Secondary instabilities on streaks in an asymptotic suction boundary layer

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Secondary instabilities are studied on a low speed streak developing in an asymptotic suction boundary layer. This unique boundary layer of constant boundary layer thickness was created by applying uniform suction through a porous plate of about 2 m^2. The low speed streaks were generated by using cylindrical roughness elements of varying diameters, d = 2, 3.5, 5, and 6.5 mm, to obtain different streak widths. Furthermore, the free stream velocity was changed, $U_\infty = (1,\ 0.95,\ 0.90)U^*$, in order to vary the maximum amplitude of the streaks. The secondary instabilities, both varicose and sinuous, were generated by blowing and suction through a 1 mm diameter hole in the plate by means of a loudspeaker. The location of the hole, X_0, is at a distance of 1847 mm from the leading edge. By carefully adjusting the spanwise placement of the roughness element 4 diameters upstream of the hole, both varicose and sinuous modes could be excited (see figure 1). The amplitude distributions in the linear regime of continuously generated varicose and sinuous instabilities are shown in figure 2 (a) and (b), respectively. The maximum amplitude was observed for $f \simeq$ 89 Hz for both modes, but at different downstream positions.

Phase averaged smoke visualizations were performed for both the varicose and sinuous instabilities with varying forcing amplitudes, which will be shown at the presentation.

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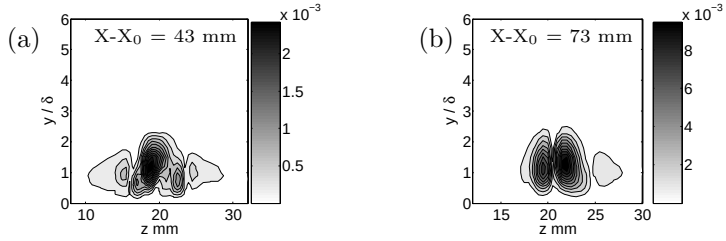

Figure 1: Contour plots of the disturbance amplitude normalized with U_∞ showing (a) varicose mode and (b) sinuous mode.

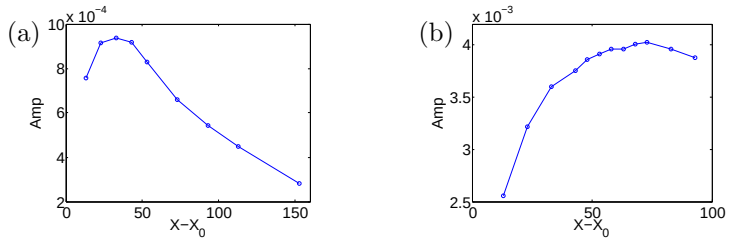

Figure 2: YZ plane integrated amplitude (Amp) distribution of the continuous waves for $d = 5.0$ mm and $U_\infty = 5$ m/s for (a) varicose mode and (b) sinuous mode.