6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11 – 15 June 2018, Glasgow, UK

STEP-INDUCED TRANSITION IN COMPRESSIBLE FLOW: EXPERIMENTAL RESULTS AND CORRELATION WITH STABILITY ANALYSIS

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Key Words: *Step, Transition, Surface Imperfections, Boundary Layer, Laminar Wing.*

Practical laminar flow wing design requires joints, panels and high-lift devices, but steps and/or gaps would arise at the junctions [1] and can lead to premature transition to turbulence [2]. The effect of sharp forward-facing steps on boundary-layer transition was systematically investigated in this work in combination with the influence of variations in the following parameters: streamwise pressure gradient, Reynolds number, Mach number and wall temperature ratio [3]. The experiments were conducted in a quasi-two-dimensional flow at high Reynolds numbers and at both low and high subsonic Mach numbers in the Cryogenic Ludwieg-Tube Göttingen. As shown in Fig. 1a, transition, measured non-intrusively by means of temperature-sensitive paint, was found to move gradually upstream towards the step location with increasing step Reynolds number. The measured transition locations were also correlated with the results of linear local stability analysis for the smooth configuration (see Fig. 1b), following the procedure suggested in [4,5] to account for the effect of steps in the e^N method for transition prediction. Detailed results will be discussed in the final version of this contribution.

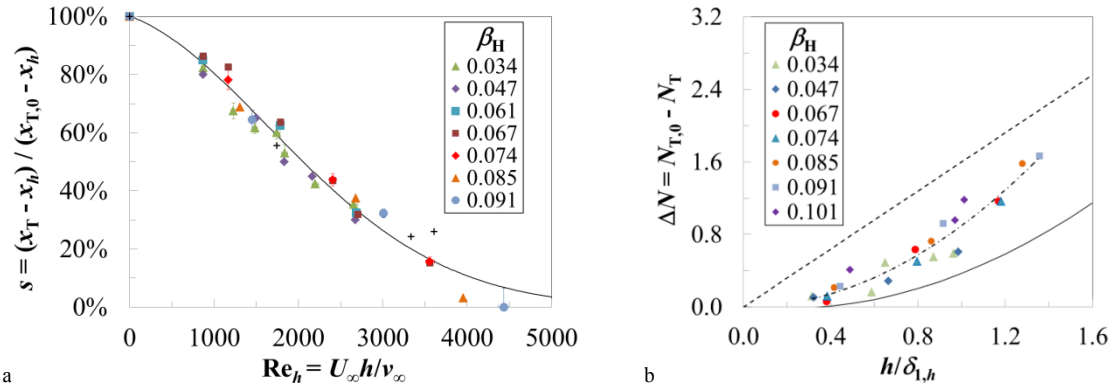

Fig. 1. Results obtained at a Mach number M = 0.65 and a wall temperature ratio T_w/T_{aw} = 1.037-1.057 [3]. β_H is the Hartree parameter characterizing the pressure gradient. a: relative change in transition location as a function of the step Reynolds number. x_T and $x_{T,0}$ are the transition locations measured with and without steps, respectively, and x_h is the step location. The function fitted to the experimental data is shown by a solid line. b: step-induced increment of amplification factors ΔN as a function of the step height relative to the boundary-layer displacement thickness. The dashed-dotted line shows the function fitted to the present data, whereas the solid and the dashed lines show the fitted functions from [4] and [5], respectively.

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