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Experimental Analysis of Swept Wing at Variable Angle Along with Tail Section of Fighter Aircraft.(BELL X5)

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ABSTRACT: Wing is major component of aircraft. The wings are aerofoils attached to each side of the fuselage and are the main lifting surfaces that support the airplane in flight. The principal structural parts of the wing are spars, ribs, and stringers. These are reinforced by trusses, I-beams, tubing, or other devices, including the skin and it's have several parts over it aileron, flap, slat and slot, etc. and sometime its act fuels tank and carrying engine too. In this project we are doing analysis on BELL X5 aircrafts sweep wing with changing its angle. A variable-sweep wing, also known as a "swing wing". A variable-sweep wing work its function in order it's allow the pilot to use the optimum sweep angle for the aircraft's current speed, slow or fast. Here "swept wing" is normally used to mean "swept back". The Bell X-5 was the first aircraft capable of changing the sweep of its wings in flight.

KEYWORDS: Wing and tail Design, Mechanism of swept wing, CFD analysis etc.

I. INTRODUCTION

The idea of making aircraft is come out from the birds how they can flap their wings and fly in the air which results in construction of flapping wing mechanism of aircraft in the first era. They noticed that birds have aerofoil shape and their body shave is very beneficial for small UAVs. The most important and focused subject in aviation that how birds can change their shape while flying and also stable in the sky. This study applied in sweep back wing in aircraft to making them more efficient and more stable in air. Sweep back wing is defined as a changing the wings at desired angles while flying to increase their performance in flight in any types of condition.

Two of the main characteristics of sweep back wing is wing angle and wing span. On an aircraft are wing sweep and wing span. For changing in span can, increasing aspect ratio increases lift-to-drag ratio, and decreases engine requirements. Decreasing aspect ratio increases the velocity and decreases drag. By sweep change of aircraft can results in increase in velocity and decrease the drag and however in decreasing the sweep can results in high lift coefficient. Examples of sweep Back wing are P-1101, Bell X-5, XF101F-1 Jaguar, and F-111 Aardvark.

The Bell x5 was firstly built in between 1838-1939 and they having serials numbers of 50-1838 and 50-1839. The first aircraft made its first flight on 15 February 1951 and second one made its first flying on 20 June 1951. By Bell x5 there are approximately 200 flight records with the maximum speed of 0.9 Mach and the highest altitude was achieved id 40000ft. First Aircraft we lost on 14 October 1953 as it's failed to recover from the spine at 60⁰ sweepback wing. Although the testing of bell x5 has been continued till 1955 and it was in service until late 1958 as a chase plane.

A variable-sweep wing, colloquially known as a "swing wing", is an airplane wing, or set of wings, that may be swept back and then returned to its original straight position during flight. It allows the aircraft's shape to be modified in flight, and is therefore an example of a variable-geometry aircraft.



Fig. 1. 3D Model

II. METHODOLOGY

The process of the entire project is composed in three phases: (i) Modification of variable swept Wing and Empennage, (ii) Calculation of changed parameters & analysis of the variable swept Wing and Empennage, (iii) Make a Prototype model of the aircraft. We will calculate the parameters like Pressure, Lift, Drag, and Coefficient of pressure which applying on the Model by analyse it in the ANSYS. Then from the gain of the new values of the parameters we will make a scaled Prototype model of the aircraft.

20° Wing	
Span	124cm
Root Chord	30cm
Tip Chord	15cm
40° Wing	
Span	98.2cm
Root Chord	30cm
Tip Chord	15cm
60° Wing	
Span	69cm
Root Chord	30cm
Tip Chord	15cm

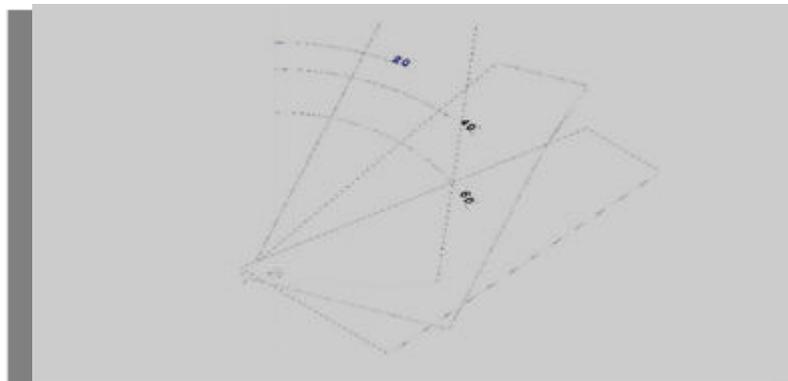


Fig. 2. Wing Configurations



III. AEROFOIL SELECTION

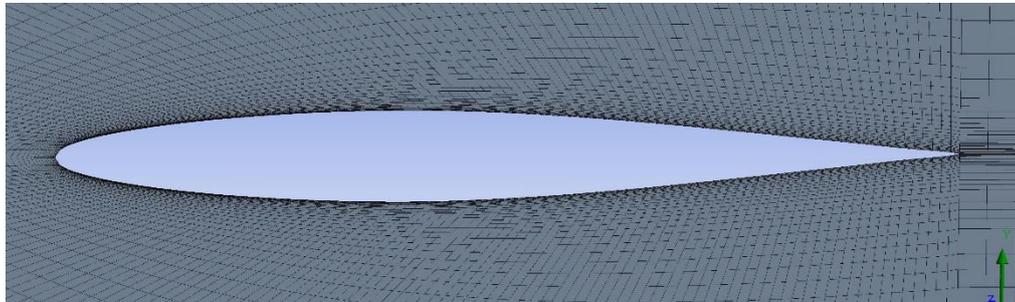


Fig. 3. NACA 64A-10 aerofoil Mesh Domain

The selection of the aerofoil is the most critical part to design a variable angle wing geometry aircraft. The aerofoil must meet the aerodynamic parameters such as coefficient of lift, drag; coefficient of moment etc. Whether it is possible to have different aerofoils for the moving wing can be only after one understands the different structural needs.

In this study an aerofoil NACA 64A-10 is chosen. The shape/contours of the aerofoil are given in the lift characteristic along with moment curve. We select this aerofoil is that generally the concept of variable swept wing is used in aircrafts that tend to operate near the supersonic region therefore it is perfect to use an aerofoil that has a less thickness and in this case 10% of the chord is used in NACA 64A-10.

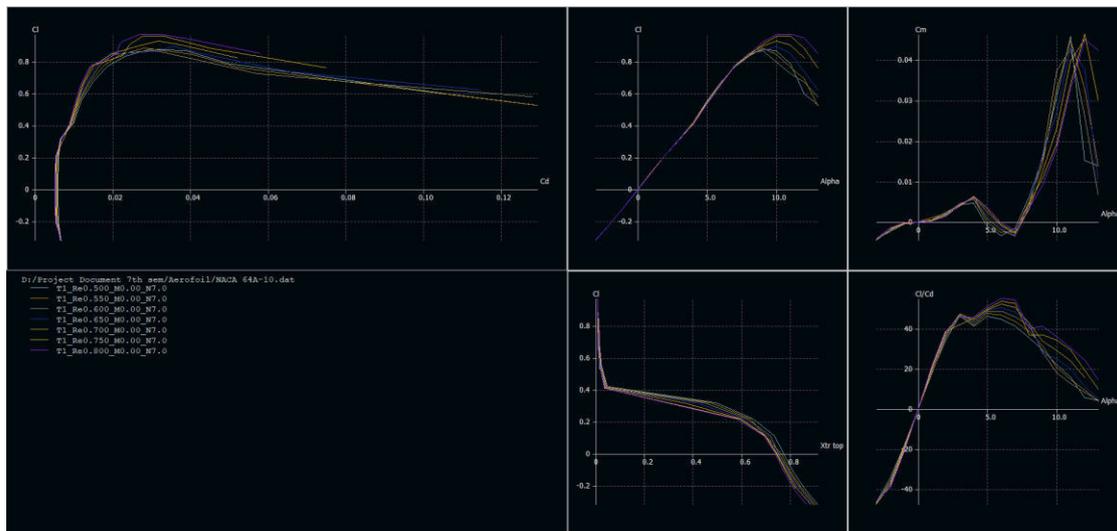


Fig. 4. Graph of aerofoil

IV. EXPERIMENTAL DATA

By performing CFD analysis in ANSYS 18.1 we found some configuration values of lift and drag on the surface of our model. We conducted the experiment in three variable angles which are on 20°, 40°, 60°. As a result of lift and drag values of 20° 40° and 60° are shown as below.

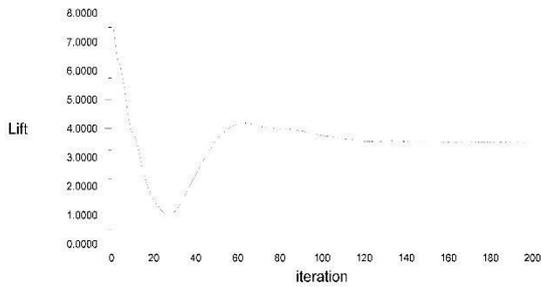


Fig. 5. Lift graph of 20° swept

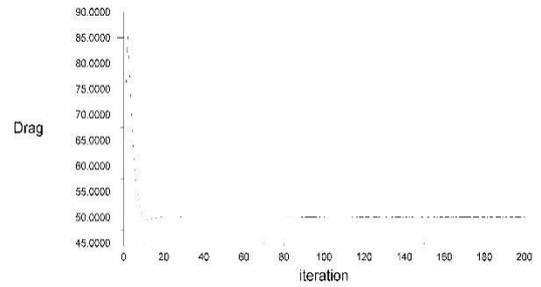


Fig. 6. Drag graph of 20° swept

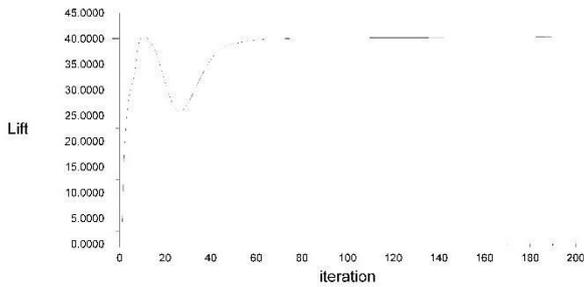


Fig. 7. Lift graph of 40° swept

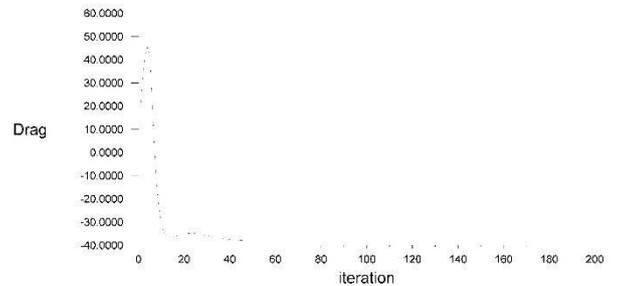


Fig. 8. Drag graph of 40° swept

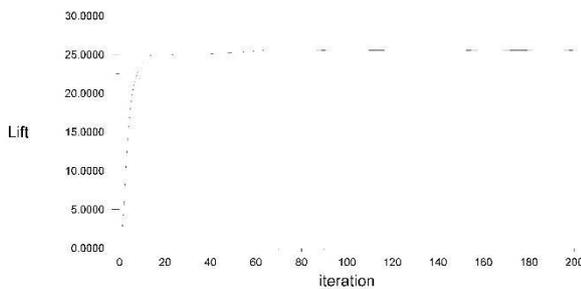


Fig. 9. Lift graph of 60° swept

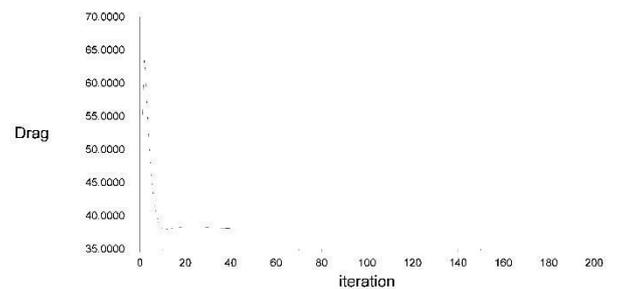


Fig. 10. Drag graph of 60° swept

By performing CFD analysis in ANSYS 18.1 we found some configuration values of pressure contour and velocity contour on the surface of our model. We conducted the CFD analysis in three variable angles which are on 20°, 40°, 60°. As a result of pressure contour and velocity contour values of 20° 40° and 60° are shown as below.

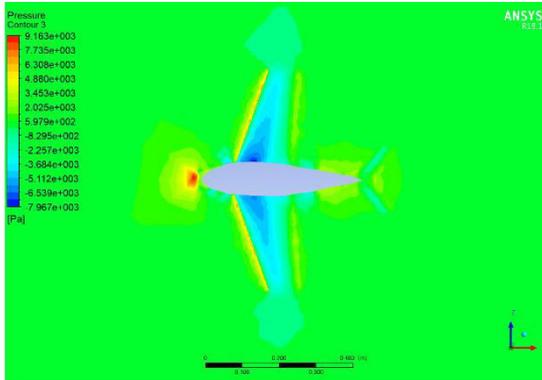


Fig. 11. Pressure contour of 20° swept

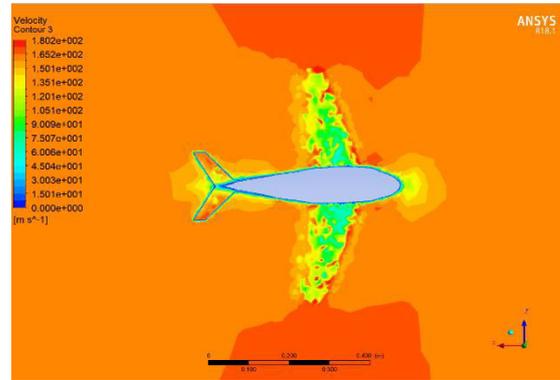


Fig.12. Velocity contour of 20° swept

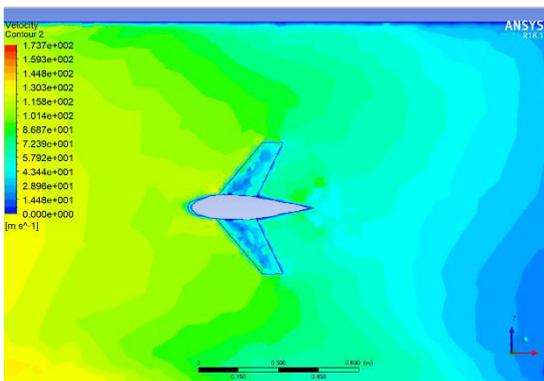


Fig. 13. Pressure contour of 40° swept

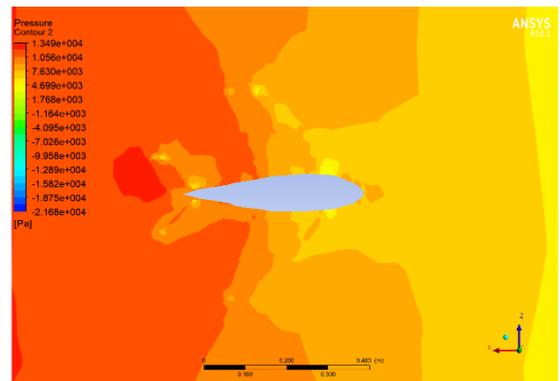


Fig. 14. Velocity contour of 40° swept

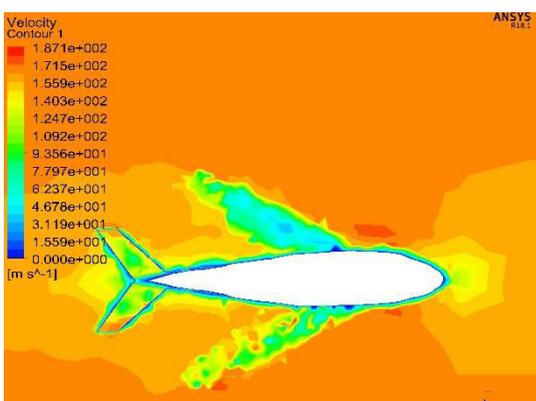


Fig. 15. Pressure contour of 60° swept

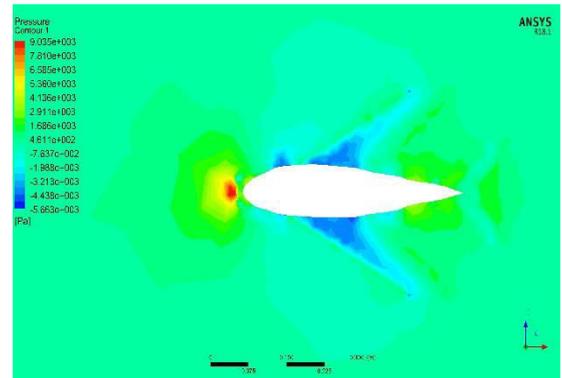


Fig. 16. Velocity contour of 60° swept



Sr. no.	Swept angle	Pressure(N)	Lift(N)	Drag(N)
1	20 ⁰	24.61	3.54	17.75
2	40 ⁰	24.9073	23.28	15.64
3	60 ⁰	18.2726	24.43	23.27

V. CONCLUSION

In the project "experimental analysis of swept wing at variable angle along with the tell section of fighter aircraft bell x5" we learn about the sweep back wing how it's changes the angles of wings in during hanger time take-off time gliding time and landing time we calculate all the dimensions and measurement to apply it on real steady model we make steady model of bell x5 and analysis it on ANSYS 18.1 then after we concluded that the drag and lift of aircraft and variable angle are different from each other as in results we got drag 17.75N and lift 3.54N in 20° sweep wing then 15.64N drag and 23.28N lift in 40° sweep wing and in last 23.27N drag and 24.43N lift in 60° sweep wing. And it finally conclude that changing angle in sweep wing is can be dangerous for any aircraft as it is in the air because of the drag rises as the angle reduces and increases more than designed parameter.

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