DESIGN OPTIMISATION OF FRONT WING OF A FSAE RACE CAR USING CFD

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ABSTRACT

In this paper numerical investigation was carried for a front wing of FSAE car used in circuit racing. A 2D model of NACA 2412 air foil for multiple element wing was simulated and 3D simplified car model consisting of front wing along with end plate and without end plate was simulated to check for the drag reduction at the wheel portion. The simulation was carried out using a commercial CFD code ANSYS-Fluent-15.

Keywords: Aerodynamic, Air foil, down force, CFD, Fluent.

INTRODUCTION

An FSAE race car is an automobile which is solely designed and built for speed races on specified circuits and tracks. Aerodynamics design is one of the area which helps in achieving better aerodynamic performance, contributing towards increase in down force. Down force adds the virtual weight from the air flow around the car and thereby it pushes the tire onto the ground which gives better traction and enhances concerning abilities. In FSAE car, add on devices like front wing, rear wing, underbody features with diffuserare added along with the body design to improve aerodynamic performance. Ground effect is the term applied to a series of aerodynamic effects used in race car design create down force [1].

MODEL AND MESHING:

The simplified 3d model of Front wing of FSAE car with end plate and without end plates are shown Figure 1. The Meshed Model of front wing with end plate is shown in figure 2.

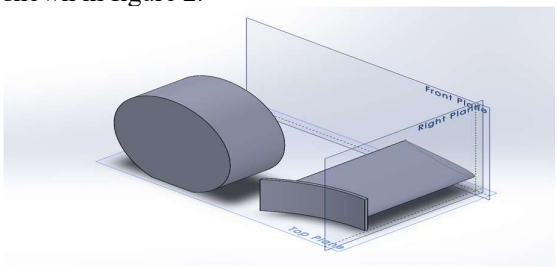

FIGURE 1: COMPUTATIONAL 3-D MODEL OF FSAE CAR WITH ENDPLATE

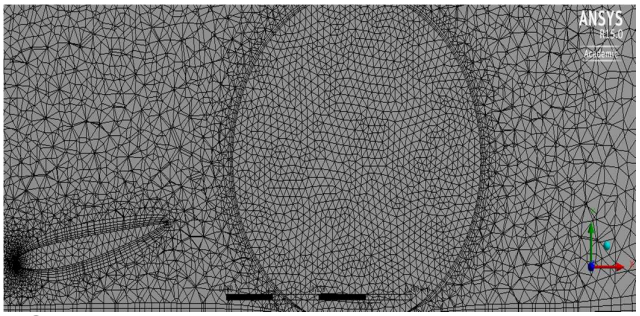

FIGURE 2: MESHED MODEL OF FSAE CAR

The 2D model of NACA 2412 air foil is shown in figure 3 and meshed model of NACA 2412 air foil for single and multi-element wing is shown in Figure 4.

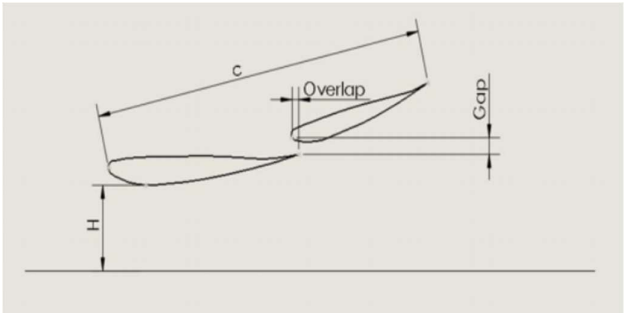

FIGURE 3: NACA 2412 AIRFOIL MODEL.

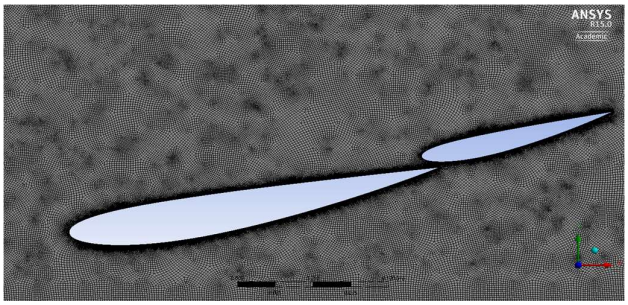

FIGURE 4: UNSTRUCTURED MESH OF NACA 2412 AIRFOIL FOR MULTI ELEMENT WING.

RESULTS AND DISCUSSION

A.Validation of Naca 2412:

For the meshed geometry of NACA 2412 2D model a comparison between k-ω SST and k-ε turbulence models was done to find out a suitable turbulence model from the experiment as shown in table 1. The result obtained indicated that k-ω SST was the most suitable turbulence model that gave values which were in close resemblance with that of the experimental results.

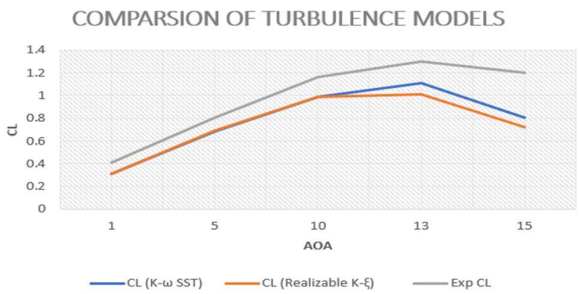

FIGURE 5: VALIDATION GRAPH FOR NACA 2412.

AOA	C_l (k-ω SST)	C_l (k-ε)	Experimental
1	0.3508	0.318	0.4124
5	0.7143	0.6938	0.7991
10	1.112	0.9857	1.1752
15	1.210	1.013	1.320

TABLE 1: COMPUTATIONAL RESULT VS EXPERIMENTAL RESULT.

A. Variation of Lift Coefficient with Aoa for Naca 2412 Single and Multi Element Air foil.

1st Element – NACA 2412	
AOA	**Lift Co-efficient**
4	-0.7392
6	-0.9516
8	-1.1047
10	-1.2144
11	-1.2784
12	-1.2591

2nd Element-NACA 2412	
AOA	**Lift-Coefficient**
13	-1.415
15	-1.466
17	-1.547
18	-1.505

TABLE 2: SHOWS THE COMPUTATIONA; RESULTS OF ONE ELEMENT WING AND TWO ELEMENT WING.

RESULTS

The figure 6(a) with End plates shows lesser pressure force acting on the wheel compared to figure 6(b) without End plates which results in reduction in drag because the end plates diverts the air away from the wheel.

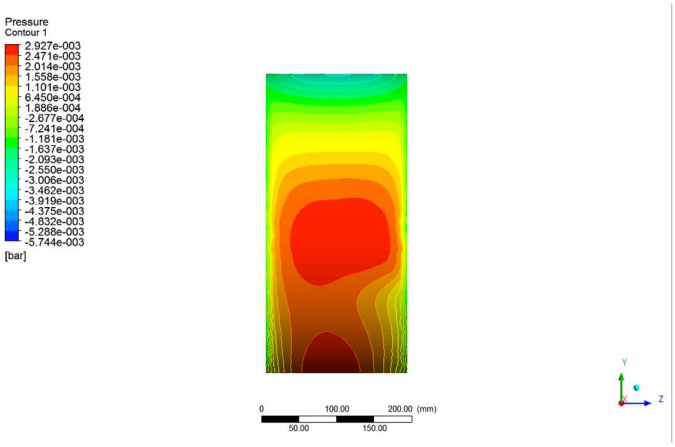

FIGURE 6(a): PRESSURE CONTOUR PLOT WITH END PLATES.

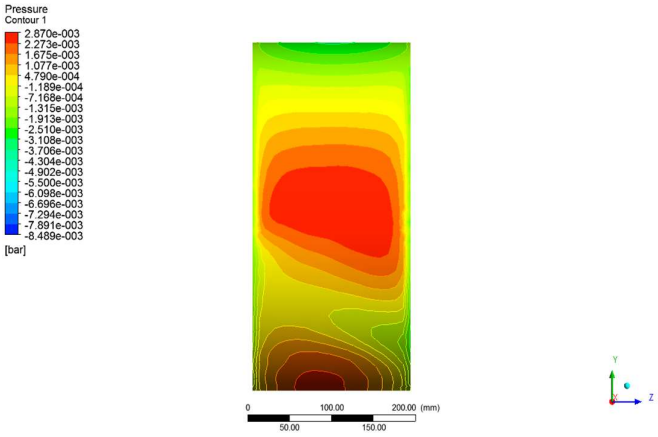

FIGURE 6(b): PRESSURE CONTOUR PLOT WITHOUT END PLATES.

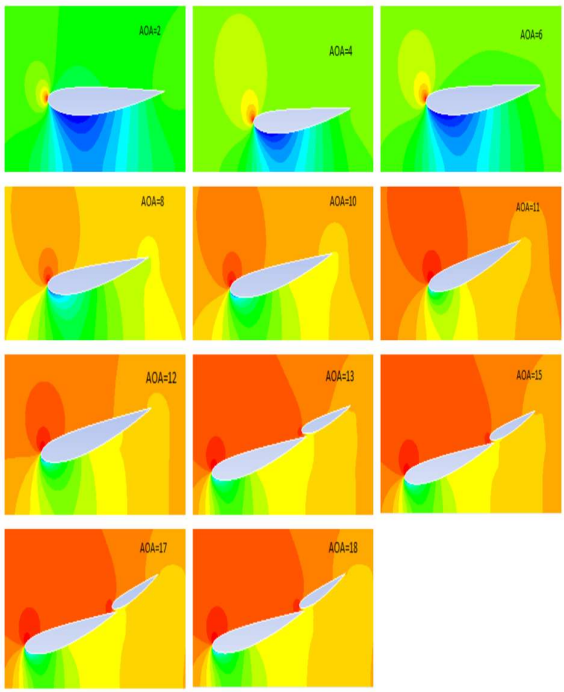

FIGURE 7: SHOWS PRESSURE DISTRIBUTION OVER THE DIFFERENT AIRFOIL MODELS FOR DIFFERENT AOA FROM 2^0 TO 18^0.

REFERENCES

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