AERODYNAMIC OPTIMIZATION OF A TWO-DIMENSIONAL TWO-ELEMENT HIGH LIFT AIRFOIL WITH A SMART DROOP NOSE DEVICE

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To meet the requirements for future aircraft, deformable structures could be a key technology. In order to prove the applicability of such a smart droop nose device under representative loads, a wind tunnel experiment will be carried out in the Russian Tsagi T101 tunnel. The present study focuses on the aerodynamic design of such a new leading edge device which will also be used in the wind tunnel campaign afterwards. In a first step, only the shape of the flexible droop nose is optimized towards landing configuration. To account for the ill-posed initial flap setting which was adopted from a three-element wing, it is subsequently included into the optimization. For this set of landing optimizations, four different strain rates of the flexible nose panel are investigated to show the potential of current and future materials. Finally, the corresponding take off setting is derived assuming constant length of the droop nose. The involvement of the flap setting parameters shows a great benefit towards the formulated landing objective function especially at lower angle of attack. High strain rates indicate the potential of future materials with stretching capabilities. Advantageously, the take off setting has a very similar droop nose shape than the landing geometry but with a slightly reduced flap angle. The geometries derived in the present study are the target shapes for the before mentioned wind tunnel experiment.

Keywords Aerodynamics; High Lift; Optimization.

1. Introduction

The European project Smart High Lift Devices for Next Generation Wings (SADE) in the seventh framework programme of the European Union focuses on the application of flexible structures for future high lift systems. In order to meet the requirements of the ACARE group (2008) for the Vision-2020 (i.e. a significant reduction of noise and emissions), conventional flight systems must be improved. A determining technology for this goal could be laminar wing design (Streit, 2008), but laminar flows are difficult to achieve because of the high sensitivity for surface smoothness. This in turn has an impact on the design of the corresponding high lift system being a movable part with usually edges and crevices. A gapless and seamless leading edge device would therefore be favourable in order to avoid flow tripping. Conventional concepts like slats or droop noses do not meet the desired standards. An enabler for the needed technological system could be a smart droop nose that uses purely deformation to change the form from retracted to deflected configuration. Recently, the principle operating mode of such a system and its functionality could be shown numerically (Monner, 2009). The next consequent step will be to show the practicability under representative loads, i.e. wind tunnel conditions, which is addressed in the last year of the SADE project with an experiment in the Tsagi T101 tunnel. The aerodynamic design of a representative smart droop nose device is presented in this paper. The baseline for this investigation is a spanwise section of the FNG (*Flügel Neuer Generation*) next generation wing, depicted in Figure 1. This