Scientific Journal Impact Factor (SJIF): 4.364
International Journal of Modern Trends in Engineering and Research
ISSN (ONLINE) : 2349 - 9745
ISSN (PRINT) : 2393 - 8161

AERODYNAMIC ANALYSIS OF EAGLE WINGLETS ON AIRCRAFT

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Abstract— In aeronautical engineering, drag reduction constitutes a challenge and there is room for improvement and innovative developments. The drag breakdown of a typical transport aircraft shows that the lift-induced drag can amount to as much as 40% of the total drag at cruise conditions and 80 to 90% of the total drag in take-off configuration. One way of reducing lift-induced drag is by using wingtip devices. By the implementation of "BIOMIMETIC ABSTRACTION" of the principle behind a bird's wingtip feathers, we study about "TIP SAILS" at the aircraft wingtip. The numerical investigation of such a wingtip device is described and preliminary indication of its aerodynamic performance is provided. The model of our wing is designed and analyzed using ANSYS.

Keywords— Drag reduction, Induced drag, Biometric Abstraction, Wing tip

I. INTRODUCTION

Wingtip devices are usually intended to improve the efficiency of fixed-wing aircraft. There are several types of wingtip devices, and although they function in different manners, the intended effect is always to reduce the aircraft's drag by partial recovery of the tip vortex energy. Wingtip devices can also improve aircraft handling characteristics and enhance safety for following aircraft. Such devices increase the effective aspect ratio of a wing without materially increasing the wingspan. An extension of span would lower lift-induced drag, but would increase parasitic drag and would require boosting the strength and weight of the wing. At some point, there is no net benefit from further increased span. There may also be operational considerations that limit the allowable wingspan. Wingtip devices increase the lift generated at the wingtip by smoothing the airflow across the upper wing near the tip and reduce the lift-induced drag caused by wingtip vortices, improving lift-to-drag ratio. This increases fuel efficiency in powered aircraft and increases cross-country speed in gliders, in both cases increasing range. In aeronautical engineering, drag reduction constitutes a challenge and there is room for improvement and innovative developments. The drag breakdown of a typical transport aircraft shows that the lift-induced drag can amount to much as 40% of the total drag at cruise conditions and 80–90% of the total drag in take-off configuration. One way of reducing lift-induced drag is by using wingtip devices. By applying biomimetic abstraction of the principle behind a bird's wingtip feathers, we study eagle wingtips, which look like an extended blended wingtip that bends upward by 360 degrees to form a large rigid ribbon.

From an aerodynamicist's point of view, the main motivation behind all wingtip devices is to reduce lift-induced drag. Aircraft manufacturers are under increasing pressure to improve efficiency due to rising operating costs and environmental issues, and this has led to some innovative developments for reducing lift-induced drag. Several different types of wingtip devices have been developed during this quest for efficiency and the selection of the wingtip device depends on the specific situation and the airplane type.

II. MOTIVATION

Now a days vortex drag generation is high due to the new wing structure models. This vortex drag may increase the induced drag and there will decrement of lift. In aircraft structure winglets are used to minimize this vortex generation problem. There are various design of winglets are used, but still partial cutoff of vortex. Our design eagle winglet (feather let) will be able to reduce the vortex

International Journal of Modern Trends in Engineering and Research (IJMTER)
Volume 04, Issue 5, [May– 2017] ISSN (Online):2349–9745; ISSN (Print):2393-8161

generation little more higher than the other winglets. We inspired this model from eagle. Generally, eagle flies at a high altitude and fast, due to its feather at the tip of eagle wing. This tip feather will reduce the vortex, it's the reason behind the at eagle speed. So that we implemented eagle winglet in aircraft wing.

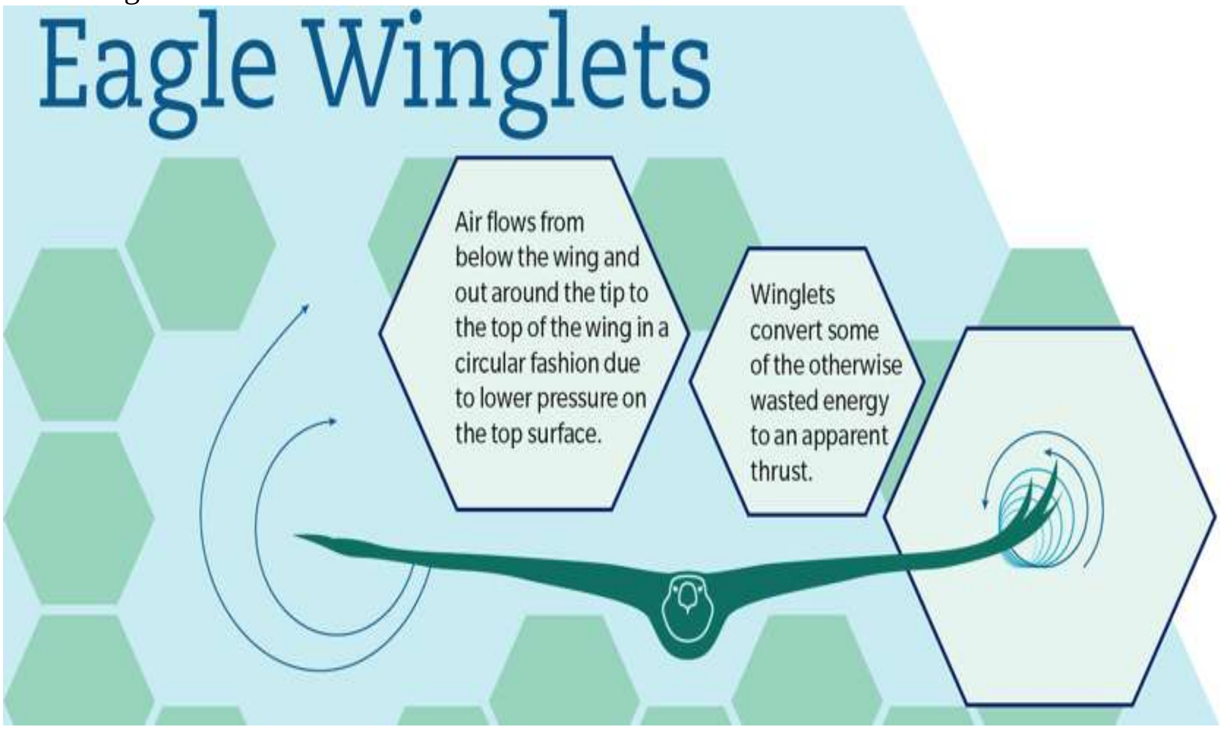
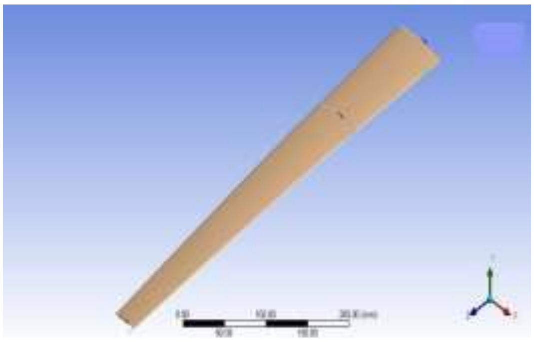
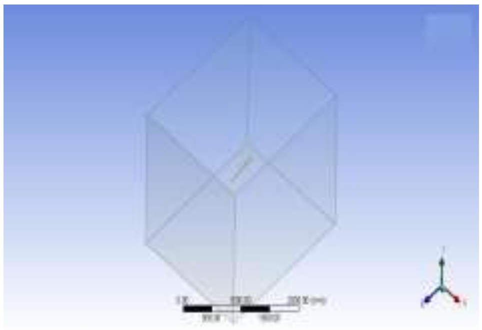


Fig.1.1.Eagle Winglet

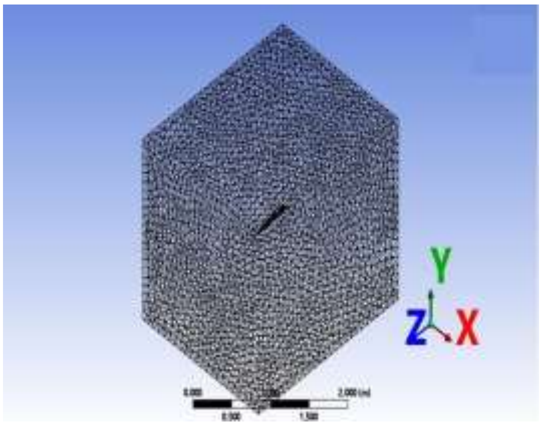
III .MODELLING OF WINGS



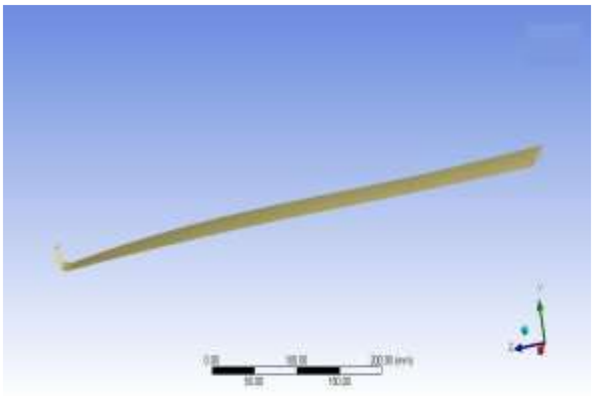
Model of wing without winglet



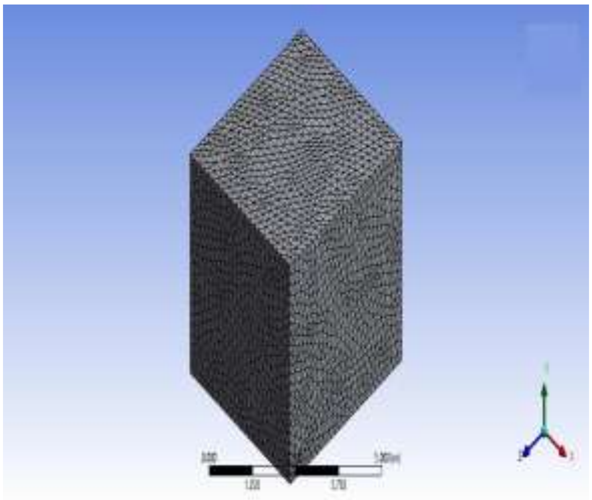
Model with enclosure



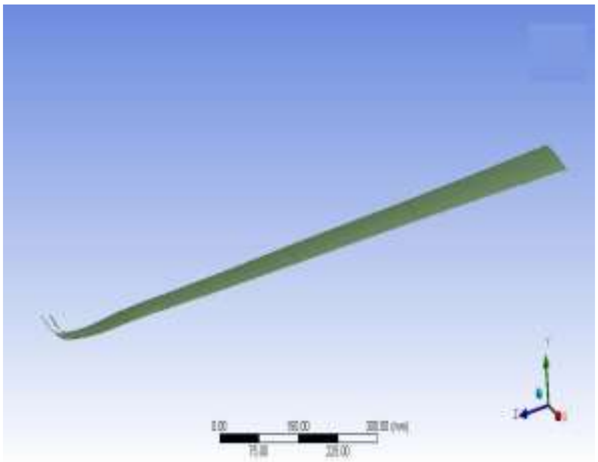
Wireframe mesh



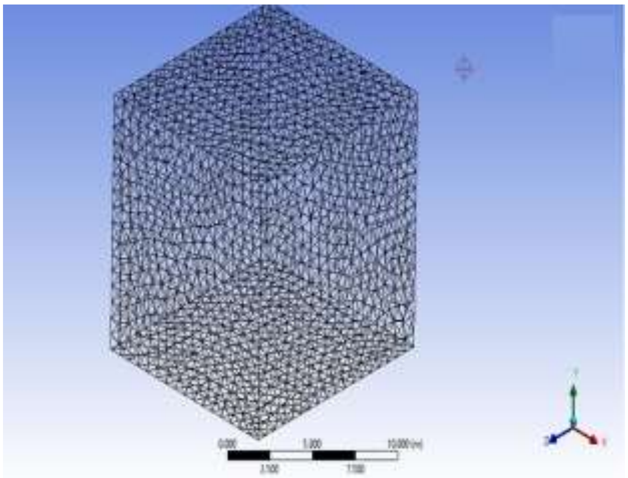
wing with single sail winglet



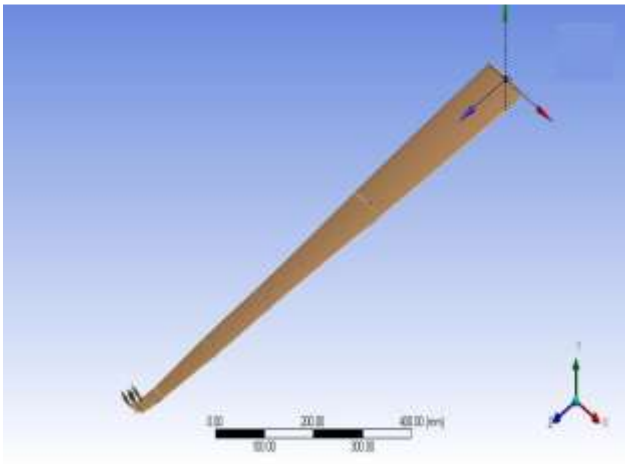
Meshed model of wing with single sail



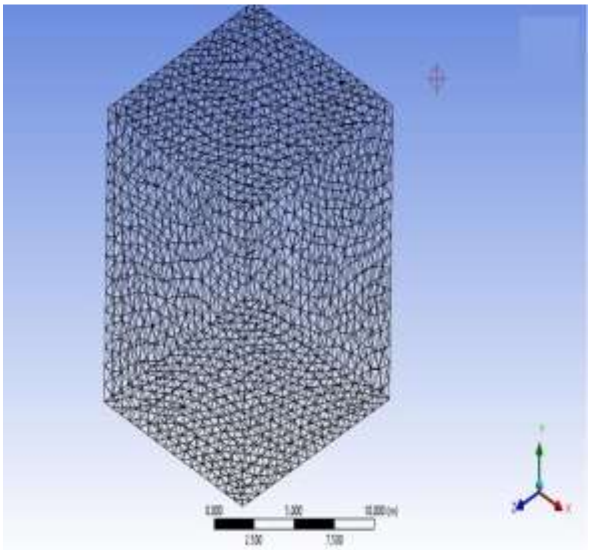
Model of wing with double sail winglet



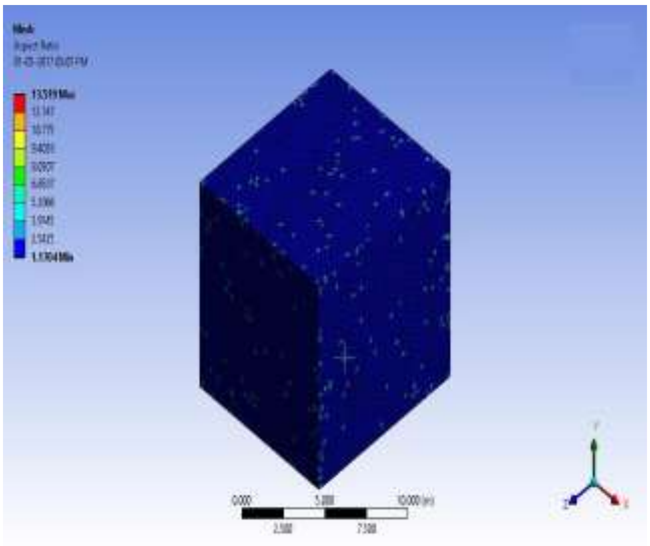
Wireframe mesh wing with double sail



Model of Wing with three sail winglet



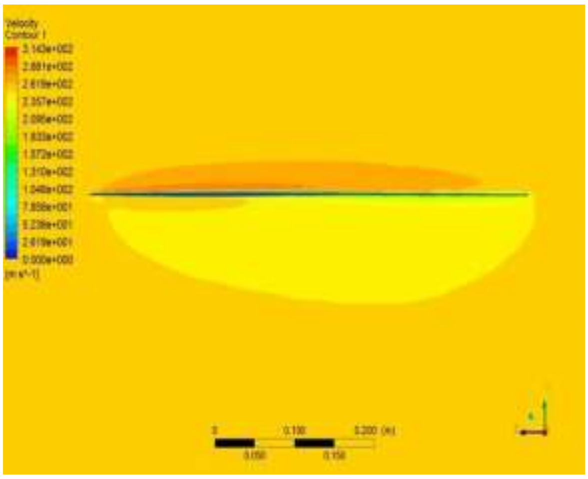
Meshed model of wing with three sail



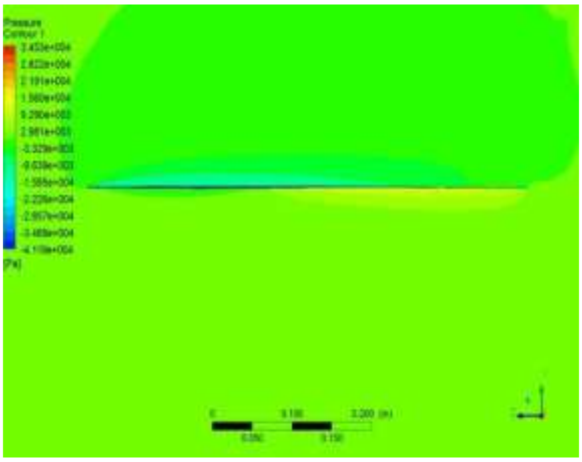
Meshed model of wing with three sail

Volume 04, Issue 5, [May– 2017] ISSN (Online):2349–9745; ISSN (Print):2393-8161

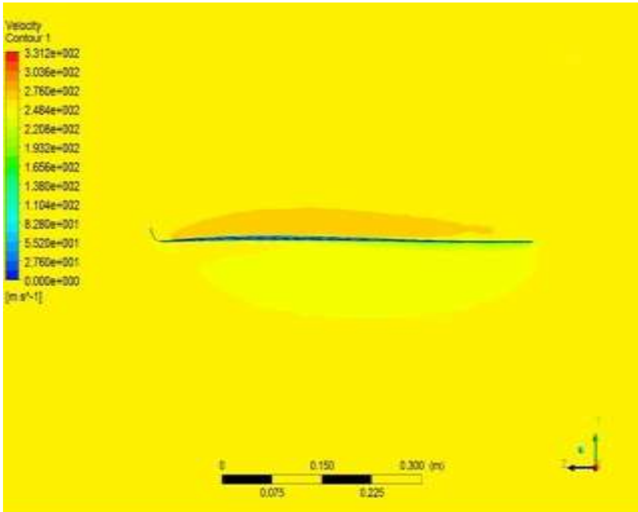
IV.RESULTS AND DISCUSSION



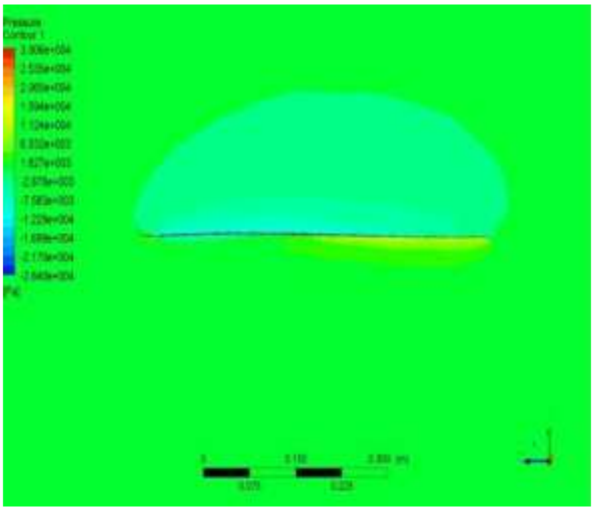
Velocity contour plot of without winglet



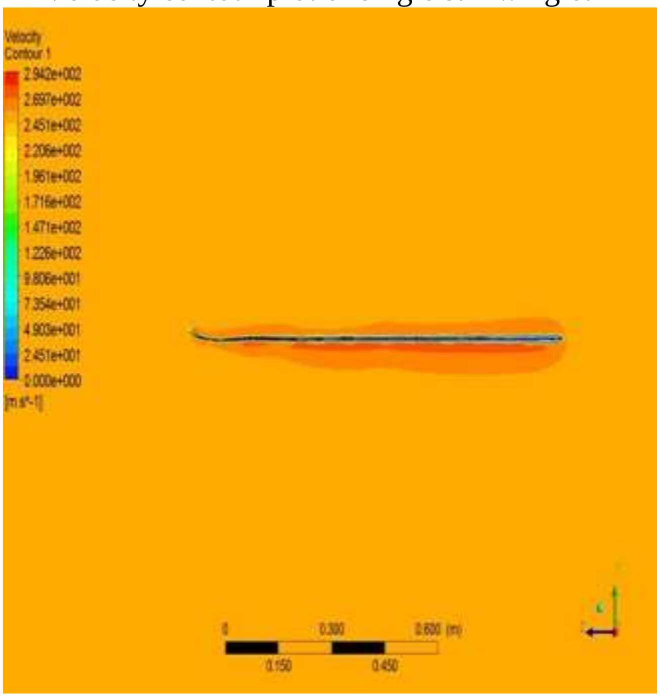
pressure plot of without winglet



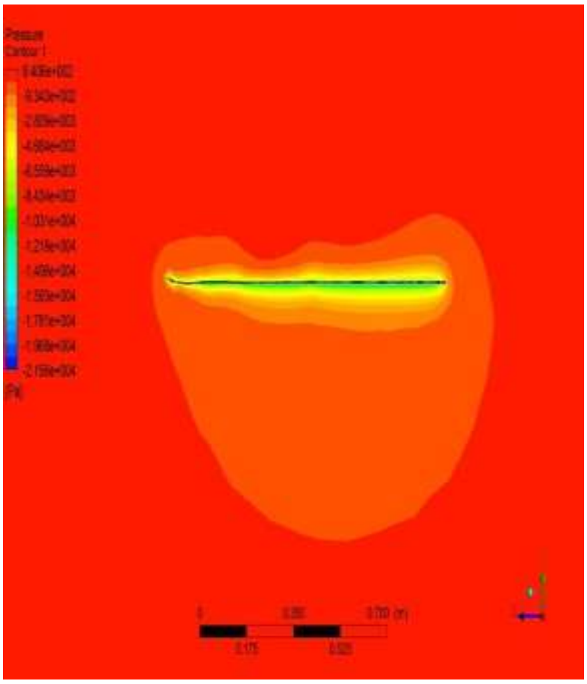
Velocity contour plot of single sail winglet



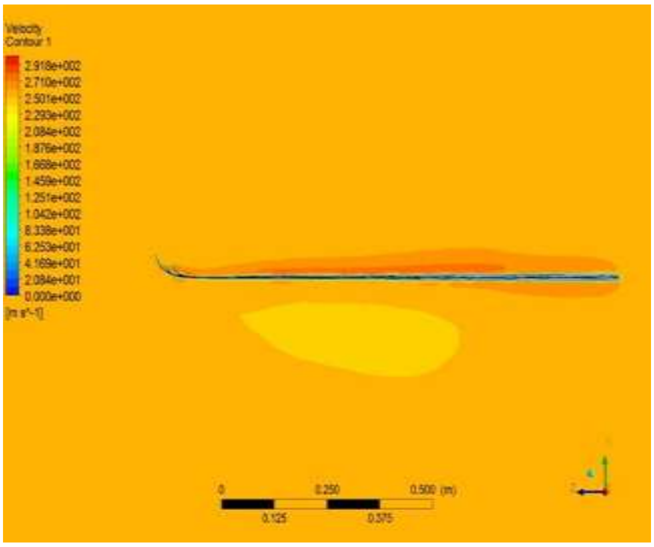
Pressure plot of single sail winglet



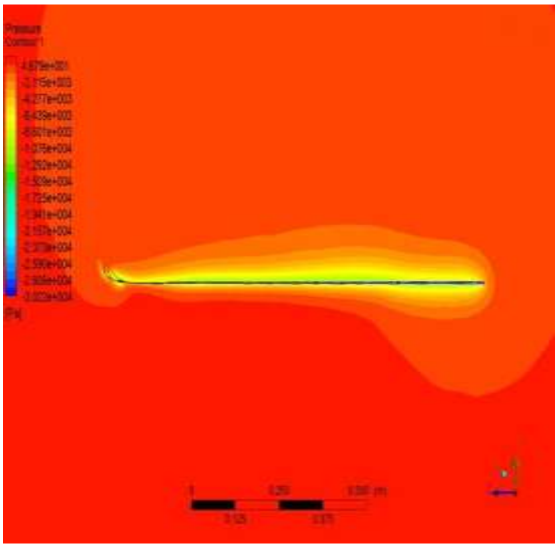
Velocity contour plot of double sail winglet



Pressure plot of double sail winglet



Velocity contour plot of three sail winglet



Pressure plot of three sail winglet

V.COMPARISON BETWEEN WINGS

Wing	Lift(N)	Drag(N)	L/D	C_D(ind)
Wing With out winglet	20.21	1.09	23.84	1.10e-6
Wing With Single Sail Winglet	23.84	1.583	15.06	1.267e-6
Wing With Double Sail Winglet	12	1.225	9.79	0.3077e-6
Wing With Three Sail Winglet	24.12	4.63	5.184	1.086e-6

VI. CONCLUSION

- By comparing with the four cases of wings, the double sail winglet has more reduction in the drag.
- When comparing with the other wings, single sail has more lift.
- The L/D ratio of without winglet has more, Comparing with the other wings.
- The lift of the three sail winglet has more than the double and without winglet design.
- The aerodynamic characteristics of these four cases of wing can be further can be improved, by modifying the wing span, tapper ratio and aspect ratios of wing.

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