

Reader's Forum

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Comment on "Computation of Unsteady Laminar Boundary Layers Subject to Traveling-Wave Freestream Fluctuations"

C. Y. Lam*

Nanyang Technological Institute
Nanyang Avenue, Singapore 2263

THE author of Ref. 1 has predicted the effects of traveling-wave oscillations on the response of laminar boundary layers. However, the author seemed to be unaware of the earlier publication of Lam² on the same subject using a differential-difference technique. In Ref. 1, it was stated that very little phase shift is expected when $Q/U_0 = 1.0$. This is inconsistent with the results shown in Fig. 3 in which the phase angle for $Q/U_0 = 1.0$ is about -33° at the wall and increases gradually away from the wall. Figure 3 also shows overshoot of the velocity-amplitude ratio for $Q/U_0 = 1.0$ of about 1.1. This is doubtful as one would expect that it should increase monotonically away from the wall to meet the freestream condition since the external pressure gradient driving the boundary layer vanishes in this case, as stated in Lam.²

The computed results for $Q/U_0 = 0.77$ were compared with the measurements of Patel³ in Fig. 2 of Ref. 1. The phase angle

for $\bar{\omega} = 0.314$ in Fig. 2 may seem to agree well with the measurements. For higher $\bar{\omega}$, though direct comparisons were not presented, it can be seen by interpolation of the wall-shear phase angle in Fig. 4 of Ref. 1 that the phase angles are in poor agreement with the measurements given in Table 1 of Ref. 3.

Recent experimental evidence² using the same experimental facilities as used by Patel confirmed that $Q/U_0 \approx 0.61$, not 0.77 as quoted in Patel.³ This has a drastic effect as it was demonstrated in Lam² that the boundary layer response is highly sensitive to changes of Q/U_0 when $Q/U_0 < 1.0$. Consequently, the use of $Q/U_0 = 0.61$ in Lam² has resulted in excellent agreement of the calculated results for both amplitude ratio and phase angle with Patel's measurements for a full range of oscillation frequencies. It is suggested that $Q/U_0 \approx 0.61$ should be used in computation in order to compare results with Patel's measurements.

References

- ¹Evans, R. L., "Computation of Unsteady Laminar Boundary Layers Subject to Traveling-Wave Freestream Fluctuations," *AIAA Journal*, Vol. 27, Nov. 1989, pp. 1644-1646.
- ²Lam, C. Y., "Calculation of Laminar Boundary Layers Under Small Harmonic Progressive Oscillations of the Free Stream," *International Journal of Heat and Fluid Flow*, Vol. 9, No. 3, 1988, pp. 321-327.
- ³Patel, M. H., "On Laminar Boundary Layers in Oscillatory Flow," *Proceedings of the Royal Society of London*, Vol. 347A, 1975, pp. 99-123.