UNSTEADY SURFACE PRESSURE INDUCED BY TURBULENCE OVER ASYMMETRICALLY BEVELED TRAILING EDGE

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Turbulence convecting over the trailing edge of a lifting surface results in surface pressure fluctuations, which is the dominating source for aerodynamic sound in low Mach number flow. The characteristics of the unsteady surface pressure (USP) are highly dependent on the flow patterns near the trailing edge. In present study, the characteristics of unsteady surface pressure induced by turbulent flow over a family of asymmetrically beveled trailing edges were studied experimentally. The geometries had a trailing-edge angle $\theta = 25^\circ$ with a flat lower surface and a rounded upper surface with radii of curvature between 1 and 6 times the airfoil thickness. The chord-based Reynolds number was $Re = 2.1 \times 10^6$.

A detailed description of the USP and flow fields around the trailing edge section was obtained by remote microphone probes (RMP) and particle image velocimetry (PIV), respectively. The beveled upper surface was characterized by a region of favorable pressure gradient, followed by strong adverse pressure gradient. The cases with smaller radius of curvature were found to exhibit larger separated region over the trailing edge. The spectral magnitudes of USP were largest in separation region. This paper is focused on scaling and understanding the USP spectra in regions of separated flow. The PIV measurements were utilized to provide the corresponding length and velocity scales.

The characteristics of the upper-surface unsteady pressure field were complex because of the strong non-equilibrium flow conditions. The characteristics of the pressure fluctuations under separated flow showed great variety and were dominated by various flow regimes in different frequency ranges. The spectral magnitude of the low-frequency USP under separated shear layer were dominated by the turbulence intensity in the local shear layer, but the frequency of the large-scale oscillations was governed by the turbulent wake. The mid-frequency range of the pressure fluctuations were dominated by the characteristics of local shear layer. The high-frequency content of the pressure fluctuations under separated shear layer with reverse flow was dominated by upstream-convecting turbulence created by reverse flow. The magnitude of the reverse flow-induced pressure fluctuations increased with faster negative phase speed.

![Figure 1](image-url)  
Figure 1. Static pressure distribution over the upper surface of the trailing edge section of the airfoil and contour of streamwise RMS velocity obtained by PIV. —, mean velocity profile; •, RMS velocity profile.