as in Ref. 2, the new expression for $\Gamma^*$ would be

$$\Gamma^* = 0.15/\chi^{1/3} \tag{14}$$

While this new value of $Y_v$ substantially decreases the predicted vortex strength, Eq. (14) still overestimates the vortex strength by a factor of more than two. One further source of error may lie in the value chosen for $Z_v$. This has been taken from Fig. 5 of Ref. 3, which implies that the vortices have the same $Z$-coordinate as the midpoint of the jet plume. The vortices might actually lie below the line, which would require a smaller value of $Z_v$, and would further reduce the numerical constant in Eq. (14).

### Conclusions

It appears that Thompson's data cannot be used to conclusively prove or disprove the validity of the author's model, because most of it lies outside the range of applicability of the model. His statement that a form of similarity variables which differs from that used by the author destroys the self-consistency of the model does not seem to be correct. As far as the vortex zone of the jet is concerned, Thompson's data sheds little light on the question of correlations for different values of $\sigma_e$ due to the scarcity of points in this region, and to the possibility of wall effects influencing some of his data. Although some errors in the empirical constants of Ref. 2 have been corrected, the author's model still overpredicts the vortex strength by a factor of more than two. Further adjustment of empirical constants would require additional experimental information, such as vortex spacing and trajectory within the vortex zone of the jet plume.

### References

[1] Thompson, A. M., "Comment on 'Vortices Induced in a Jet by a Subsonic Crossflow,'" *AIAA Journal*, Vol. 10, No. 3, March 1972, to be published.

[2] Durando, N. A., "Vortices Induced in a Jet by a Subsonic Crossflow," *AIAA Journal*, Vol. 9, No. 2, Feb. 1971, pp. 325–327.

[3] Pratte, B. D., and Baines, W. D., "Profiles of the Round Turbulent Jet in a Crossflow," *Journal of the Hydraulics Division, Proceedings of the ASCE*, Nov., 1967, pp. 53–64.

[4] Keffer, J. F., and Baines, W. D., "The Round Turbulent Jet in a Crosswind," *Journal of Fluid Mechanics*, 1963, Vol. 15, pp. 481–496.

# Comment on "A New Integral Calculation of Skin Friction on a Porous Plate"

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THE technique[1] of using a double-integral variation of the Kármán-Pohlhausen method was published by Whitehead[2] in 1949. The technique was applied to the case of the laminar boundary layer on an impervious surface and in a pressure gradient.

### References

[1] Zien, T.-F., "A New Integral Calculation of Skin Friction on a Porous Plate," *AIAA Journal*, Vol. 9, No. 7, July 1971, pp. 1423–1425.

[2] Whitehead, L. G., "An Integral Relationship for Boundary Layer Flow," *Aircraft Engineering*, Vol. 21, 1949, pp. 14–16.

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# Reply by Author to P. S. Granville

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THE author wishes to thank P. S. Granville for his interest and for bringing Whitehead's work[1] to the author's attention.

As Granville correctly pointed out, the idea of using double-integration had indeed appeared earlier in Ref. 1. However, it should be noted that Volkov's technique,[2] which was directly generalized in Ref. 3 to allow for surface mass transfer, was based on a somewhat different use of the idea. Particularly, the determination of skin friction in Ref. 2 differs from that in Ref. 1.

### References

[1] Whitehead, L. G., "An Integral Relationship for Boundary Layer Flow," *Aircraft Engineering*, Vol. 21, 1949, pp. 14–16.

[2] Volkov, V. N., "A Refinement of the Kármán-Pohlhausen Integral Method in Boundary Layer Theory," *Inzhenerno-Fizicheskii Zhurnal*, Vol. 9, No. 5, 1965, pp. 583–588; English translation, *Journal of Engineering Physics*, Vol. 9, No. 5, pp. 371–374.

[3] Zien, T.-F., "A New Integral Calculation of Skin Friction on a Porous Plate," *AIAA Journal*, Vol. 9, No. 7, July 1971, pp. 1423–1425.

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# Comment on "Large Deflection Analysis of Plates"

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IN his recent paper,[1] Yang in common with other workers[2] in the field of large deflections has used Levy's results[3] for a simply-supported square plate under uniform pressure as a standard against which the accuracy of his own finite element results may be assessed. In Ref. 4, a similar but less extensive study than Yang's of the nonlinear behavior of plates, employing conforming triangular finite elements,[5,6] revealed that Levy's original data was not sufficiently accurate for comparison with results from high-precision finite elements; moreover the boundary conditions employed by Levy were not identical to the usual kinematic constraints of a displacement finite element model.

The effect of employing more terms ($n$) in the Fourier Series expansion of Levy is shown below in Table 1

**Table 1 Effect of additional terms on Levy's results**

| | Membrane $(\sigma/E)(1-\nu^2)\times 10^4$ | Bending $(\sigma/E)(1-\nu^2)\times 10^4$ | $(w/t)$ |
|---|---|---|---|
| 3 | 0.3865 | 0.3106 | 1.82444 |
| 5 | 0.3910 | 0.3624 | 1.84061 |
| 7 | 0.3901 | 0.3385 | 1.83681 |
| 9 | 0.3904 | 0.3505 | 1.83795 |
| 11 | 0.3903 | 0.3435 | 1.83750 |
| 13 | 0.3903 | 0.3478 | 1.83770 |
| Levy[3] | 0.392 | 0.384 | 1.846 |

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