NASA CR- 175,624

NASA-CR-175624
19850014056

Status Report on NASA Grant NAG 1-396

"Calculation of Vortex-Flap Aerodynamic Characteristics"

October 1, 1984 - March 31, 1985

by

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April 22, 1985

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The primary objective in this reporting period (October 1, 1984 to March 31, 1985) was the calculation of lateral-directional characteristics for configurations with vortex flaps. The calculation was done with the VORSTAB code (Ref. 1). The latter was also used by Grantz in Reference 2. In view of the poor correlation between the VORSTAB results and data in Reference 2, it was decided to examine in detail the reasons behind the discrepancy. At first, it was found from the input data of Reference 2 that the leading edge shape used in the VORSTAB code was inconsistent with that for the NASA VLM-SA code. Secondly, the straight fuselage was described by only a few input points of largely different intervals and through the cubic spline interpolation. As a result, the interpolated shape was largely distorted. This was corrected by using straight-segment interpolation. Finally, one error in calculating the lateral-directional derivatives for configurations with leading-edge vortex flaps with or without deflections was discovered in the code. After these corrections, characteristics for Grantz configurations were re-calculated with results presented in Figs. 1 - 4. In Fig. 1, it is seen that C_L with undeflected vortex flap is underpredicted for this configuration. The same situation is true also for the NASA VLM-SA code (Ref. 2). In addition, data show that full effect of vortex bursting does not occur until at a higher angle of attack than that predicted by the theory. On the other hand, with the vortex flap deflected at 40 deg., the lift is over-predicted as shown in Fig. 3. It is possible that this may have been caused by the presence of forbody vortices.

The prediction of dihedral effect is now largely improved as shown in Figs 2 and 4. The original calculation by Grantz can be found on pages 138 and 140 of Reference 2.

In addition to calculating lateral-directional characteristics for configurations with vortex flaps, exercising the design concept of vortex flaps with two-level optimization for a $70^{o}/50^{o}$ cranked arrow wing has also been under way during this reporting period.

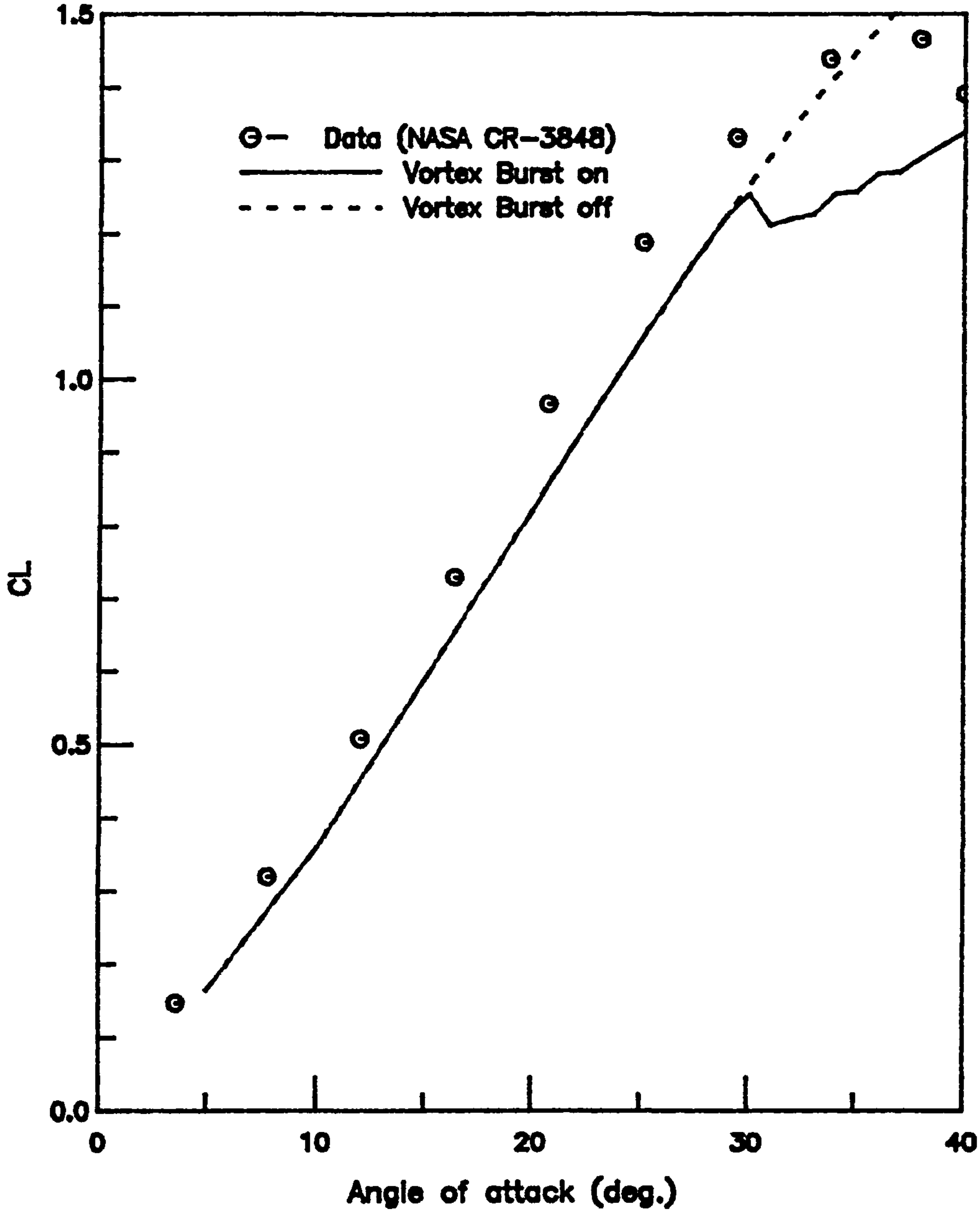
References

1. Lan, C. E., "VORSTAB-A Computer Program for Calculating Lateral-Directional Stability Derivatives with Vortex Flow Effect", NASA CR-172501, January 1985.

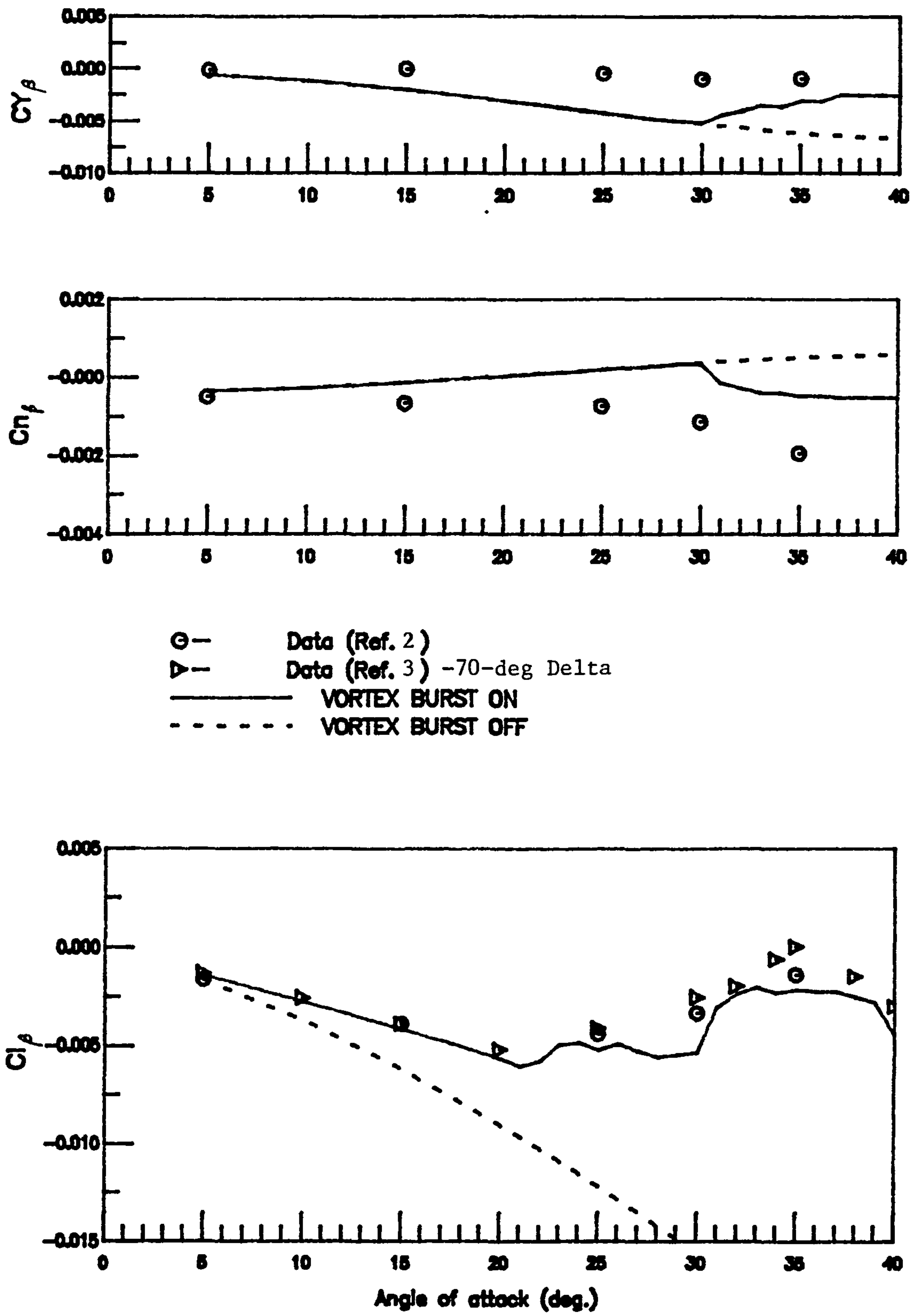
2. Grantz, A.C., "The Lateral-Directional Characteristics of a 74-Degree Delta Wing Employing Gothic Planform Vortex Flaps", NASA CR-3848, Nov. 1984.

References, Continued:

3. Johnson, J. L., Jr., Grafton, S.B. and Yip, L.P., "Exploratory Investigation of the Effects of Vortex Bursting on the High-Angle-of-Attack Lateral-Directional Stability Characteristics of Highly-Swept Wings", AIAA Paper 80-0463.

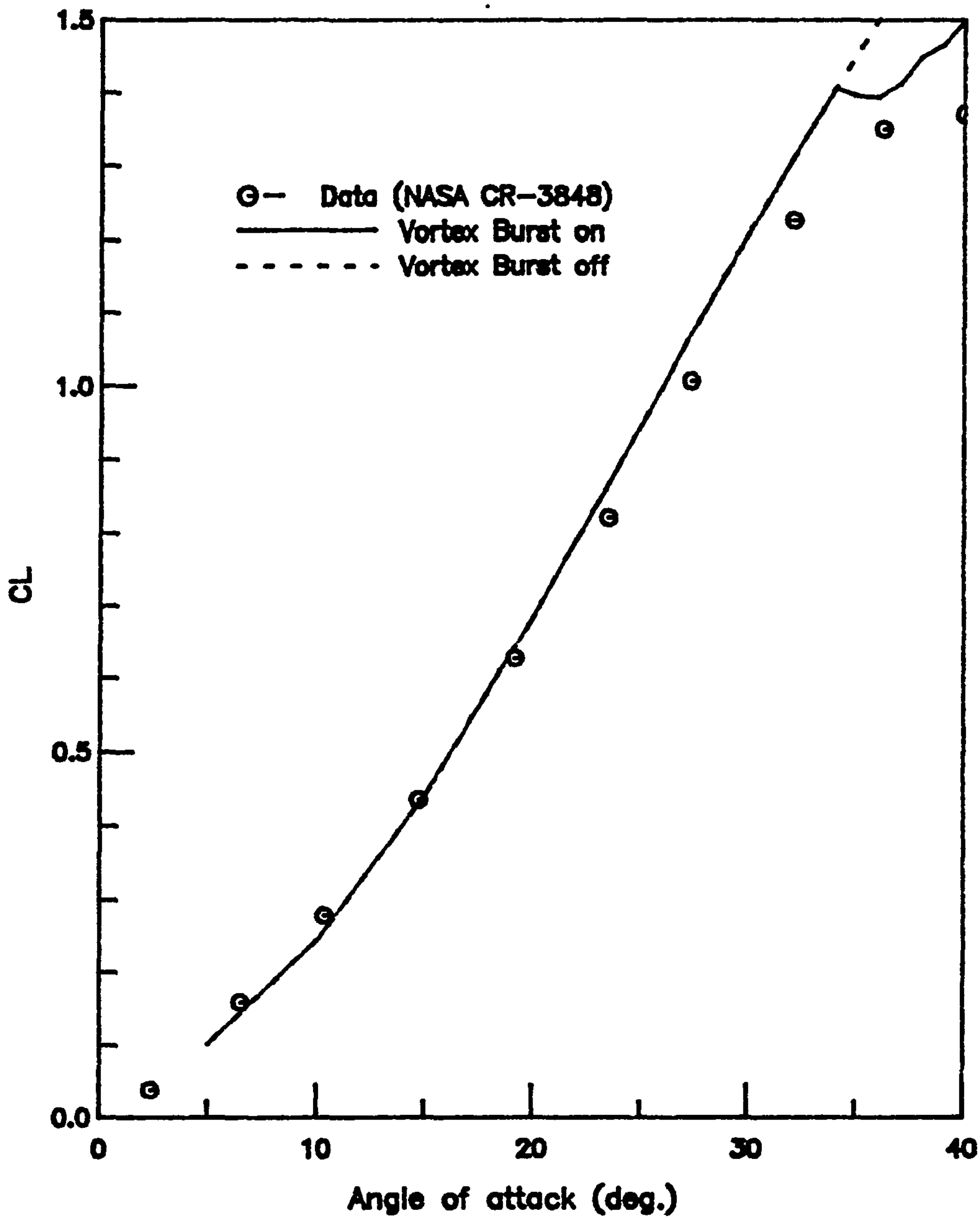


Fig—1 Comparison of theoretical and experimental longitudinal lift coefficients with $\delta_{LE}=0$.

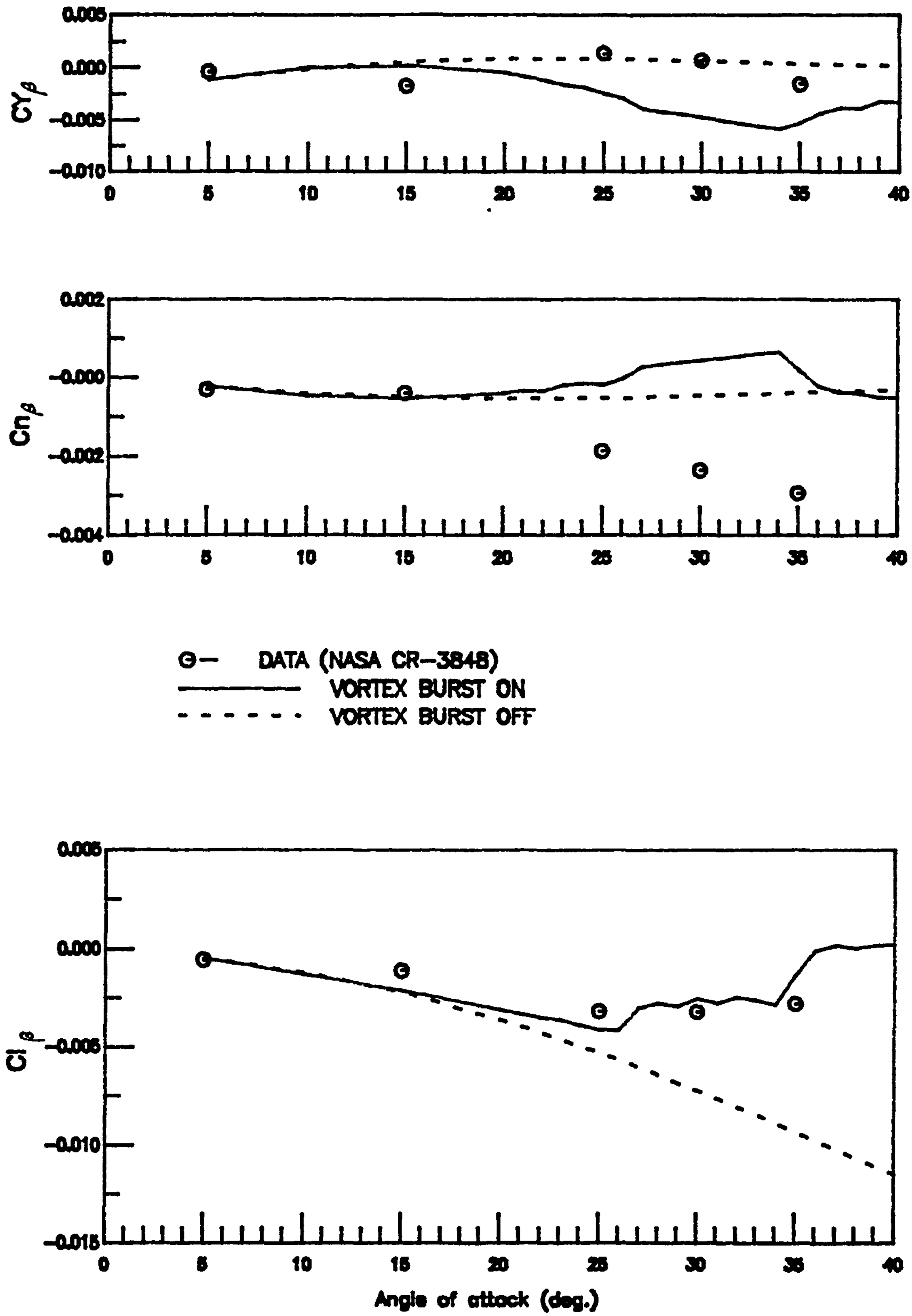


(a) Tail off

Fig—2 Comparison of theoretical and experimental lateral—directional stability characteristics with $\delta_{LE} = 0$.



Fig—3 Comparison of theoretical and experimental longitudinal lift coefficients with δ_{LE}=40.



(a) Tail off

Fig−4 Comparison of theoretical and experimental lateral−directional stability characteristics with δ_{LE} = 40.

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