International Journal of Core Engineering & Management (ISSN: 2348-9510)
Special Issue, NCETME -2017, St. Johns College of Engineering and Technology, Yemmiganur

# DESIGN AND ANALYSIS OF V-TAIL UNMANNED AIR VEHICLE (UAV) FOR SURVEILLANCE APPLICATION

*Dr.V.Nagaprasad Naidu[1], P.Hussain Babu[2], T.Giri Kesava[3]*
*[1,2,3] Department of Mechanical Engineering, Intell Engineering College*

*Abstract*

***Unmanned Aerial Vehicles (UAVs) are gaining popularity in military operations as surveillance and weapons platforms. The size of military UAVs varies from very large to hand-held and they are so popular that more UAVs are now being produced than conventional aircraft. These military platforms are expensive to buy and to support. This cost factor has so far limited their use in commercial and industrial applications, such as, security, inspection, ensuring obedience to the laws or search and rescue. The conclusion is made that the design what is made is air worthy and easy to handle and CATIA V5 software is used for designing the V tail and analysed by Ansys and XFLR5 softwares.***

***Index Terms—catia v5 ,uav, aircraft,v tail, ansys, aerial vehicles, survelliance***

## I. INTRODUCTION

An Unmanned Air Vehicle (UAV), in simple terms is an aircraft without a human pilot on board. Its flight is controlled either autonomously by computers in the vehicle or under the remote control of a pilot on the ground or in another vehicle. Of the many types UAV's that are available, one of the types of UAV is UAV (Unmanned Aerial Vehicle / Unmanned Aerial Vehicle). The concept behind V tail UAV is that the system could be back packed, assembled and deployed by no more than two persons. Originally these UAV's were designed to be hand launched and controlled through a laptop, through the display showing video images and navigation and housekeeping data. They were powered by small petrol or diesel engines and this required the fuel supply to be included in the backpacks. Now days with the development of improved battery technology and light weight electric motors, makes the back pack more realistically possible. However battery performance at low temperatures might be a cause for concern.

The V-tail, invented and patented in 1930 by Polish engineer Jerzy Rudlicki, has not been a popular choice for aircraft manufacturers. The X-shaped tail surfaces of the experimental Lockheed XFV were essentially a V tail that extended both above and below the fuselage. Conventionally the most popular conventionally V-tailed aircraft in mass production was the Beech craft Bonanza Model 35, often known as the V-tail Bonanza or simply V-Tail. Other examples include the F-117 Nighthawk stealth fighter and the Fouga Magister trainer.

Ideally, with fewer surfaces than a conventional three-aerofoil tail or a T-tail, the V-tail is lighter, has less wetted surface area, so thus produces less induced and parasitic drag. However, NACA studies indicated that the V-tail surfaces must be larger than simple projection into the vertical & horizontal planes would suggest, such that total wetted area is roughly constant; reduction of intersection surfaces from three to two does, however, produce a net reduction in drag through elimination of some interference drag.

In modern day, light jet general aviation aircraft such as the Cirrus Jet, Eclipse 400 or the unmanned aerial drone Global Hawk often have the power plant placed outside the aircraft to protect the passengers and make certification easier. In such cases V-tails are used to avoid placing the vertical stabilizer in the exhaust of the engine, which would disrupt the flow of the exhaust, reducing thrust and increasing wear on the stabilizer, possibly leading to damage over time.

## II. CAD MODELLING

Computer Aided Design (CAD), also known as Computer Aided Design and

Drafting (CADD), is the use of computer technology for the process of design and design-documentation. Computer Aided Drafting describes the process of drafting with a computer. CADD software provides the user with input-tools for the purpose of streamlining design processes, drafting, documentation, and manufacturing processes. CADD output is often in the form of electronic files for print or machining operations. CADD software uses either vector based graphics to depict the objects of traditional drafting, or may also produce raster graphics showing the overall appearance of designed objects

## III. DESIGN PARAMETER

Out of the case studies carried out the following configuration for the airframe is selected.

### Design configuration

**Aerofoil:**An airfoil-shaped body moved through a fluid produces an aerodynamic force. The component of this force perpendicular to the direction of motion is called lift. The component parallel to the direction of motion is called drag. Subsonic flight airfoils have a characteristic shape with a rounded leading edge, followed by a sharp trailing edge, often with asymmetric camber. Foils of similar function designed with water as the working fluid are called hydrofoils.The lift on an airfoil is primarily the result of its angle of attack and shape. When oriented at a suitable angle, the airfoil deflects the oncoming air, resulting in a force on the airfoil in the direction opposite to the deflection. This force is known as aerodynamic force and can be resolved into two components: Lift and drag. Most foil shapes require a positive angle of attack to generate lift, but cambered airfoils can generate lift at zero angle of attack. This "turning" of the air in the vicinity of the airfoil creates curved streamlines which results in lower pressure on one side and higher pressure on the other. This pressure difference is accompanied by a velocity difference, via Bernoulli's principle, so the resulting flowfield about the airfoil has a higher average velocity on the upper surface than on the lower surface. The lift force can be related directly to the average top/bottom velocity difference without computing the pressure by using the concept of circulation and the Kutta-Joukowski theorem.

## IV. BACKGROUND INFORMATION Airfoil Design

Airfoils may be designed to produce

1. low drag without generating any lift
2. low drag while producing a given amount of lift
3. very high lift to drag ratio
4. maximum lift and drag doesn't really matter

To achieve any of these, constraints may apply on

1. thickness,
2. stagger angle,
3. pitching moment,
4. off-design performance,
5. Stall characteristics, etc.

**Design Approach**

1. Design by authority
2. Use of an already designed airfoil
3. Works well if the goals of a particular design problem matches with the goals of the original airfoil design
4. The availability of the test data ensures, with the available tools now airfoil section can be designed with accurate predictability without testing

**NACA 2412 AEROFOIL**

Geometry of the profile:

- Thickness = 12 %
- Max thickness position = 30%
- Camber = 2%
- Max camber position = 40%

Characteristics of the profile:

- Thin and highly cambered.
- Delays laminar separation.
- Increases stalling angle.
- Produces lift at zero angle of attack.
- Highly concave underside of the airfoil is the major contribution of lift.

**WING DESIGN**

Wing design is made by combination of many airfoil sections. So to design a wind turbine blade airfoil coordinates are needed. The airfoil coordinates were taken from airfoil investigation database. Defining airfoil coordinates in CATIA is tedious, as it requires manually feeding each coordinate of the airfoil in the textbox. So the airfoil coordinates were moved to a Microsoft Excel file. Microsoft excels enables coordinates to be transferred to other software's using macros. This feature of Microsoft excel is used to transfer the airfoil coordinates from excel to CATIA.

### Specification For Rectangular Wing

Specification for rectangular wing as given as follows:

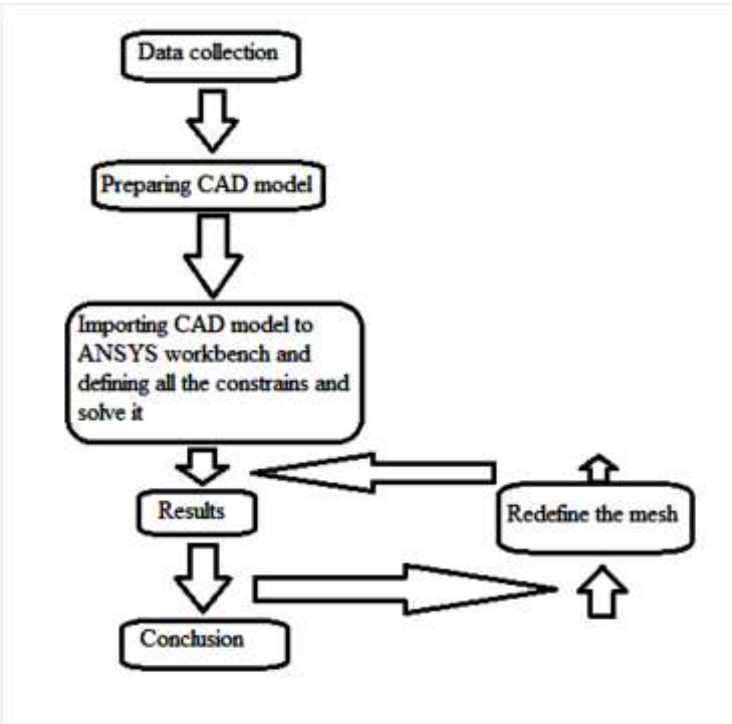
**Table: Specification for basic rectangular wing**

| Parameters | Dimensions |
|---|---|
| Wing area (A) | 1750 $cm^2$ |
| Wing Span (b) | 100 cm |
| Chord (c) | 17.5 cm |

## V. STRUCTURAL ANALYSIS

### Overall general data section

To complete this project, we will follow the following flow chart to do this project in a proper sequence respectively.




The important stages are creating CATIA model, defining constrains, results, redefining the mesh size and comparing results to the original results to validate the results and conclusion

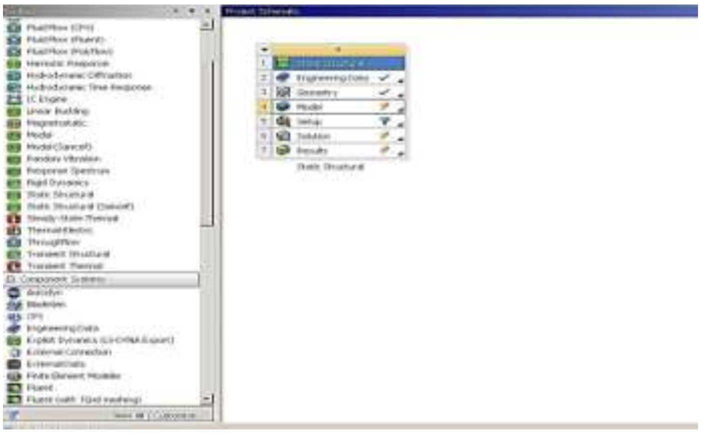
## VI. MAIN RESULT

**FEA section for static structural analysis.**

**Problem specification**
In static structural analysis we are interested in the total deformation, Von Misses stress which is also known as equivalent stress, shear stress and stress intensity induced in the skin structure of the V tail MAV.

**Open ANSYS Workbench**

We are ready to do a simulation in ANSYS Workbench. Open ANSYS Workbench by going to **Start > ANSYS > Workbench**. This will open the startup screen seen as seen below.



**V XFLR5 ANALYSIS**

Ideally, with fewer surfaces than a conventional three-aerofoil tail or a T-tail, the V-tail is lighter, has less wetted surface area, so thus produces less induced and parasitic drag. However, NACA studies indicated that the V-tail surfaces must be

## VII. RESULTS

**Design Approach**

For this analysis, a rectangular wing using the conventional Eppler 61 aerofoil will be designed, and it will be compared with for the performance characteristics of the V tail MAV. The specifications are given below.

International Journal of Core Engineering & Management (ISSN: 2348-9510)
Special Issue, NCETME -2017, St. Johns College of Engineering and Technology, Yemmiganur

**Specification for Rectangular Wing**

Specification for rectangular wing as given below.

| Parameters | Dimensions |
|---|---|
| Wing area (A) | 172.64 cm2 |
| Span (b) | 420 mm |
| Chord (c) | 90mm |

**Performance Comparison**

The following analysis of the baseline was conducted at Re=350000. Figure shows information for the Eppler 61 airfoil at -5 to 15 degrees deflection. These deflections were chosen as they represent the maximum deflection for current aircraft.

Depicts the information about the variation of induced drag against the angle of attack. From this graphical information we concluded that the Aerofoil produces less amount of induced drag .This creates maximum lift in less nagle of attack with low Reynolds number.

**Typical Properties of ABS:**

ABS standard grades have been developed specifically to meet the requirements of major customers. ABS is readily modified both by the addition of additives and by variation of the ratio heat resistance, good machinability, and electroplatable. Fibre reinforcement can be incorporated to increase stiffness and dimensional stability. ABS is readily blended or alloyed with other polymers further increasing the range of properties available. Fire retardancy may be obtained either by the inclusion of fire retardant additives or by blending with PVC. The natural material is an opaque ivory colour and is readily coloured with pigments or dyes. Transparent grades are also available. A variety of grades are available for different applications, the material is typically injection moulded or extruded.

| | |
|---|---|
| Density (g/cm3) | 1.06 |
| Surface Hardness | RR107 |
| Tensile Strength (MPa) | 42 |
| Flexural Modulus (GPa) | 2.4 |
| Notched Izod (kJ/m) | 0.4 |
| Linear Expansion (/°C x 10-5) | 8 |
| Elongation at Break (%) | 8 |

| | |
|---|---|
| Strain at Yield (%) | 2.5 |
| Max. Operating Temp. (°C) | 70 |
| Water Absorption (%) | 0.3 |
| Oxygen Index (%) | 19 |
| Volume Resistivity (log ohm.cm) | 16 |
| Dielectric Strength (MV/m) | 20 |
| Dissipation Factor 1kHz | 0.008 |
| Dielectric Constant 1kHz | 2.7 |
| HDT @ 0.45 MPa (°C) | 98 |
| HDT @ 1.80 MPa (°C) | 89 |
| Material. Drying hrs @ (°C) | 4 @ 90 |
| Melting Temp. Range (°C) | 210– 240 |
| Mould Shrinkage (%) | 0.6 |
| Mould Temp. Range (°C) | 40 – 80 |

## VIII. CONCLUSION

In future the model will be develop in the composite materialto add more strength as per the battlefield usage. In V-Tail section satellite radio/video transmitter will be fixed to make the visible and audiable from the ground , they could be used for military applications, such as aerial reconnaissance without alerting the enemies that they are under survilance. Special type of cameras will be boarded in the aircraft such as sonar cameras thermal cameras which helps by detecting mines and underground building and there are many future improvements are going to be included in it. All components have been designed to be as light weight and high performance as possible so as to maximize payload capacity The aim of project was to design and analysis a V-Tail Unmanned Air Vehicle (UAV) which can be used for surveillance application. The V-tail configuration has the advantage that it can control any of the various thick, dark, sticky substances and to turn about the vertical axis used of an air craft, space craft or projectile easily and faster than other the T-Tail aircraft.. This originating in and characteristics of a particular region design having high stability and aerodynamics which can able to fly up to 5 to 6Km. This aircraft is light weight it is easy to assemble and disassemble according to the mission needed in a battle field and for one who secretly keeps watch on another or others purpose also. The conclusion is made that the design what is made is air worthy and easy to handle and CATIA V5 software is used for designing the V tail and analysed by Ansys and XFLR5 softwares.

**REFERENCES**

[1] Barnard, R.H.; Philpott, D.R. (2010). "10. Aircraft control". Aircraft Flight (4th ed.). Harlow, England: Prentice Hall. p. 275. ISBN 978-0-273-73098-9.
[2] "Blohm & Voss BV P.213 Luft '46 entry". Luft46.com. Retrieved 2013-06-01.
[3] Hunt, Adam & Ruth Merkis-Hunt: Skeletal Remains, pages 64-70. Kitplanes Magazine, September 2000.
[4] Raymer, Daniel P. (1999). Aircraft Design: A Conceptual Approach (3rd ed.). Reston, Virginia: American Institute of Aeronautics and Astronautics. p. 78. ISBN 1-56347-281-3.
[5] "Cirrus SJ50 Design Notes". www.the-jet.com. Cirrus Design Corporation. 2008. Retrieved 2008-08-14.
[6] "FAA Airworthiness Directive 93-CE-37-AD as Amended". Federal (Volume 68, Number 93)Docket No. 93-CE-37-AD; Amendment 39-13147; AD 94-20-04 R2. Federal Register. May 14, 2003. Retrieved 2008-08-14.
[7] "L'Aéronautique, Volume 17". L'Aeronautique (in French) 17: 333. 1935.
[8] Flight magazine (October 1911). "Flight 28 October 1911". Retrieved 11 January 2011.
[9] Eckalbar, John C. (1986). "Simple Aerodynamics"
[10] Wu H., Sun, D., Zhou, Z., 2004, "Micro Air Vehicle: Configuration, Analysis, Fabrication and Test", IEEE/ASME Transactions on Mechatronics, vol. 9, no. 1, p. 108-117.
**[11]** Jamieson, the solid models from various resources are converted into STL format files or other format files, which mostly come along with the FDM machines. Slicing