Experimental Investigation of Aerodynamic Behavior of a Flat Plate with Tapered Edges

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Abstract— An aerodynamic analysis has been done in this experimental investigation on a flat plate with tapered edges. Experiments were carried out in a low speed wind tunnel which is open circuit type and the experimental data was collected at different Reynolds number. All the experiments have been done on the flat plate under the influence of angle of attack and Reynolds number. Flat plate has been tested from 0o to 180o angle of attack increasing 30o in each step and at four different Reynolds numbers and at positive and negative inclination of edges. The coefficient of drag was calculated. It was also observed that the drag coefficients get increased with increase of Reynolds number, and also increases with angle of attack up to certain limit. The maximum value of drag coefficient is observed at 1200 angle of attack and maximum value of drag coefficient is observed as 0.38 at negative edges of inclination.

Key words: Flat Plate, Tapered Edges

I. INTRODUCTION

Air is considered as the working media in the aerodynamic science when it passes through any object. National Advisory Committee of Aeronautics (NACA) contributes a lot in the field aerodynamics. Sir Isaac Newton was considered as the first aero dynamist of modern world because of his famous publication Principia. Sir George Cayley gave four fundamental of flight of any object i.e. lift, weight, drag and thrust. Wright brothers got success in their experiments and made first flight for human race. Now a day low Reynolds number applications are widely used in aerodynamics which has wide application in the field of aerospace, civil and military engineering. All the objects when travels through the air have to handle the aerodynamic forces (Lift and Drag). In recent years many experiments has been done to enhance the aerodynamic performance of the objects. Aerodynamic characteristics are mainly dependent on three factors, first is angle of attack second is Reynolds number and third is the geometry of object.

II. EXPERIMENTAL SET-UP

The present experimental work has been done with the help of an open circuit, suction type, sub sonic wind tunnel which has capacity of maximum velocity of 40 m/s. The flow of air is generated by a single stage axial flow fan which has suitable mechanism to make variation in the velocity of air. Wind tunnel has test section of dimension (LBH) 900mm x 300mm x 300mm. Test section has suitable mechanism to hold the test specimen (flat plate). Wind tunnel has honey comb structure with MS screen to correcting the flow of air. Honey-comb structure is used to generate laminar flow. Contraction zone is provided in the wind tunnel after honey-comb structure to accelerate the flow. Flow of air is discharged in the test section through this contraction zone. Load cell system (strain gauge meter) is provided in the test section which has digital meter to show the coefficient of drag. Wind tunnel which is used for this purpose is shown in figure.

Fig. 1: Wind Tunnel

III. THE TEST MODEL

A. (Flat Plate with tapered edges)

The test model which is used here for the experimental purpose is a flat plate having the dimension of 200 mm (span). The flat plate is made up of wooden material with good surface finish and having its edges tapered. The test model is shown in figure below.

Fig. 2: Flat plate with tapered edges

For the measurement of the coefficient of drag the load cell system is used and provided below the test section of wind tunnel and attached with the holding mechanism of the test section, on which the test model should have to be mounted. A round protractor is provided to set the desired angle of attack for the airfoil. Figure number three and four gives the idea about the tapered edges of the flat plate. We find out the coefficient of lift at both the positions.

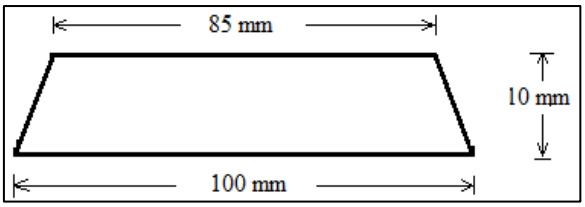

Fig. 3: Positive inclination of edges

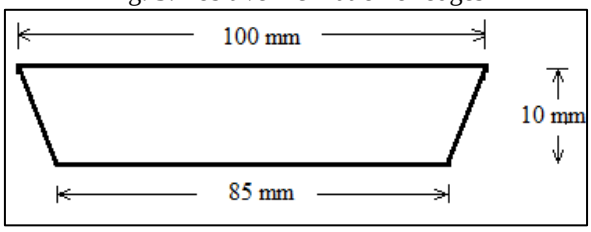

Fig. 4: Negative inclination of edges

IV. RESULTS

The drag coefficient at both the conditions (Positive and negative inclination) and been discussed here. There is a large difference has been observed in drag coefficient at both the conditions. The graphs have been plotted between the angle of attack and the drag coefficient and the variation has been observed.

The difference between the drag coefficients due to inclination of its edges is now shown in figures given below.

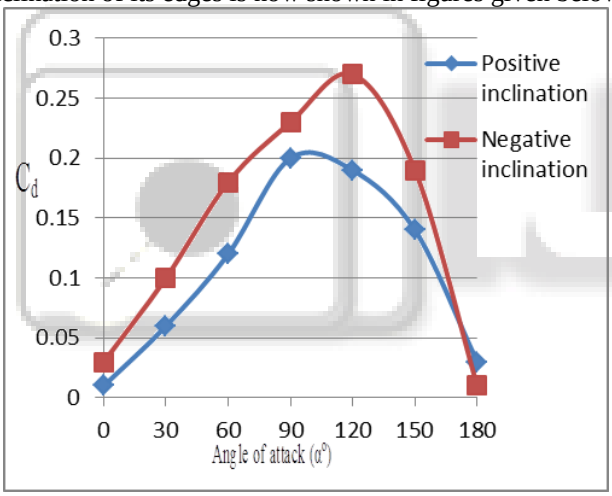

Fig. 5: Drag coefficients at 15m/s.

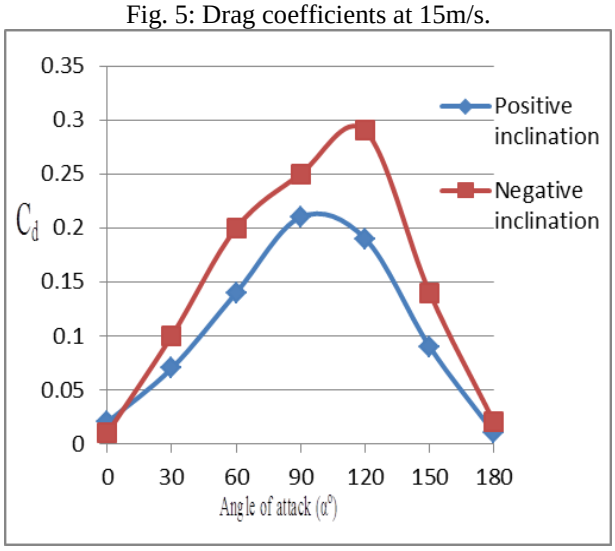

Fig. 6: Drag coefficients at 20 m/s.

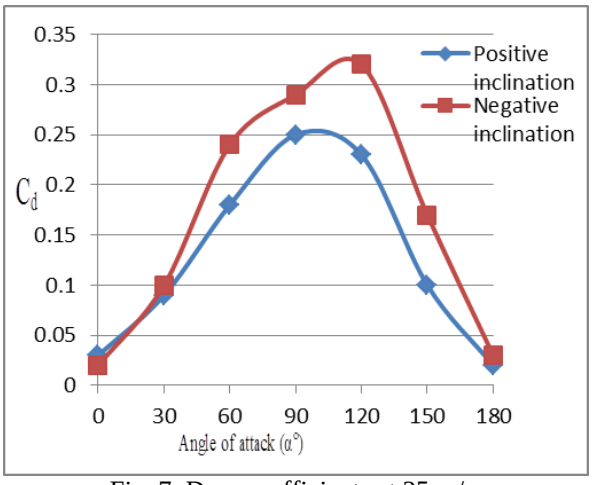

Fig. 7: Drag coefficients at 25 m/s.

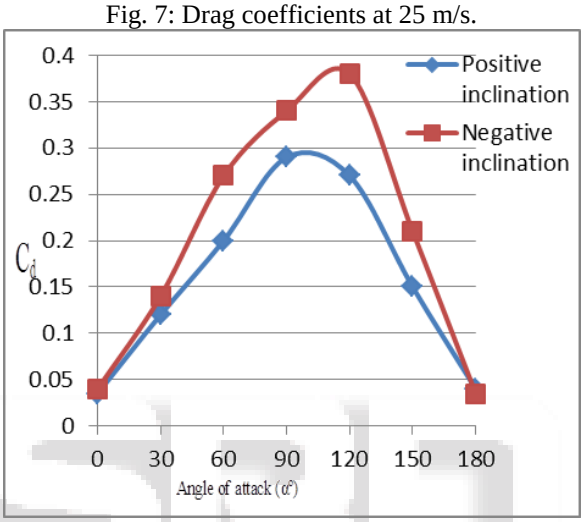

Fig. 8: Drag coefficients at 30 m/s.

V. CONCLUSION

Experiment has been concluded that the geometry of the flat plate also have impact on its aerodynamic behavior. The inclination of its edges varies the coefficient of drag. The maximum value of drag coefficient has been occurred at velocity of 30 m/s. and at 120^0 angle of attack at negative inclination of tapered edges. Drag coefficient is increased with increasing of attack angle and velocity of flowing air.

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