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COMPUTATION OF TRANSONIC VISCOUS FLOW PAST THE NTF 65-DEGREE DELTA WING

by

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Abstract

This project is a continuation of the work performed in the summers of 1991 and 1992, during which a 9-block structured grid for the computational domain around each of the four NTF 65-degree Delta Wing models with the sting mount were created. The objective of the project is to validate and supplement the test data on the wing models by computing the viscous flow field about the models.

The CFL3D code, which solves the full Navier-Stokes equations with an implicit upwind finite-volume scheme, has been employed to perform the viscous flow simulation. Preliminary solution to the small radius-leading edge wing model has been obtained for the following transonic cases, all at a Reynold's number of 9×10^6:

Mach	Angle of Attack	Turbulence Model	Lift Coeff	Drag Coeff
0.85	12°	(Laminar)	0.530	0.109
0.8	6°	(Laminar)	0.257	0.026
0.8	6°	Baldwin-Lomax	0.242	0.022

Results of a typical case are presented in Figures 1 to 3. In this case, separation occurs along the leading edges and a pair of primary vortices are formed on the upper surface. Streamlines and pressure variation in the vortices are depicted in Figure 1. Formation of a secondary and a tertiary vortex beneath each primary vortex is also predicted. In Figure 2, the pressure contours on both the upper and lower surfaces of the wing model and the sting joint are traced. The low pressure region along the leading edge on the upper surface also indicates the formation of the vortices.

The wing models were tested in the NTF 8-foot Transonic Wind Tunnel in summer of 1991, and spanwise pressure distribution were obtained for numerous test cases. Figure 3 shows fairly good agreement between the computed result and the experimental data for the present case. The numerical simulation is able to predict the general location and strength of the primary vortex, but does not quite match the sharp pressure gradient in the vortex as indicated by the experimental data. This discrepancy is also observed in all other cases computed. It is believed that this discrepancy can be eliminated by adding or redistributing more grid points near the location where the vortex occurs. This is being attempted.

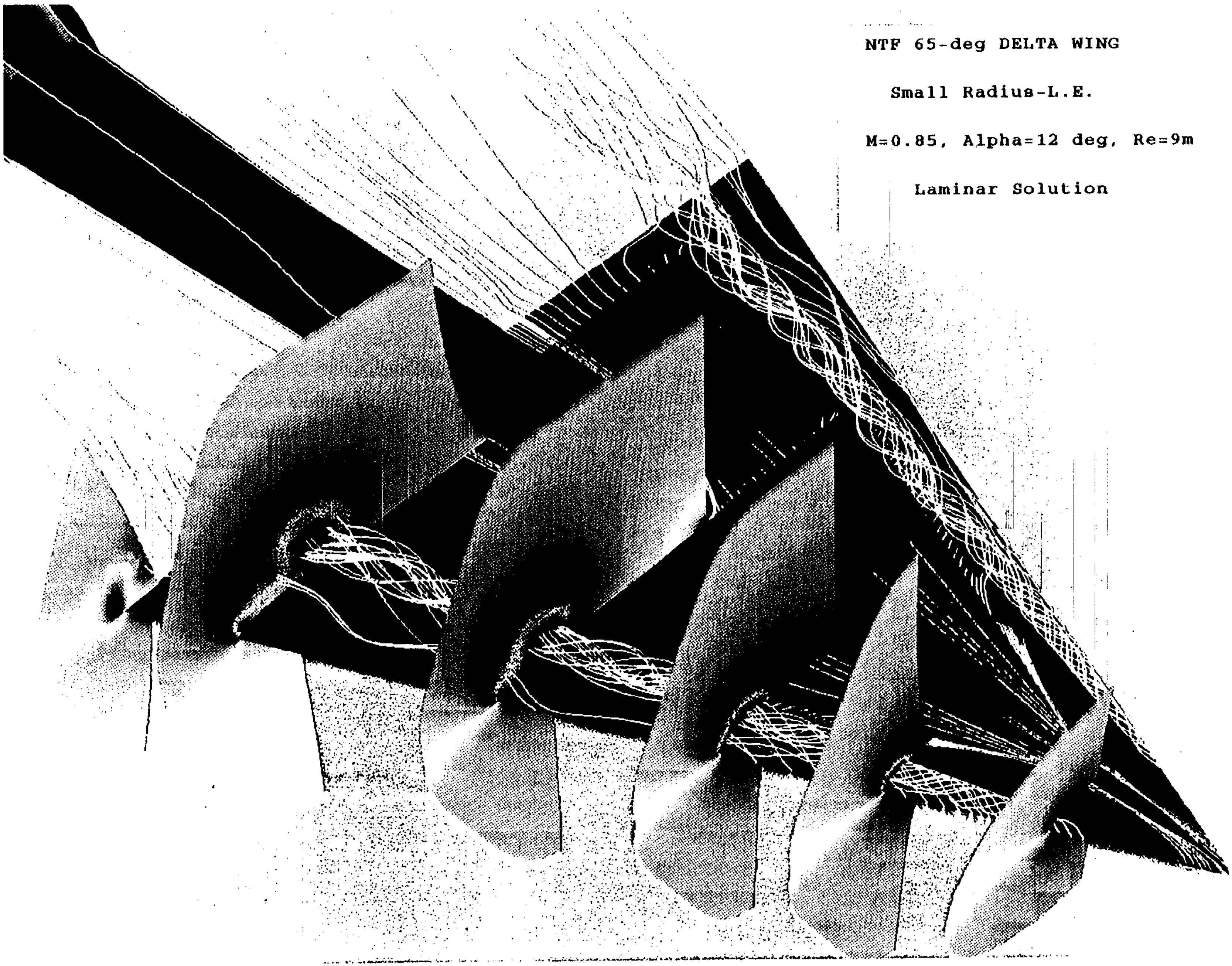

Fig. 1 Pressure Coefficient Contours and Line Trace in Vortex

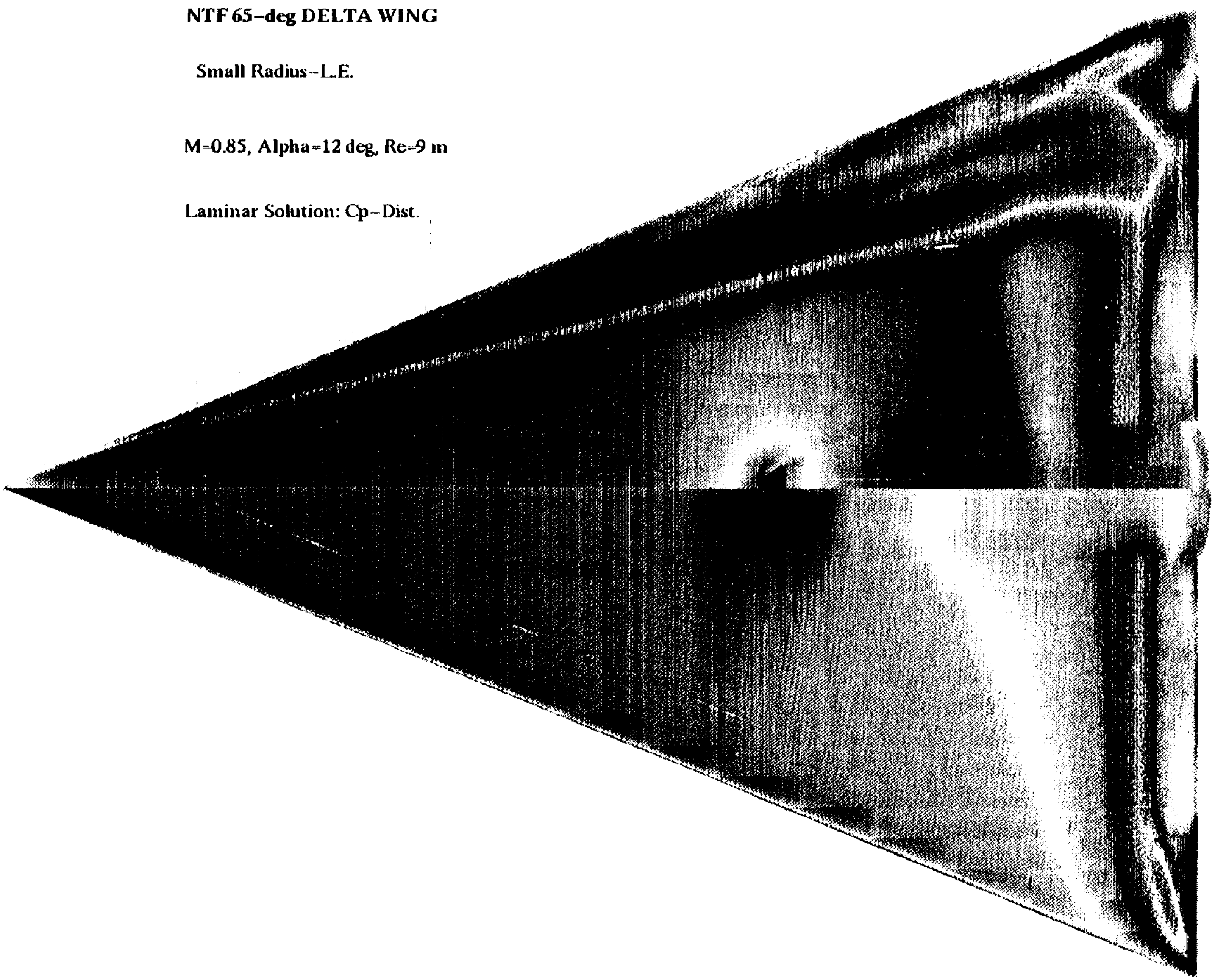

Fig 2. Pressure Coefficient Contours on Wing Surface

65° Delta Wing Spanwise Pressure Coefficients

Small Radius L.E.

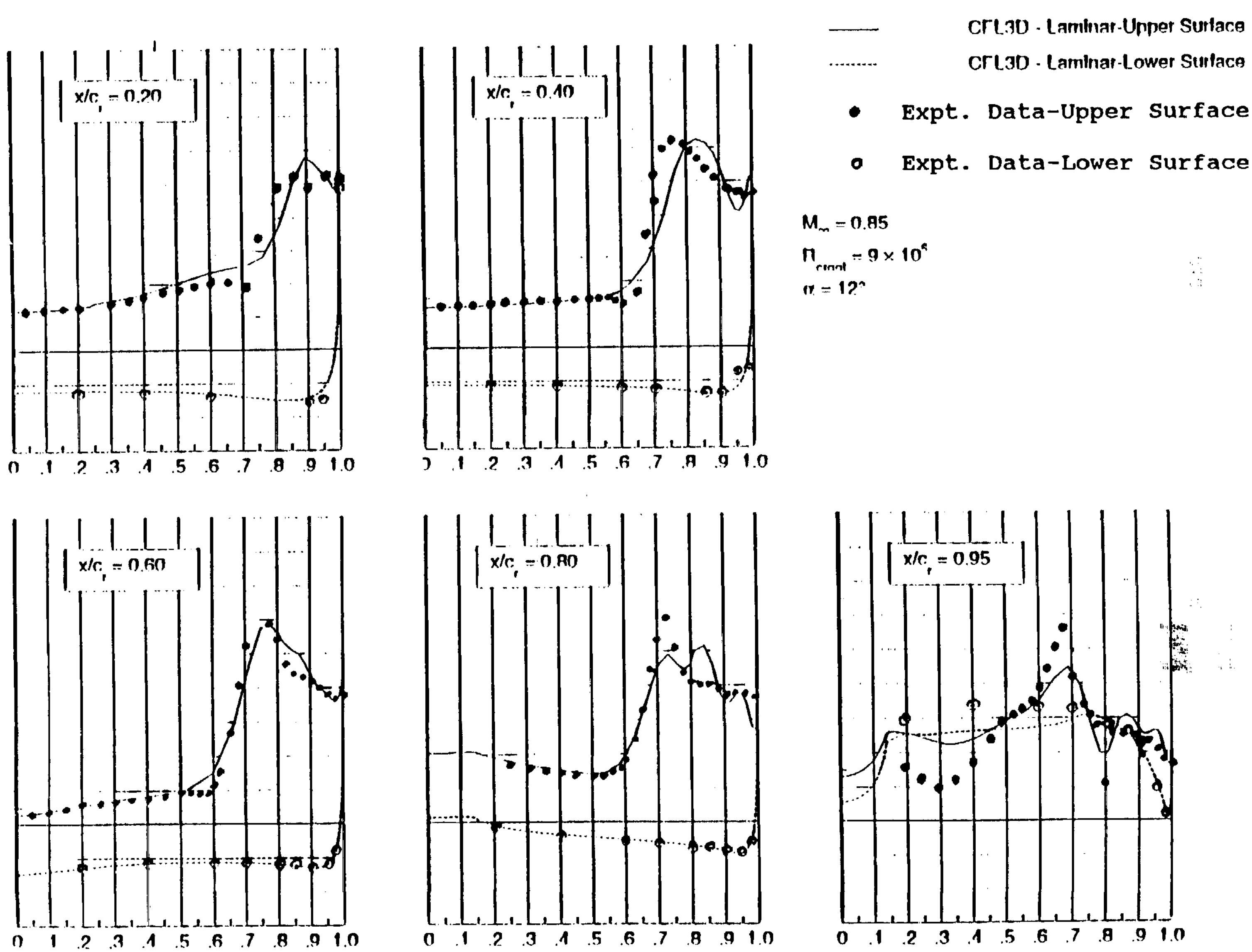

Fig 3. Comparision of Computed Cp-Distribution with NTF Data