VISUALIZATION OF FLOW FIELDS ABOUT AN AIRFOIL WITH A GURNEY FLAP

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KEYWORDS:
Main subjects: Gurney flap, aerodynamic characteristics, flow visualization
Fluid: incompressible flows
Visualization method(s): tuft method, smoke method
Other keywords: coefficients of lift, coefficients of drag, polar curves

ABSTRACT: The aim of this paper is to show effects of the Gurney flaps for aerodynamic characteristics of NACA4412 airfoil and visualization of the flow fields in wind-tunnel experiments. The Gurney flap is a high-lift device with a L shape beam attached at the trailing edge of the lower surface of a wing. It has been used for racing cars mainly in Formula 1 since 1970s, but the aerodynamic characteristics are not open to the public. The motivation of this research is to seek general usage of the Gurney flaps to wings not only in racing cars but also in airplanes, etc. In wind-tunnel experiments the flaps is 0, 2, 4, and 6% of the chord length in height, and Reynolds number is 6.5×10^5. Measurement condition is three-dimensional (3D) or quasi two-dimensional (2D), according to without or with side plates. In the former case, the stall angle increased as the mounted flap was higher. In the latter case the stall angle hardly increased, but coefficients of lift (C_L) increased than in the former case at same attack angle. In both cases, coefficients of drag (C_D) increased as the mounted flap was higher at same attack angle. Flow visualization by a tuft method (Fig.1) shows that the Gurney flap changes the flow direction to the lower surface side to obtain the lift force. Further it has been found that each family of polar curves for 2D or 3D measurements constitutes a curve like an envelope (Fig.2). By use of the "envelope", when the necessary value of C_L is given, the combination of an attack angle and a flap height with the lowest value of C_D can be obtained. As concluding remarks, usage of Gurney flaps is effective to get high coefficients of lift with small and light wings, or when C_D increases within tolerance level.

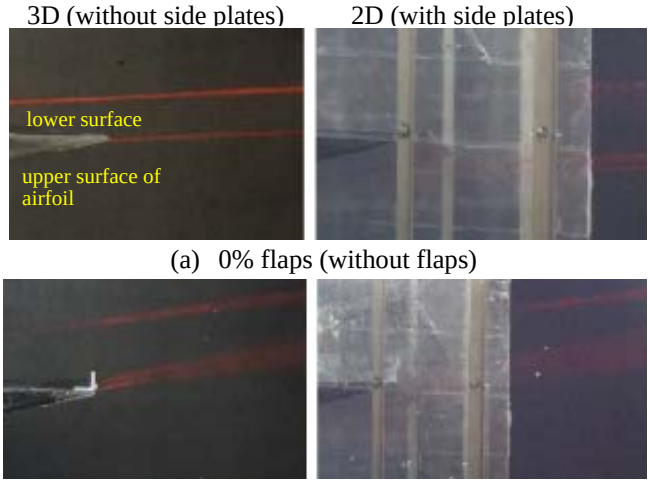

Fig.1 Visualization with red tufts at zero attack angle

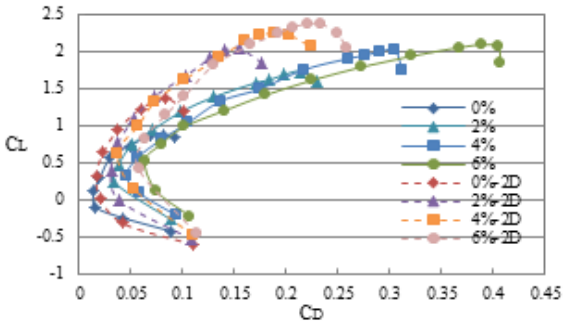

Fig.2 Polar curves

References

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