Experimental Studies of Crossflow Transition

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Motivation:

Improved aerodynamics represents a significant source of aircraft efficiency savings. The influence of discrete roughness element height on stationary and travelling wave development in a moderate freestream turbulence wind tunnel is being explored.

Research:

Naphthalene surface flow visualisation is used to ascertain the wavelength of the stationary crossflow mode as well as where transition occurs. In the figure shown the flow is from left- to right and the red lines denote chordwise position; it shows a streaky pattern due to the stationary crossflow, and that transition is somewhere between 45-50% chord.

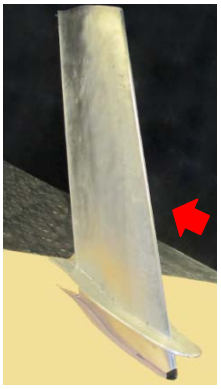

Fig. 40-degree swept wing

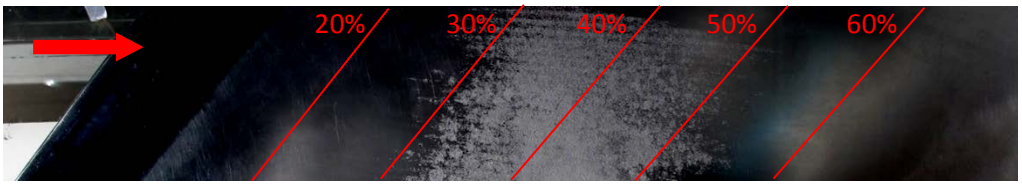

Fig. Naphthalene flow visualisation

Hotwire measurments shown in the figure reveal the variation in mean velocity across several crossflow wavelengths. Spreading of the mean flow profiles is due to the stationary crossflow.

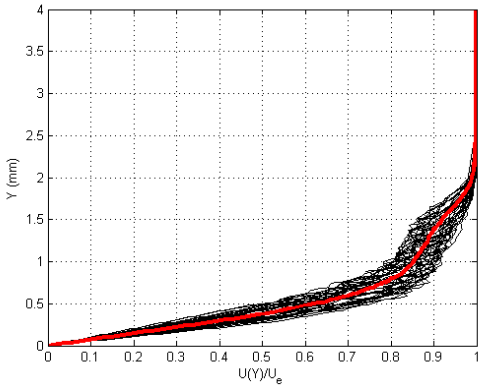

Fig. Mean velocity profiles at a 40% chord – black lines are at several spanwise locations, and the red line is the spanwise-average mean profile

Industrial application:

Experimental verification of the theoretical and numerical approaches being developed will provide needed reassurances for industrial use. These experiments are the first for many years here in the UK, and will contribute to the advancement of the UK Aerospace Sector.

Saeed, T. I., Morrison, J. F., and Mughal, M. S., "Roughness effects on swept-wing crossflow transition in moderate free-stream turbulence", in 29th International Congress of Aeronautical Science, St. Petersburg, Russia , 2014, ICAS-2014-0542.