Study of Aircraft Nose For Different Condition of Air Resistance

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Abstract- *This paper provides an introduction to characteristics of aircraft nose for different condition of air resistance. An aircraft nose cone is the forward most part of aircraft, hence it experiences the highest drag while taking of and landing. For different aircraft the size and shape of the nose cone varies. The scope of the paper is to develop some outstanding design of the aircraft nose which should have excellent aerodynamic qualities by using different materials and shapes such as conic, parabolic, hawk series, elliptical and power series for designing and manufacturing. A summary of existing modelling and simulation frameworks give an insight into state-of-the-art assessment capabilities as it concerns advanced concepts. They are the prerequisite to allow a holistic assessment during the early stages of the preliminary aircraft design process and to identify benefits and drawbacks for all involved stakeholder.*

Keywords- Aircraft Nose cone, Air Resistance, aerodynamic lift and drag, conical, parabolic, elliptical and radomes.

I. INTRODUCTION

A nose cone is the frontmost section of aircraft. The nose cone should be designed to offer minimum aerodynamic drag. Nose cones are also designed for travel in under water, space, missiles and rockets. Nose cone is also a radome protecting the weather radar from aerodynamic forces as it houses the radar inside it. The shape of the nose cone must be chosen to offer minimum aerodynamic drag so a solid of revolution is used that gives least resistance to motion when travelling in air at high speeds.

Due to the extreme temperatures and resistance involved, nose cones for high-speed applications should have to be made of refractory materials. Pyrolytic carbon similar to graphite but with covalent bonds is one choice, reinforced carbon-carbon composite or HRSI ceramics (High-Temperature Reusable Surface Insulation Tiles) are other popular choices.

II. CONSTRUCTION MATERIALS

The basic materials used for construction aircraft nose and body are as follows-

1. Aluminium

Aluminium alloys are mostly used in modern aircraft construction. Aluminium alloys have a high strength-to-weight ratio. Aluminium alloys are corrosion resistant and comparatively easy to fabricate. The outstanding characteristic of aluminium is its lightweight.

2. Magnesium

Magnesium is the world's lightest structural metal. It is a material that weighs two-thirds as much as aluminium. Magnesium is used to make helicopters. But it has low resistance to corrosion compared to other materials which has limited its use in conventional aircraft.

3. Titanium

Titanium is a lightweight, strong, corrosion resistant metal. Titanium is ideal for applications where aluminium alloys are too weak and stainless steel is too heavy. Titanium has greater resistance to corrosion it is unaffected by long exposure to saline water and moist atmosphere.

4. Steel Alloys

Alloy steels used in aircraft construction have great strength more so than other fields of engineering would require. Steel alloys contain small percentages of carbon, nickel, chromium, vanadium, and molybdenum which make it very useful for aircraft purposes.

III. SHAPES OF DIFFERENT NOSE CONES

The different types of nose cones used in modern day aircraft are as follows-

1. CONICAL:

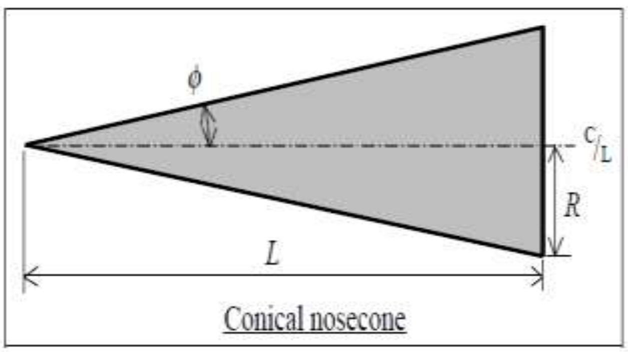

Fig.1

The above Fig.1 shows a conical nose cone, it is the most common nose cone used in aircrafts. This shape is often chosen for its ease of manufacture, and is also often (mis)chosen for its drag characteristics. The sides of a conical nose cone profile are straight lines.

So the diameter equation is simply,

$$Y = \frac{xR}{L}$$

2. BI-CONIC:

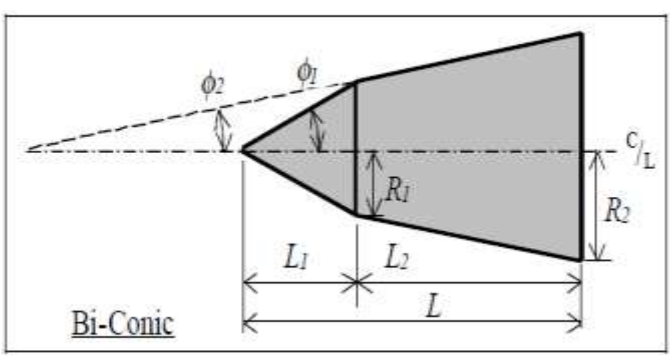

Fig.2

A Bi-Conic nosecone shape is simply a cone mounted on top of a frustrum of a cone where the base of the upper cone is equal in diameter to the smaller diameter of the frustrum.

3. ELLIPTICAL:

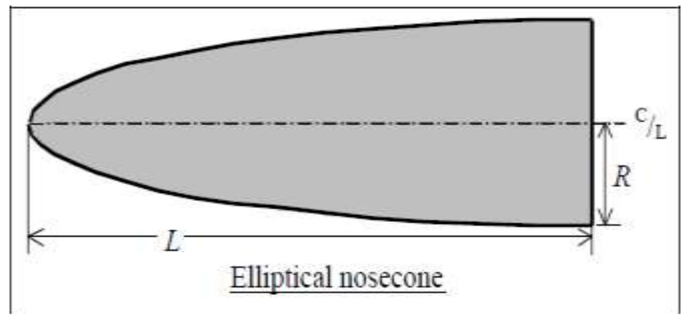

Fig.3

The profile of this shape is one-half of an ellipse, with the major axis being the centre line and the minor axis being the base of the nosecone. A rotation of a full ellipse about its major axis is called a prolate spheroid, so an elliptical nose shape is commonly known as a *prolate* hemispheroid. This shape is very popular in model rocketry due to the bluntnose and tangent base, which are attractive features for subsonic flight. Note that this is not a shape normally found in professional rocketry.

The diameter nose cone equation is,

$$Y = R\sqrt{1-(X^2/L^2)}$$

4. PARABOLIC SERIES:

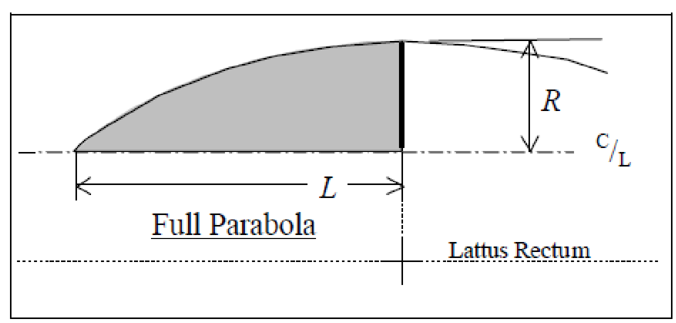

Fig.4

The Parabolic nose cone shape is not the blunt shape that is imagined when people commonly refer to a 'parabolic' nose cone. The Parabolic Series nose shape is obtained by rotating a segment of a parabola around a line parallel to its Latus Rectum. The construction of a parabolic nose cone is similar to that of the Tangent Ogive shape nose cone, except that a parabola is the defining shape rather than a circle this construction produces a nose shape with a sharp tip.

The diameter nose cone equation is,

$$Y = R\left(\frac{2\left(\frac{X}{L}\right)-K(X/L)2}{2-K}\right)$$

IV. REVIEW OF EXISTING MODELLING AND SIMULATION FRAMEWORKS FOR AIRCRAFT NOSE

This section provides an overview of existing aircraft nose modelling approaches as well as simulations.

Table 1.

Name	Year	Methodology
1.A Sanjay Varma, G Sai Sathyanarayana and Sandeep J.	2016	CFD Analysis of Various Nose Profiles.
2. J. Ma, Yaowei Yong, and Shuting Lei	2012	3D FEM Investigation.
3. Bogdan -Alexandra belega	2015	Analysis of Nose Cone Using CFD and SPH.
4. Jieliang Zhao, Shaoze Yan, Liren Deng, He Huang, Yueming Liu	2017	Design and Analysis of Biomimetic Nose Cone.

Various approaches exist to model and analysis the aircraft nose cone in general the above mention methodologies provide the overall aerodynamics of an aircraft nose cone with accurate results. A Sanjay Varma, G Sai Sathyanarayana and Sandeep J. have carried out a great work on nose cone using the CFD analysis. The objective was to identify the types of nose profiles and its specific aerodynamic characteristics with minimum pressure coefficient and critical Mach number. And to develop some prototype profiles with outstanding aerodynamic qualities and low cost for use in construction projects for missile increasing their range and effect on target. The present problem is analysed using ANSYS software. Flow phenomena observed in numerical simulations during Mach 0.8 for different nose cone profiles are highlighted, critical design aspects and performance characteristics of the selected nose cones.

Jieliang Zhao, Shaoze Yan, Liren Deng, He Huang, Yueming Liu carried out a lot of observational experiments on honeybee's abdomen which enhances the flight characteristics of honeybee by adjusting its biomorphic shape. A morphing structure is designed from honeybee's abdomen. The morphing structure is directly designed from the abdomen of honeybee which improves not only the aerodynamic characteristic but also the axial scalability and bending properties of aerospace vehicle, which can lead to the super-man flight performance. Combined to obtain optimum design a new morphing structure is proposed and applied to the design of morphing nose cone of aerospace vehicle. More simulations are carried out to optimize the structural parameters of morphing nose cone in order to obtain optimum design. This concept design of biomimetic nose cone will provide an efficient way for aerospace vehicle to reduce the aerodynamic drag and simultaneously increase robustness and cost effective.

Bogdan -Alexandra belega did research on new nose cones concept that promises a gain in performance over existing conventional nose cones. The main objective was to identify the types of nose cones with ejector channels and specific aerodynamic characteristics of different types of nose cones. The main intention is to develop some prototype profiles with outstanding aerodynamic qualities and low cost for use in construction projects for different nose cone profiles. This design method consists of a geometry creation step in which a three-dimensional geometry is generated, a mathematical model presented and a simple flow analysis using (ANSYS), step which predicts the air intake mass flow rate. The Flow phenomena of different nose profiles is obtained from simulations in which different nose cone operations are highlighted, critical design aspects and operation conditions of various profiles and performance characteristics of the selected nose cone are presented and discussed.

V. CONCLUSION

The review of concepts dealing with aircraft nose cone showed several promising approaches to increase the current efficiencies, however, the variety and concept maturity are manageable. During the development of ideas and concepts, researchers should rethink the current practice when it concerns the aircraft nose cone. Future research should focus on the further elaboration of these concepts in terms of their good aerodynamics operational robustness, technology maturity and certification. Furthermore, a holistic assessment during the early stages of the preliminary aircraft design process would allow the identification of benefits and drawbacks for all involved stakeholders. These findings are often the basis for decision making for further resource allocation pursuing the overall goal of reducing the aerodynamic drag, manufacturing cost robust, designs and greater efficiencies

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