SYNOPTIC: Drag of Rectangular Cavities in Supersonic and Transonic Flow Including the Effects of Cavity Resonance, O. Wayne McGregor, Fort Worth Division of General Dynamics, Fort Worth, Tex., and R. A. White, University of Illinois at Urbana-Champaign, Urbana, Ill.; *AIAA Journal*, Vol. 8, No. 11, pp. 1959–1964.

Fluid Mechanics; Jets, Wakes, and Viscid Flow Interactions

Theme

Presents the results of an experimental and supporting analytical investigation on the change in the drag characteristics of cavities spanned by turbulent shear layers and exhibiting self-induced pressure oscillations (often termed resonance). The effect of pressure oscillations within the cavity is shown to increase the drag as much as 250%.

Content

The drag of relatively short rectangular cavities (length-to-depth ratios of 0.50–3.0) with turbulent shear layer has been measured at transonic and supersonic Mach numbers (0.30–3.0). Pressure oscillations within the cavity were found to occur over the entire Mach number range investigated and other work has shown it to occur at both lower and higher Mach numbers. The existence of these pressure oscillations was found to be directly correlated to increases in cavity drag.

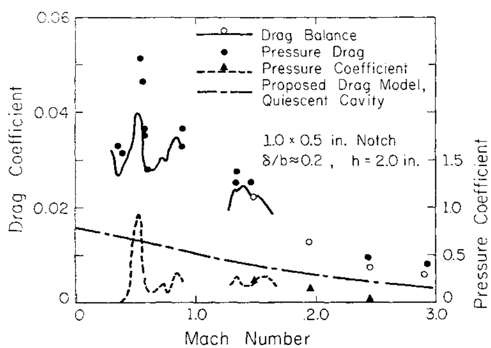

Fig. 1 Drag and pressure oscillation amplitude data for a typical rectangular notch.

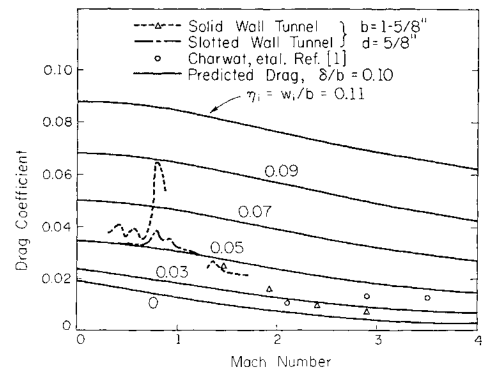

Fig. 2 Parametric description of effect of resonance on cavity drag with comparison to experimental data.

This is clearly shown in Fig. 1 where both the drag coefficient and the cavity pressure coefficient are seen to increase or decrease simultaneously.

The effects of external reinforcement of resonance by reflection of radiated pressure waves are examined both experimentally and analytically. The experiments are in good agreement with the results of the analytical model and allow the effects of reinforcement to be separated from the self-induced portion. The wind tunnel size to cavity size necessary for negligible reinforcement is also presented.

Existing methods for predicting cavity drag are inadequate to cope with the resonance phenomena. A new model for predicting the lower bound of cavity drag (nonresonating cavity) is presented. This model is also used to predict the qualitative effect of resonance on cavity drag. Typical results are shown in Fig. 2.