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Design and Analysis of Spiroid Winglet for Drag Reduction

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Abstract*—One of the main concern of the Aircraft is to reduce the Drag and to increase the fuel efficiency of the Aircraft. Now we considered the existing Aircraft wing with the addition of our designed Spiroid winglet. There are two types of Spiroid Winglet which has been optimized for our concept. Modelling and analysis is performed through Open VSP software. Finally the results has been validated with the aircraft without winglet and aircraft with Spiroid winglet. And it clearly states that aircraft with Spiroid winglet gives less drag when compared to the aircraft which doesn't have winglet.

***Keywords*— Aircraft, Spiroid Winglet, Open VSP Software.**

I. Introduction

The main purpose of the aircraft wing is to produce lift. To increase the efficiency of the lift we are using different types of airfoil. Later we are using the winglets which is used to reduce the drag and reduce wing tip vortices. In the similar manner we are optimizing a spiroid winglet from different shapes, which helps to reduce the drag and increase the lift compared to other types of winglets. Obtain the fundamental knowledge about spiroid winglet and its impact on aircraft aerodynamic performance. Analyze and improve the aerodynamic performance of the spiroid wing in terms of lift, drag, etc. Compare the performance with a basic wing and a wing with spiroid winglet, in terms of pressure coefficients. The main objective is to reduce the drag by partial recovery of wingtip vortex energy.

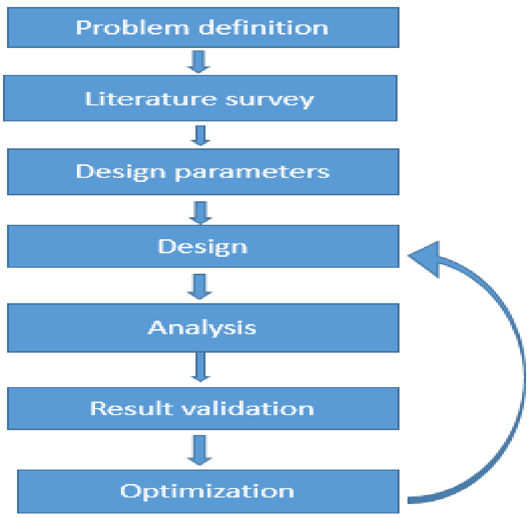

Fig 1. Flow diagram

II.DESIGN PARAMETER

Design specifications of wing:-

Wing Span	28.35 meters
Tip chord length	1.6 meters
Root chord length	7.32 meters
Sweep Angle	25 degrees (Sweep backward)
Airfoil	NACA 2412

Two types of Winglets are considered:

1. Wing with Spiroid winglet 1
- Diamond Shaped
- NACA 2412 Airfoil

2. Wing with Spiroid winglet 2
- Parallelogram Shaped
- NACA 2412 Airfoil

III.BOUNDARY CONDITIONS

- Mach number 0.75
- Angle of attack has been maintained at 1 degree, 5.5 degrees and 10 degrees.
- Standard Air density at sea level 1.225 kg/m^3
- Wall is assumed to be stationary.

IV.DESIGN, MODEL AND ANALYSIS

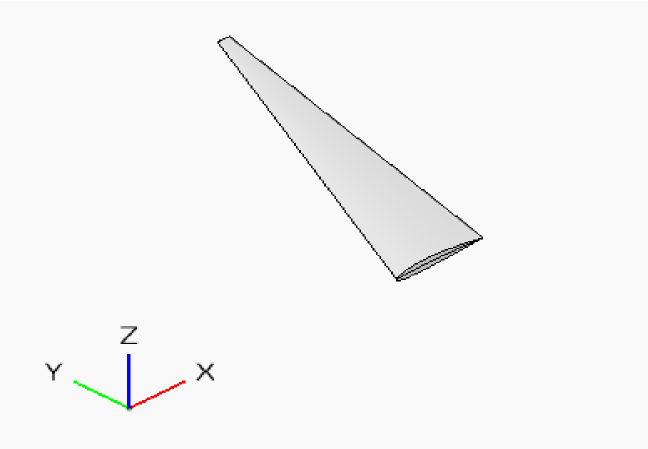

Fig 2. Wing model without winglet

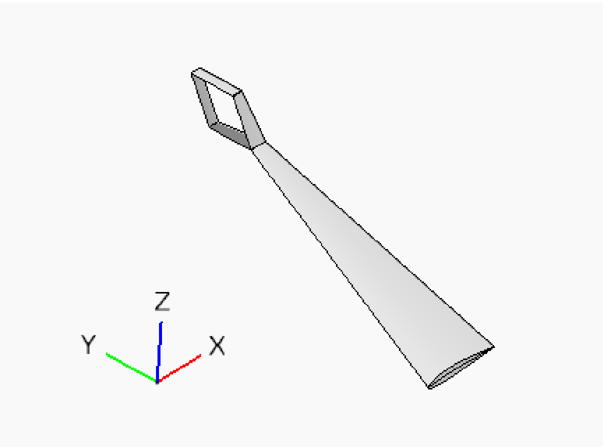

Fig 3. Spiroid Winglet 1

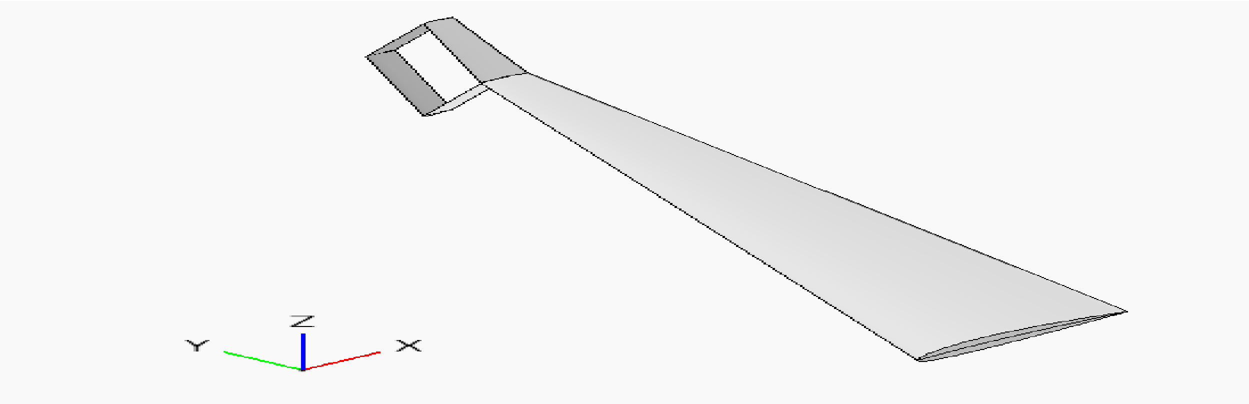

Fig 4. Spiroid Winglet 3

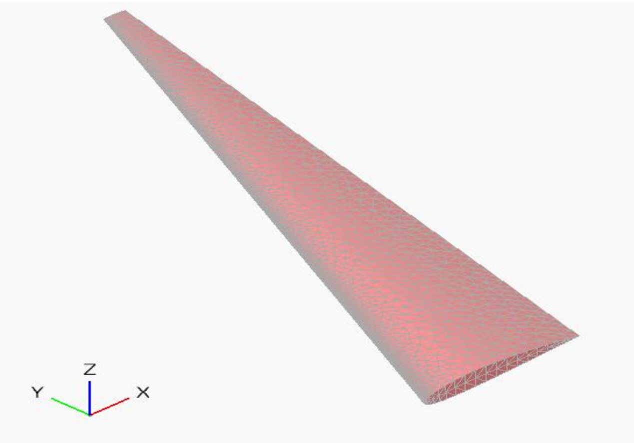

Fig 5. Mesh elements of Wing model = 22892

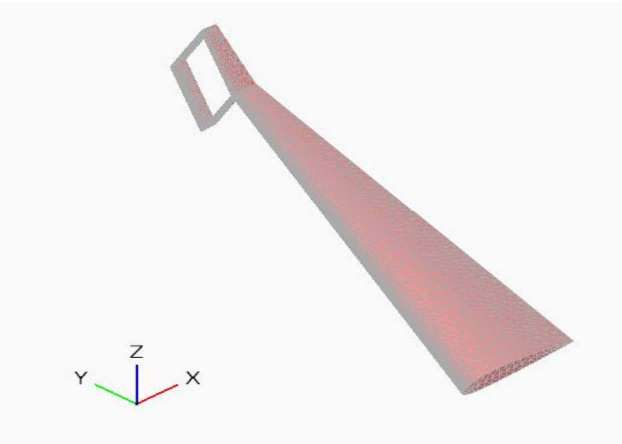

Fig 6. Mesh Elements of Spiroid winglet 1 = 24852

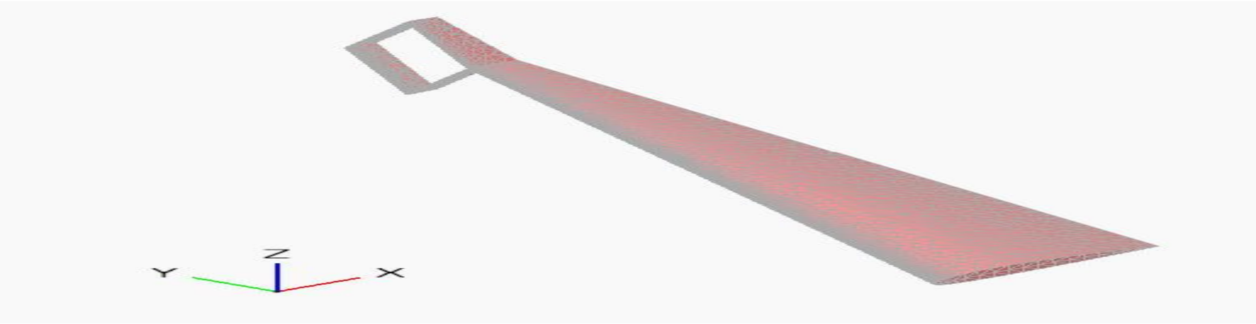

Fig 7. Mesh Elements of Spiroid Winglet 2 = 22892

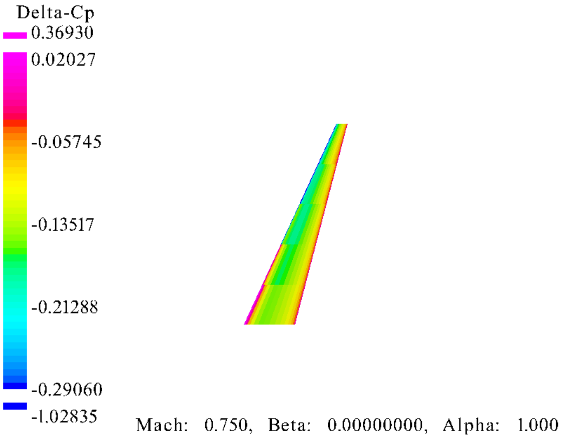

Fig 8. Pressure contour for the wing without winglet

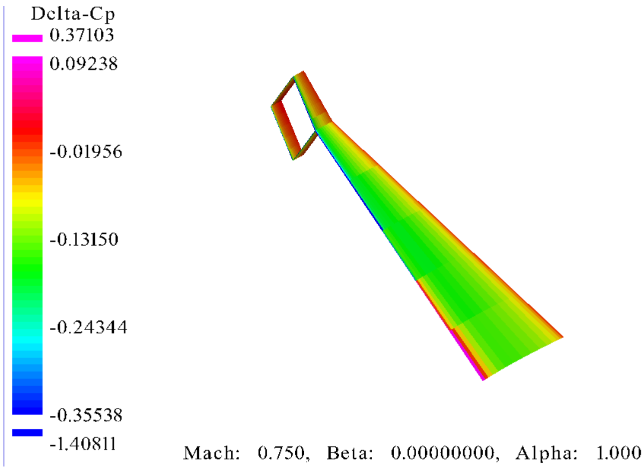

Fig 9. Pressure contour for spiroid winglet 1

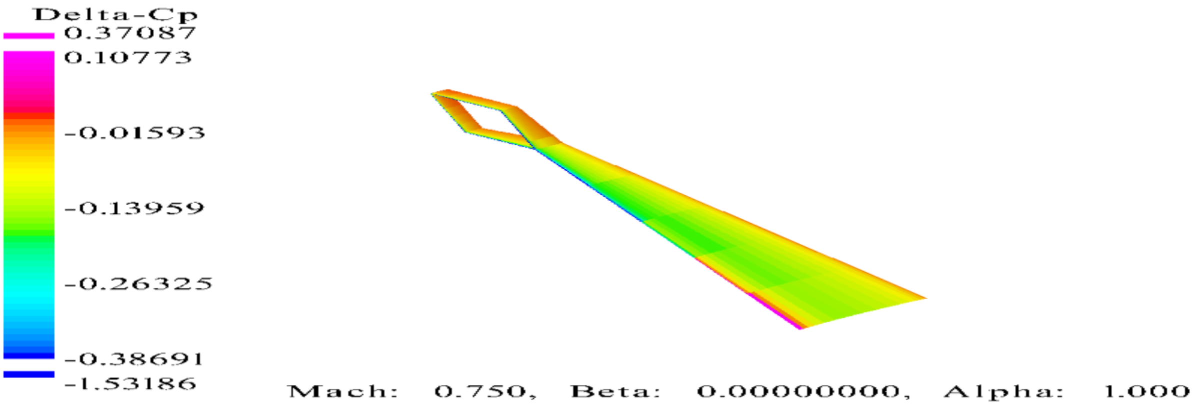

Fig 10. Pressure contour for Spiroid winglet 2

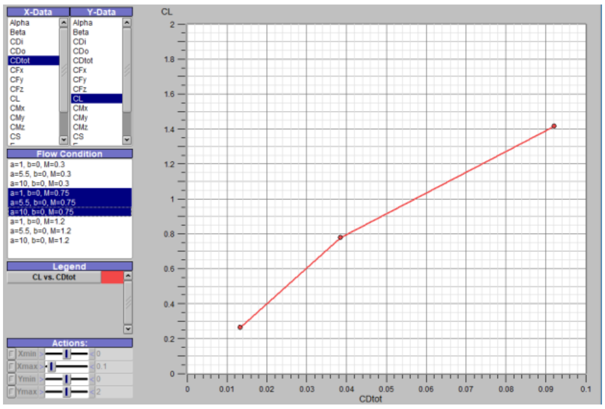

Fig 11.CL Vs CD graph for actual wing

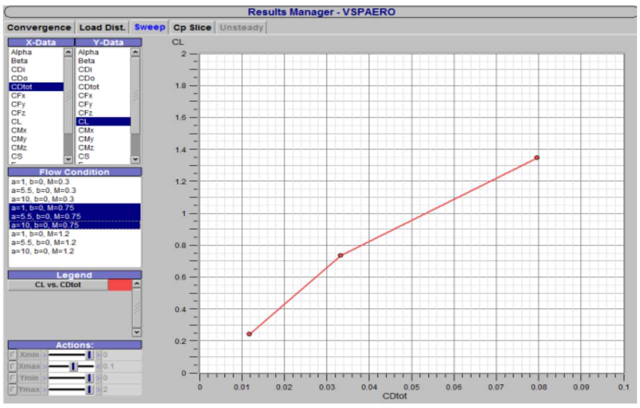

Fig 11.CL Vs CD graph for Spiroid Winglet 1

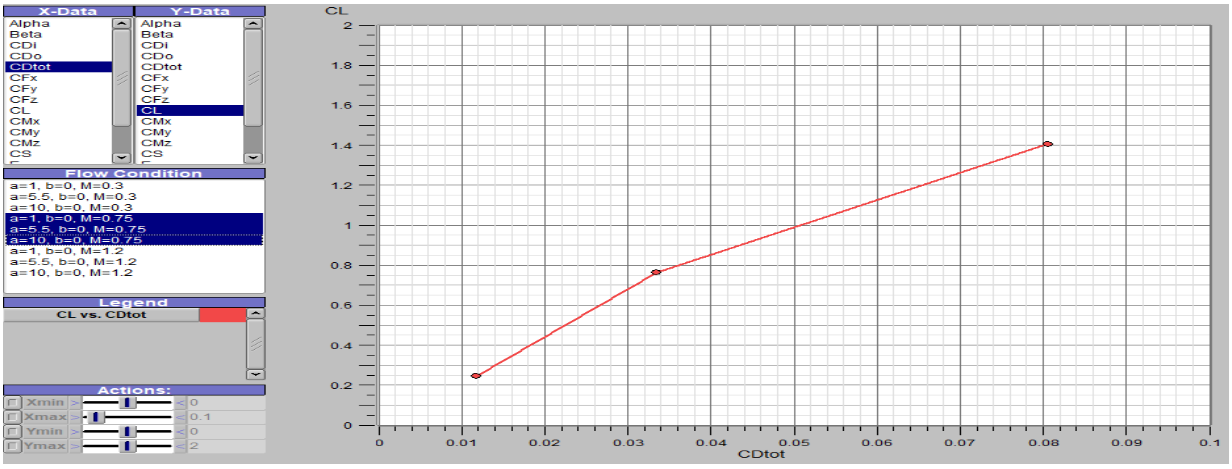

Fig 11.CL Vs CD graph for Spiroid Winglet 2

IV.RESULTS

Table 1

Mach No	Angle of Attack	Wing without winglet		Spiroid winglet 1		Spiroid winglet 2	
		Coefficient of lift (C_L)	Coefficient of total drag (C_{Dtot})	Coefficient of lift (C_L)	Coefficient of total drag (C_{Dtot})	Coefficient of lift (C_L)	Coefficient of total drag (C_{Dtot})
0.75	1	0.26298	0.01335	0.24182	0.01173	0.2461	0.01173
0.75	5.5	0.77787	0.03855	0.73535	0.03328	0.76313	0.03345
0.75	10	1.41705	0.09254	1.34809	0.07992	1.40813	0.08102

V.CONCLUSION

- On the basis of the table and the figure shown above, Wing with spiroid winglet 2 with the following features was identified as the optimum design:
- Parallelogram shaped
- All sides NACA 2412 Airfoil
- Drag is reduced in spiroid winglet 2.

VI. REFERENCE

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