Reader's Forum

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Comment on "Computation of the Potential Flow over Airfoils with Cusped or Thin Trailing Edges"

H.N.V. Dutt*
National Aeronautical Laboratory, Bangalore, India

IN a recent paper, Ardonceau[1] developed a method for analysis of airfoils with cusped or thin trailing edges in inviscid incompressible flows using a method of singularities in a transformed plane. It has been stated that for thin and/or cusped formed trailing-edge airfoils, the surface singularity methods pose problems, especially near the trailing edge. This is demonstrated in Ref. 1 by computing pressures over a NACA 65012 airfoil at a 10 deg incidence where the pressure distribution exhibits an unrealistic loop near the trailing edge.

It is the purpose of this comment to point out that the surface singularity methods, indeed, pose no such problems and work very well for cusped and/or thin trailing-edge airfoils also. It is difficult to determine from the references cited in Ardonceau's paper which particular surface source/vortex code is used in the example presented. Surface vortex methods are well documented, however, in Refs. 2 and 3. These methods are based on the use of a linearly varying vortex distribution on flat panels to compute the inviscid pressure distribution on single or multielement airfoils. In Ref. 3, linearly varying sources are used to simulate the effects of boundary layer.

We note that the influence of a top trailing-edge panel on any top surface panel behaves in the limit like $\frac{1}{4}\pi$, and that of the bottom trailing-edge panel on any top surface panel behaves like $-\frac{1}{4}\pi$. Once this limiting behavior is properly taken into account, the surface vortex method poses no problems at a cusped or thin trailing edge. This method has been tested on a large number of single and multicomponent airfoils with no problems of any kind. The results of computation of pressure distribution for the NACA 65012 airfoil are shown in Fig. 1. Figure 1 also illustrates the pressure distribution on the same airfoil at 10 deg incidence using the method of Ref. 4, which is a conformal mapping method. It can be observed that the peaks are very well predicted and thin trailing edge does not pose any difficulty for the surface vortex method. Also, the lift coefficient predicted by the surface vortex method is 1.185, which is very comparable to the lift coefficient of 1.188 given by the method of Ref. 4. In addition, lift was invariant when the number of panels increased from 60 to 80 and 100. Another important point to be noted here is that the surface vortex method used in this Comment produces a drag coeffi-

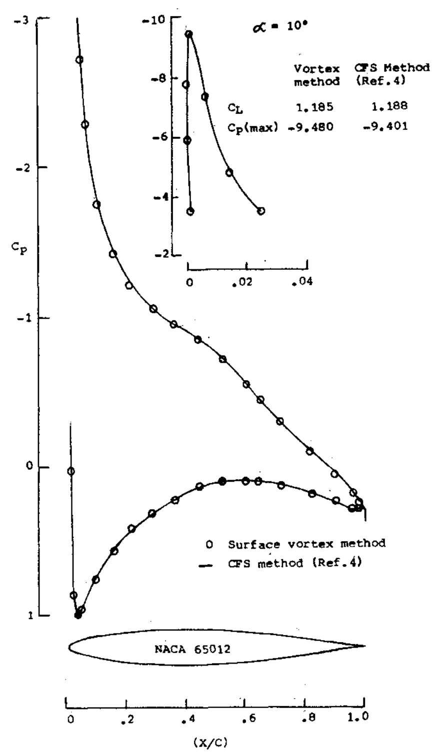

Fig. 1 Pressure distribution over NACA 65012 airfoil, wing surface vortex method, 10 deg incidence.

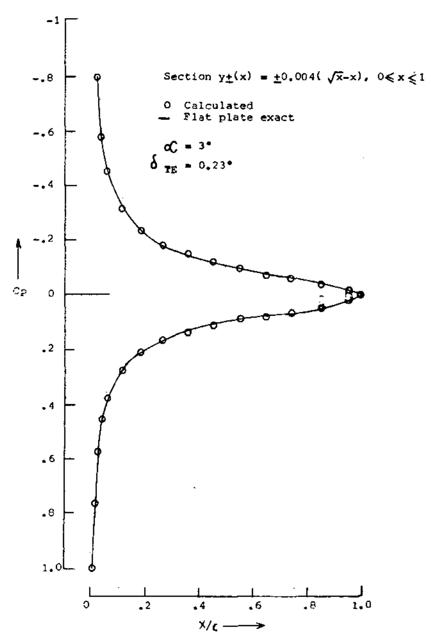

Fig. 2 Extremely thin airfoil section: Comparison between surface vortex method and exact solution for a flat plate.

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*Scientist, Aerodynamics Division.

cient of 0.002, which is much closer to zero than the value of $cx = -0.0067$ presented in Ref. 1.

To demonstrate the capability of the surface vortex method used here, Fig. 2 presents the results of a 0.2% thick airfoil at 3 deg incidence compared with flat plate solutions. The current results are indistinguishable from those of flat plate solutions.

References

[1]Ardonceau, P.L., "Computation of Potential Flow over Airfoils with Cusped or Thin Trailing Edges," *AIAA Journal,* Vol. 24, Aug. 1986, pp. 1375–1377.

[2]Mokry, M., "Calculation of the Potential Flow past Multi-Component Airfoils Using a Vortex Panel Method in the Complex Plane," NRC, Canada, NAE LR-596, Nov. 1978.

[3]Dutt, H.N.V. and Sreekanth, A.K., "A Theoretical Method for the Analysis of Airfoils in Viscous Flows," *Journal of Aircraft,* Vol. 17, Sept. 1980.

[4]Catherall, D., Foster, D.N., and Sells, C.C.L., "Two-Dimensional Incompressible Flow past a Lifting Aerofoil," RAE Tech. Rept. 69118, 1969.