body. Stun polar is gotten utilizing the vector plots. A total report on the reattachment stun, division layer, and drag decrease was finished. Fast stream past a limit body makes bow stun. Spikes can be utilized to decrease streamlined drag. Bow stun makes high weight locale which inturn causes high wave drag. A locale of distribution can diminishes streamlined drag to an extraordinary much. After the spike district, the stun again reattaches. Stun polar diagram was plotted L/D proportion to identify drag decrease. Schlieren shadow diagram was additionally used to ponder a similar impact in IITK.
- **B.Kaleeswaran, S.Ranjith Kumar, Jeniwer Bimro.N**. tells about the streamlined examination more than 2D supersonic nose cone models of rockets. Initial a Spherical nose cone show was tried with a Mach speed of 3 and after that with a similar Mach speed another Spherical model with an illustrative nose pit was tried
- **Md.Akhtar Khan, Karrothu Vigneshwara, Suresh Kukutla** examined and broke down the stream field over an aerofoil area incorporated with spikes (Mach number more prominent than
- **Lawrence D. Huebner NASA Langley Research Center Anthony M. Mitchell and Ellis J. Boudreaux Wright** [Laboratory/Eglin Wind Stress Base conduted investigate attainability of an air spike for hypersonic rockets, arrangement of wind burrow spike-secured rocket arch Mach number 6 to acquire quantitative surface weight and temperature-rise information, and also subjective stream representation information.
- **R. C. Mehta Anyang** tells altogether changes in its stream field and impacts streamlined drag and divider warm transition in a rapid stream. Length, shape, and spike nose arrangement on the decrease warmth motion is numerically assessed at Mach 6 at zero approach and distinctive aero spike shape.
- **Dennis M. Bushnell Langley** discusses Advanced Aircraft configurationally approaches, over the speed extend, which are either empowered, or significantly upgraded, by smart Flow Control.

IV.PROPOSED METHOD:

A.Modeling and Analysis :

The procedure consists of two stages step1 and step2 :

Step 1 : Modeling

The model is first designed with CATIA V5, then ANSYS can detect it to do the further analysis. The final shape which is designed by CATIA V5 is depicted in the following figures.

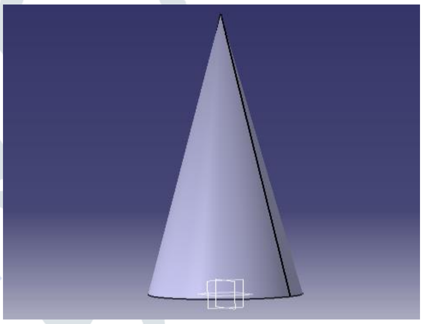


Fig 1: The final shape of Conical Shaped Nose Cone designed by CATIA V5

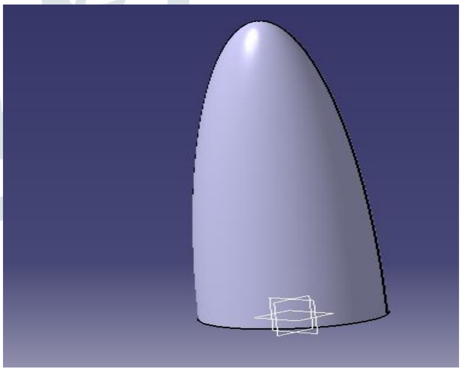


Fig 2 : The final shape of Elliptical Shaped Nose Cone designed by CATIA V5

Step 2: Analysis

Our model is imported into the ANSYS, we are choosing the materials like Ti-6Al-4V, Ti-6Al-6V-2Sn and Titanium Grade-1 by maintaining nose cone shape and size as constant initially, after choosing various materials, we generated mesh for all materials and allowing for simulation.

Nose cones with different materials like Ti-6Al-4V, Ti-6Al-6V-2Sn and Titanium Grade-l are investigated by structural analysis. The main concentration is on total deformation of nose cone of different materials mentioned above with their capabilities to withstand when the cone section is travelled through a compressible fluid medium (air). Based on the shape the air intensity may be directed around the nose cone by balancing the force with whole body. When the air intensity exerts on the nose, it is subjected to stresses, strains along with deformation.

V. RESULTS AND COMPARISON

In simulation, we perform structural analysis on both conical shaped and elliptical shaped nose cones of different materials under conditions of force : 6000N, pressure : $10*10^5$MPa($1.e^{+009}$Pa). The behavior of different materials in such conditions are to be analyzed.

A.Results Comparison of Conical Nose Cone:

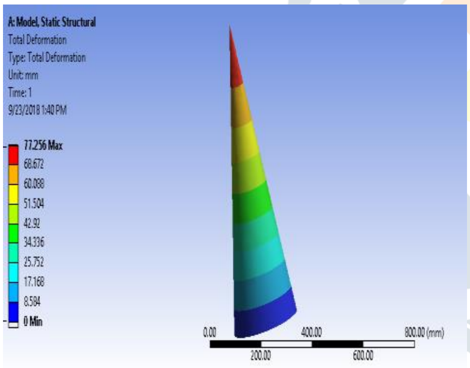


Fig 3: Total Deformation of Ti-6Al-4V (conical)

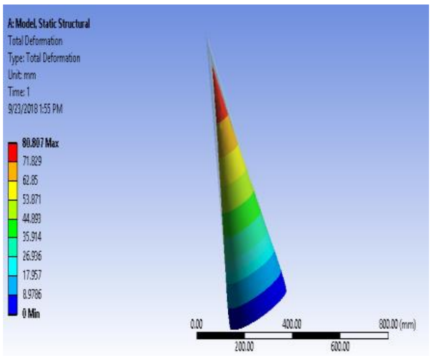
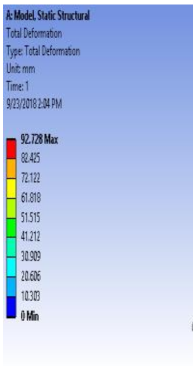


Fig 4: Total Deformation of Ti-6Al-6V-2Sn(conical)



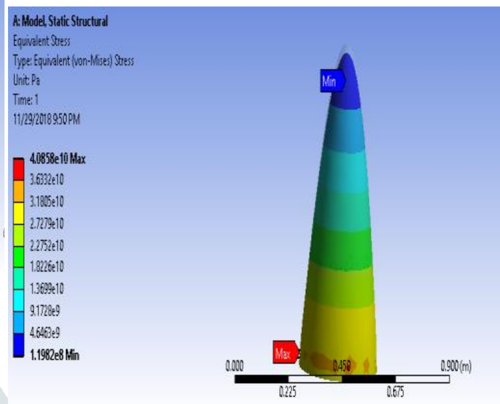


Fig 5: Total Deformation of Titanium grade-l(conical)

Ti-6Al-4V

Object Name	Total Deformation	Equivalent Stress	Directional Deformation	Equivalent Elastic Strain
Results				
Minimum	0m	$4.9078e^{+9}$ Pa	0.004997m	0.00409
Maximum	0.07725m	$2.023e^{+10}$ Pa	0.004993m	0.00169

Ti-6Al-6V-2Sn

Object Name	Total Deformation	Equivalent Stress	Directional Deformation	Equivalent Elastic Strain
Results				
Minimum	0m	$4.9071e^{+9}$ Pa	-0.004836m	0.00426
Maximum	0.08080m	$1.9807e^{+10}$ Pa	.004831m	0.00017

Titanium Grade-l

Object Name	Total Deformation	Equivalent Stress	Directional Deformation	Equivalent Elastic Strain
Results				
Minimum	0m	$4.9077e^{+9}$ Pa	-0.005957m	0.00490
Maximum	0.0927m	$2.0191e^{+10}$ Pa	0.005952m	0.002035

B.Results Comparison of Elliptical Nose Cone:

Fig 6: Total Deformation of Ti-6Al-4V(elliptical)

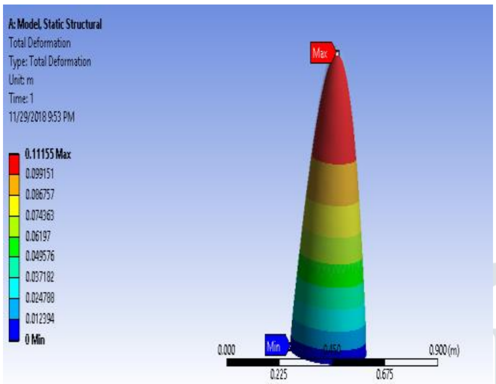


Fig 7: Total Deformation of Ti-6Al-6V-2Sn(elliptical)

Fig 8 : Total Deformation of Titanium grade-l(elliptical)

C.Results Comparison of Elliptical Nose Cone:

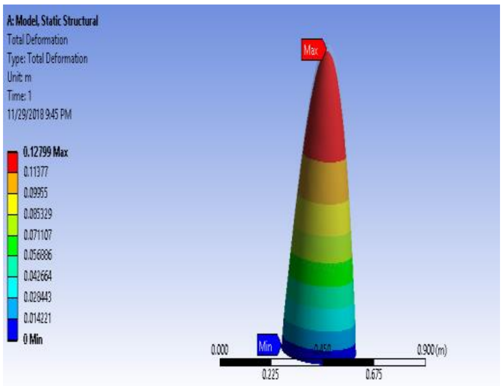
Ti-6Al-4V

Object Name	Total Deformation	Equivalent Stress	Directional Deformation	Equivalent Elastic Strain
Results				
Minimum	0. m	1.1982e+008 Pa	-1.2854e-002 m	3.5537e-003 m/m
Maximum	0.10664 m	4.0858e+010 Pa	1.3237e-002 m	0.34301 m/m

Ti-6Al-6V-2Sn

Object Name	Total Deformation	Equivalent Stress	Directional Deformation	Equivalent Elastic Strain
Results				
Minimum	0m	$1.328e^{+008}$ Pa	$-1.2515e^{-002}$ m	$3.729e^{-003}$
Maximum	0.11155m	$3.9961e^{+010}$ Pa	$1.288e^{-002}$ m	0.34999

Titanium Grade-l



Object Name	Total Deformation	Equivalent Stress	Directional Deformation	Equivalent Elastic Strain
Results				
Minimum	0m	$1.1999e^{+008}$ Pa	$-1.5332e^{-002}$ m	$4.263e^{-003}$
Maximum	0.12799m	$4.0773e^{+010}$ Pa	$1.5787e^{-002}$ m	0.41075

VI.CONCLUSION

In the present study, the nose cone is designed by the Catia(v5) software and analysis done by the Ansys software.

	Conical	Elliptical
Ti-6Al-4V		
Total Deformation	77.2mm	106.6mm
Ti-6Al-6V-2Sn		
Total Deformation	80.8mm	111.5mm
Titanium Grade-l		
Total Deformation	92.7mm	127.9mm

By referring the above results, Ti-6Al-4V material has less total deformation compared to the other materials at both shapes.So Ti-6Al-4V material is preferable and also it has high quality, low weight proportion and great erosion resistance.

Future scope :

Different other composite materials can be used for analysis. In this project the total deformation of missile nose cone and structural stresses of missile nose cone are analyzed. For further Investigation, the parts assembly and its analysis is also can be done through CATIA and ANSYS softwares. Can also find the regression analysis.

Modal analysis can be done the to find out the performance of the missile nose.

VII.REFERENCES

1. Anderson Jr., John D. (2007). Basics of Aerodynamics. (fourth ed.).
2. New York: McGraw Hill. ANSYS, Inc. (2006). ANSYS Mechanical (Release14,5.0) [Computer Software]. Canonsburg, PA: ANSYS,
3. Inc.. Harkness Industries, Inc. (2006). Urethane Products Selector Guide. Recovered July 22, 2008, from: http://www.harknessindustries.com/pdfs/Product_Guide.pdf
4. Hibbeler, R.C. (2008). Mechanics of Matters (seventh ed.). Up Saddle River: Pearson Prentice Hall.
5. Oberg, Erik, F. D. Jones, and H.L. Horton (Eds.). (2000). Apparatus' Handnotes (26th ed.). New York, NY: Industrial Press Incorporated.
6. OPNAV (September 1998). Endorsed Navy Institute Network Idea for the Navy Consolidated Sonobuoys (N88-NTSP-A-50-8910B/A). Joined States: U.S. Government Printing Office.
7. Pope, Alan. (1966). Wind-Tunnel Testing (second ed.). Joined States of America: John Wiley and Sons, Inc.
8. Raymer, Daniel P. (2006). Air ship Design: a Conceptual Approach (fourth ed.). Reston: American Institute of Aeronautics and Astronautics, Inc.
9. Reynolds Advanced Materials. (2008). All that You Need for Mold Making and Casting.
10. Schlichting, Dr. Hermann. (1968). Limit Layer Theory (sixth ed.). Joined States of America: McGraw Hill.

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