UNIVERSITY OF SOUTHAMPTON

ABSTRACT

FACULTY OF ENGINEERING, SCIENCE & MATHEMATICS

SCHOOL OF ENGINEERING SCIENCES

Doctor of Philosophy

THE DEVELOPMENT OF PASSIVE FLOW CONTROL VORTICES

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Surface flow visualisation and Particle Image Velocimetry (PIV) were used to investigate the flow-field of sub-boundary layer vane vortex generators (VVGs) and steady jet vortex generators (SJVGs) in a separated flow at 20m/s. The vortex generators were mounted on a 2D bump which was situated on the floor of a 350mm by 250mm wind tunnel and had a separation zone on its trailing edge.

Surface flow visualisation was used to select VVG spacings and SJVG velocity ratios for effective separation control and investigate surface flow. Instantaneous and mean parameters downstream of the VVG and SJVG were measured non-intrusively using PIV. The instantaneous behaviour of the vortices was assessed using the coherence of a vortex and fluctuations in the location of instantaneous peak vorticity. Coherence is a parameter that was developed in the course of this research and had not been encountered in the literature at the time experiments ceased. The mean behaviour of the vortices was assessed using traditional variables, such as, mean peak vorticity and its location, diameter and circulation of the vortex. A flat plate VVG study was performed to allow direct comparisons with previous work to be made.

It was found that vortices generated by both VVGs and SJVGs were unsteady irrespective of geometry, became incoherent with downstream distance and had an exponential decay in mean peak vorticity. Surface flow visualisation indicated that for multiple VVG configurations the co-rotating configuration with a spacing of 3h effectively minimised separation on the 2D bump. For SJVGs, a velocity ratio of 1.0 was sufficient for separation control.