Lift And Drag Force Analysis On Cambered Aerofoil For Different Chord Length

Abstract

In this study conducted in Open foam software. In aerodynamic aspect Cambered aerofoil has the greater static stability. This study includes all the data regarding aerofoil and chord lengths are 500mm, 600mm, 750mm. Maximum thickness is maintained at 12% of chord length. Drag force and lift force are derived for various chord length. The chord lengths are 500mm, 600mm, 750mm and angle of attack is maintained at zero degree. In this study performed in openfoam software and Ansys software. The results shows that drag and lift forces are increased with respectively increase the chord length of the aerofoil.

Problem Statement

CFD study on Cambered Aerofoil. Estimating drag force and lift force for various chord length and maximum thickness using Open foam software. Also, estimate coefficient of drag and coefficient of lift. That the coefficient of drag and coefficient of lift are calculated analytically. The openfoam results are compared with the Ansys results.

1. Introduction

An aerofoil is the cross sectional shape of wing. An aerofoil shaped body moved through a fluid(air) processes produces an aerodynamic force. Different types of aerofoils are operating for different purposes all over the world. For the drag reduction purpose mostly suitable aerofoil is cambered aerofoil. In this study only considering the drag and lift forces of the cambered aerofoil for different chord length. The lift on an aerofoil is primarily the result of its angle of attack and shape. But, In this study the angle of attack is maintained with zero degree.

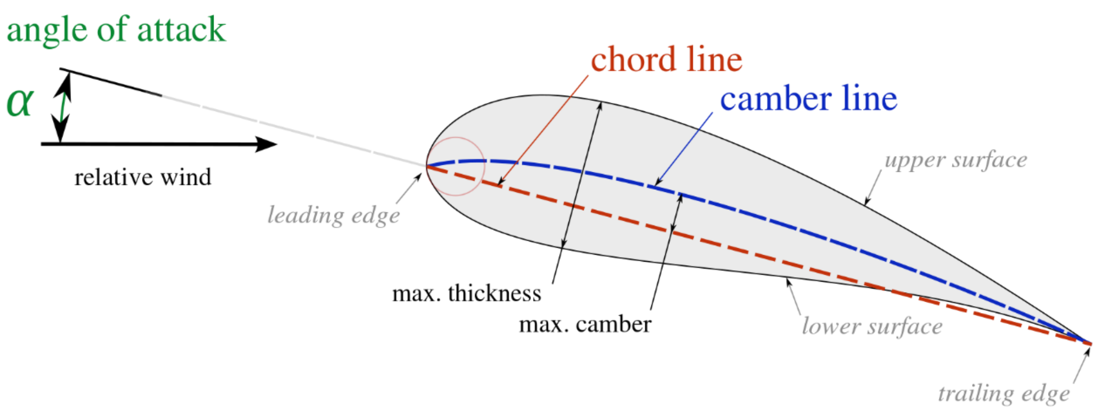


Fig1. Cambered Aerofoil

Nomenclature
D - Drag force (N)
C_D - Drag coefficient
L - Lift force (N)
C_L - Lift coefficient
A - Projected cross-sectional area of aerofoil (m^2)
ρ - Density of the air ($^{kg}/_{m^3}$)
V - Speed of the object, relative to the surrounding air ($^{m}/_{s}$)
ν - Kinematic viscosity of air ($^{m^2}/_{s}$)

2. Experimental Method

2.1 Experimental Study On Openfoam

In this study the geometry of the aerofoil is designed using solidworks software. The varies chord length of the aerofoils are designed in solidworks. That the chord lengths are 500mm, 600mm, 750mm. Maximum thickness is maintained at 12% of chord length The chord line of the aerofoil as shown in fig.1 In openfoam the boundary conditions and transport conditions are fixed to access the files of nut, nu Tilda, p, U, transport properties, boundary, controlDict and fvSolution. Using the simpleFoam to generate the mesh. The generated mesh in the form of rectangle shape.

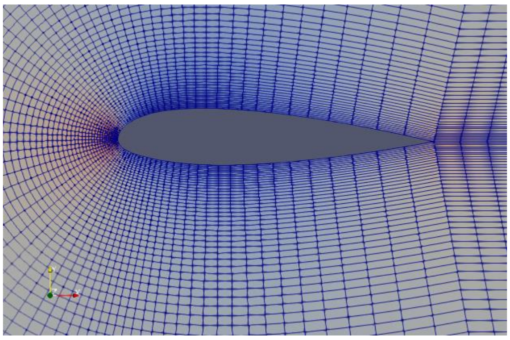
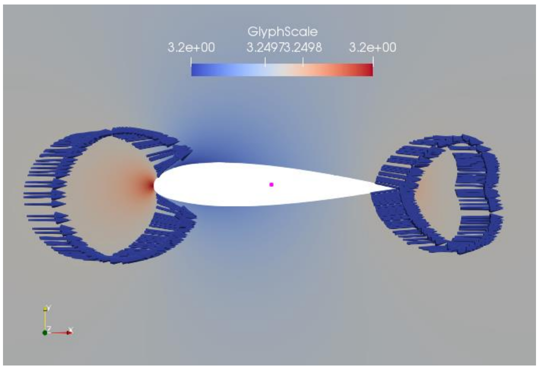


Fig2. Mesh generation

Inlet velocity of air is maintained at 100 $^{m}/_{s}$. That the air flow is uniformly maintained. There is no slip in the aerofoil boundary surface. Pressure in the outlet is uniformly maintained zero gradient. Density and kinematic viscosity of the air is maintain the standard value of $1.225^{kg}/_{m^3}$ and 1.48×10^{-5} $^{m^2}/_{s}$. Reynolds number for this turbulence case is 8.986×10^6.



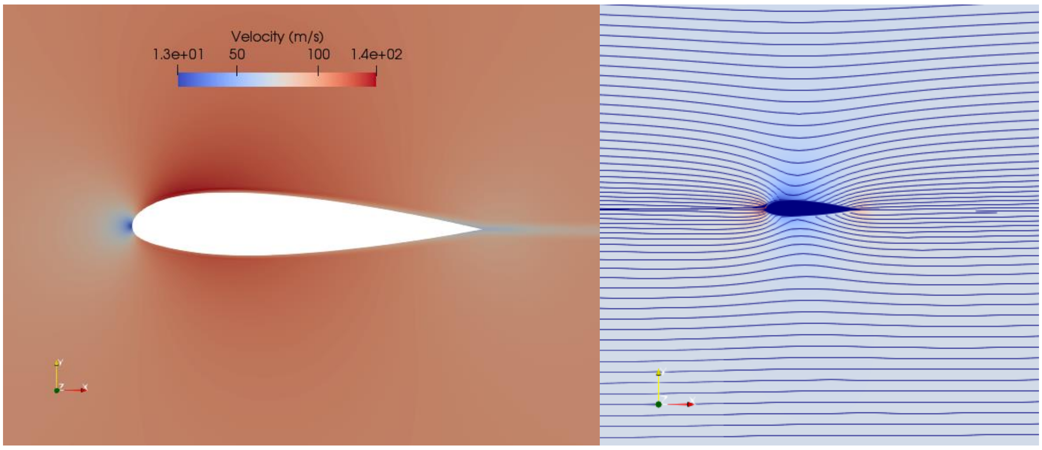


Fig3. Air flow over the surface of aerofoil

Fig3. shows the air flow over the surface of aerofoil. At the leading edge of the aerofoil is maintain the airflow speed of 13 ${}^{m}/_{s}$ due to obstruction. Using GlyphScale to see the obstruction airflow of aerofoil.

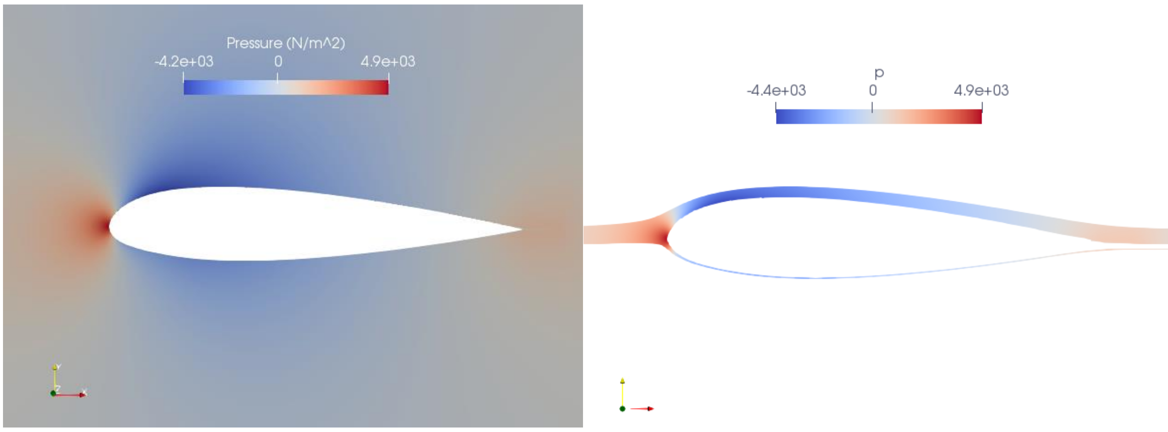


Fig4. Pressure acting over the aerofoil

Fig4. shows the pressure acting over the surface of aerofoil. In high pressure acting over the aerofoil is plotted to red stream region and low pressure acting over the aerofoil is plotted to blue stream region. Fig2, fig3 and fig4 are taken from the aerofoil of chord length is 500mm.Fig5 and fig6 are the aerofoils of chord lengths 600mm and 750mm respectively.

Fig5. Aerofoil of chord length 600mm

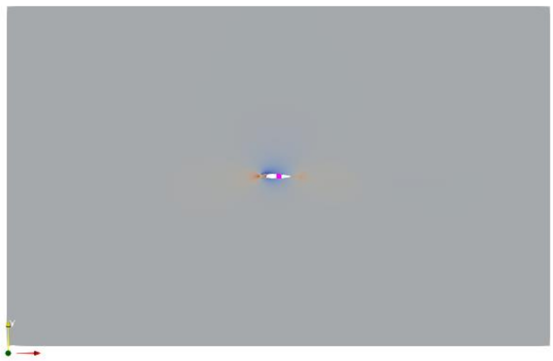


Fig6. Aerofoil of chord length 750mm

2.2 Experimental Study On Ansys

In this study is performed on Ansys workbench. The required solidworks geometry files are imported to Ansys workbench geometry section. In this study perform the model of wind tunnel test. Inlet velocity of air flow over the aerofoil is 100 $m/_s$. Outlet pressure is maintained at zero pascal. Fig7. shows that the air flow over the enclosure.

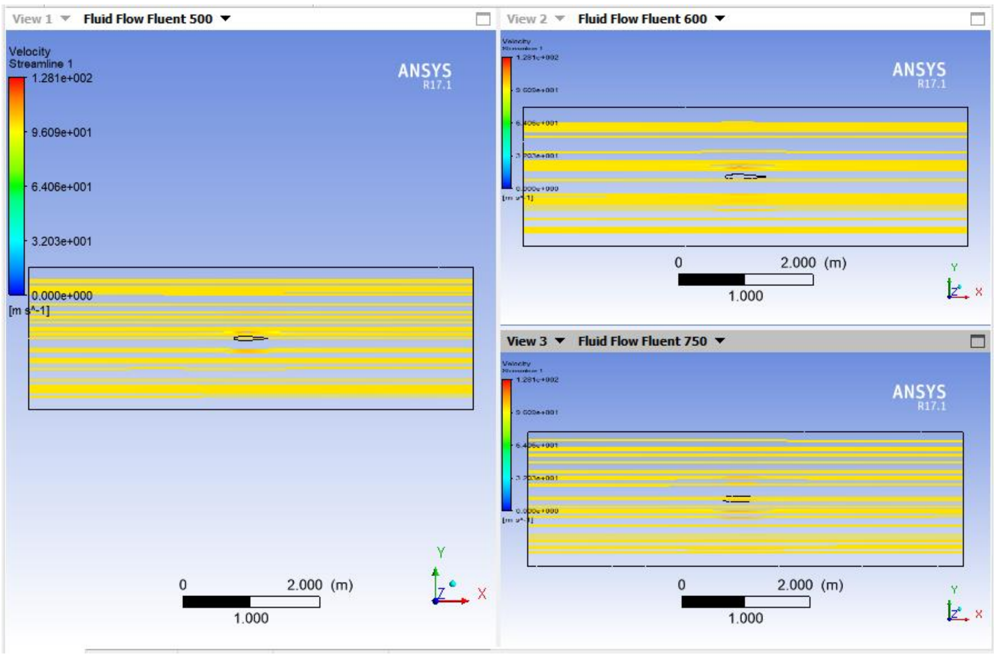


Fig7. Airflow streamline

Fig8. shows that the pressure over the aerofoil. From the contour diagram describes the high pressure acting at trailing edge and low pressure acting at leading edge. Because of its obstruction.

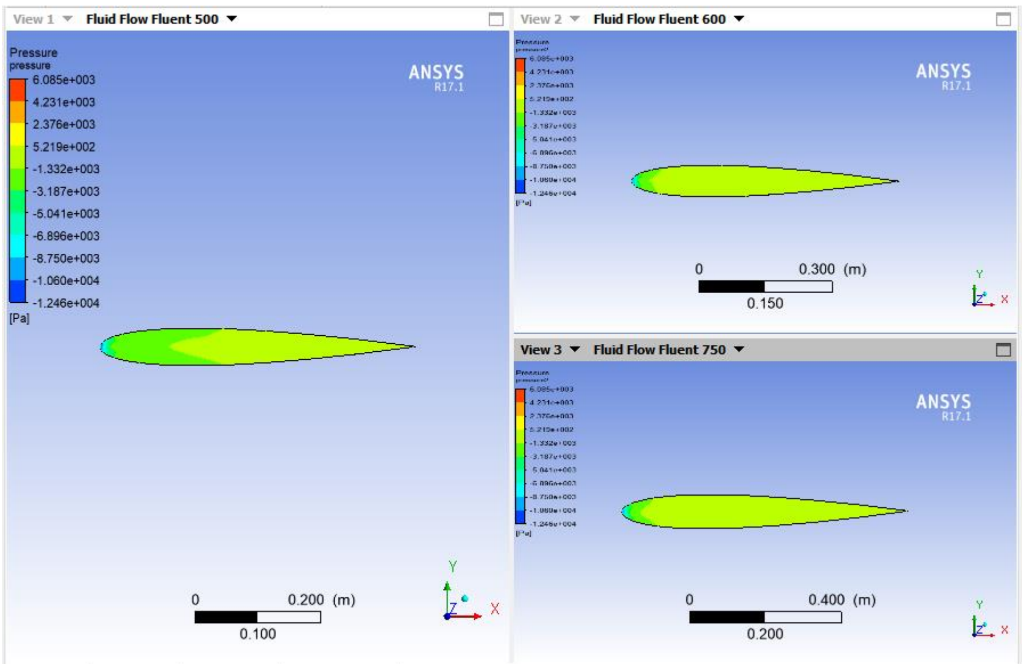


Fig8. Pressure over the aerofoil

3. Result

Ansys Result

Chord Length (mm)	Drag Force (N)	C_D	Lift Force (N)	C_L
500	33.387126	0.068987433	3.2442242	0.006703503
600	39.490259	0.067970285	23.224982	0.03997359
750	49.421926	0.06796851	48.782444	0.067090801

OpenFoam Result

Chord Length (mm)	Drag Force (N)	C_D	Lift Force (N)	C_L
500	30.302	0.0626	3.179	0.0066
600	35.905	0.0618	21.785	0.0375
750	44.864	0.0617	45.701	0.0629

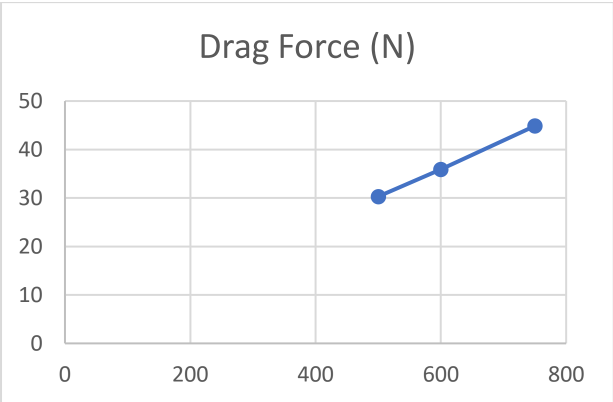


Fig9. Drag force vs Chord length

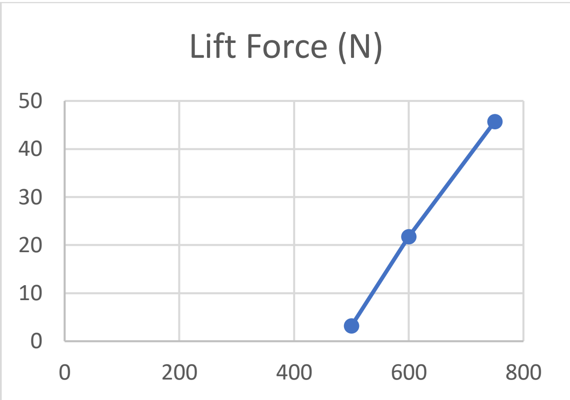
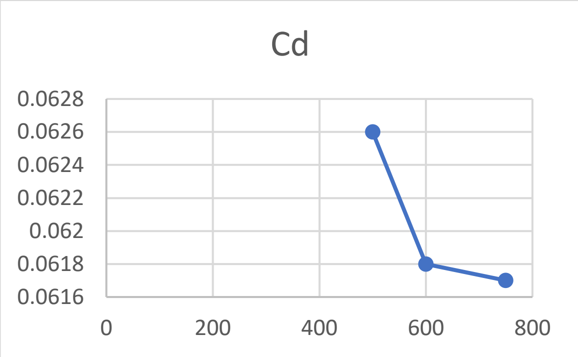


Fig10. Lift force vs Chord length

The Ansys result and Openfoam result are tabulated. From the comparison of result, approximately 5-10 percentage error occurs. The varies graphs are drawn using thus results. From this graph affect of increasing the chord length of the aerofoil results the drag and lift forces are also increased. Drag coefficient and lift coefficient graphs are also drawn. For that all graphs, x-axis is drawn to the chord length of the aerofoil.



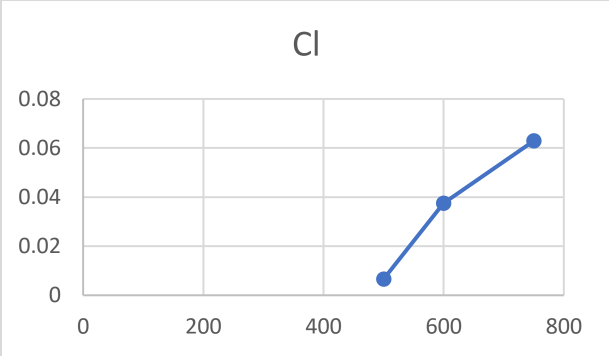


Fig11. Drag coefficient vs Chord length

Fig12. Lift coefficient vs Chord length

4. Conclusion

The tests on the simplified cambered aerofoil have shown changes in drag and lift forces due to changes in geometry that could significantly reduce the fuel consumption. They have shown how the drag and lift is proportioned to the different chord lengths of aerofoil. Whereas the drag and lift in the aerofoil is increased with respectively increase the chord length of the aerofoil. In this study 500mm chord length of the aerofoil is suitable for the reduction of drag and reduce the fuel consumption.

Significant reductions in the drag of the aerofoil were obtained by the reduction of chord length.