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Aerodynamic Analysis of a Helicopter Fuselage with Rotating Rotor Head

Abstract

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Saving fuel and reducing emissions is of utmost importance for future aviation. The European Commission together with the European Aeronautical Industry launched the CleanSky Joint Technology Initiative. Within CleanSky environmental issues in the rotorcraft domain are addressed by the **G**reen **R**otorcraft **C**onsortium (**GRC**). The GRC subproject **ADHeRo** (**A**erodynamic **D**esign **O**ptimisation of a **He**licopter Fuselage including a **Ro**tating Rotor Head) deals with the aerodynamic investigation of a helicopter fuselage of a twin engine light transport helicopter configuration with regard to parasite drag reduction. The complete programme comprises wind tunnel tests and additional numerical analysis of a baseline configuration and its modified variants.

This paper presents results of the first phase of ADHeRo with a focus on the baseline wind tunnel campaign. The wind tunnel model (scale 1:5) includes fuselage with mast fairing, landing skids, and a rotating rotor head including the blade cuffs. The tailboom is truncated upstream the horizontal stabilizers (see Figure 1). Engine intake and outlet are closed by coverings adapted to the model geometry. The model consists of exchangeable components in order to facilitate quick modification and detailed drag decomposition. The modelled parts of the helicopter induce approximately 80 % of the total parasite drag thus forming a major potential for shape optimisations.

The experiments are carried out at the experimental facilities of the Institute of Aerodynamics and Fluid Mechanics of the Technische Universität München. The wind tunnel is of Göttingen type and during ADHeRo operated with an open test section. It allows for freestream velocities up to 65m/s yielding Reynolds numbers of about $1x10^6$. In the test section the model is mounted on a sting via the tailboom ensuring an undisturbed flowfield around the aft body (see Figure 2). During the measurement campaign a series of force, steady and unsteady pressure, stereo particle image velocimetry and hot wire measurements are performed. The study also improves the understanding of surface flow and wake field structures. In this context the region of the rear fuselage upsweep as well as the rotor head and mast fairing are of special interest. The experimental investigations are accompanied by **U**nsteady **R**eynolds **A**veraged **N**avier **S**tokes (**URANS**) simulations of selected test cases. For this purpose unstructured grids are employed, see Figure 3. Thus, this study permits identifying prospects for flow control in these regions to attenuate separation and vortex generation.

Figure 1: CAD – view of the ADHeRo – wind tunnel model

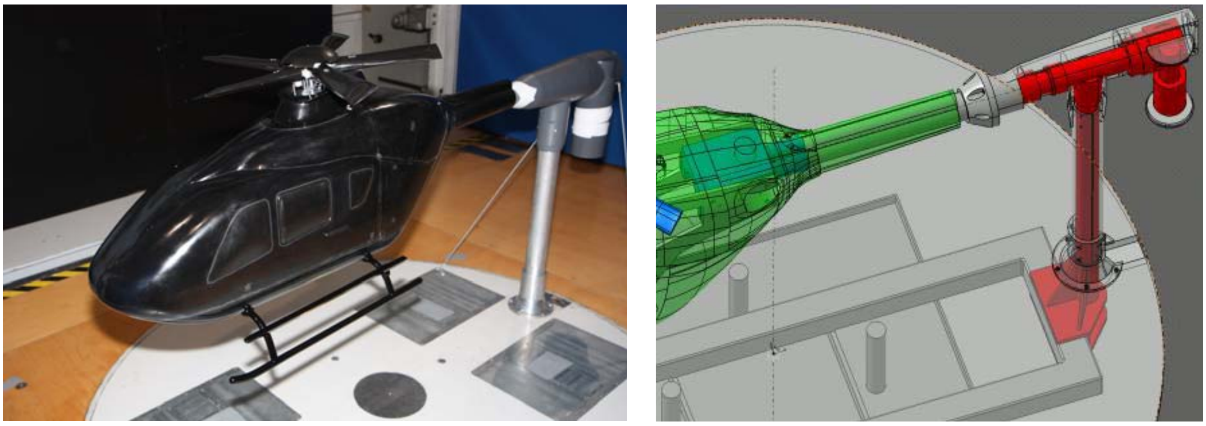

Figure 2: Model in test section, model support

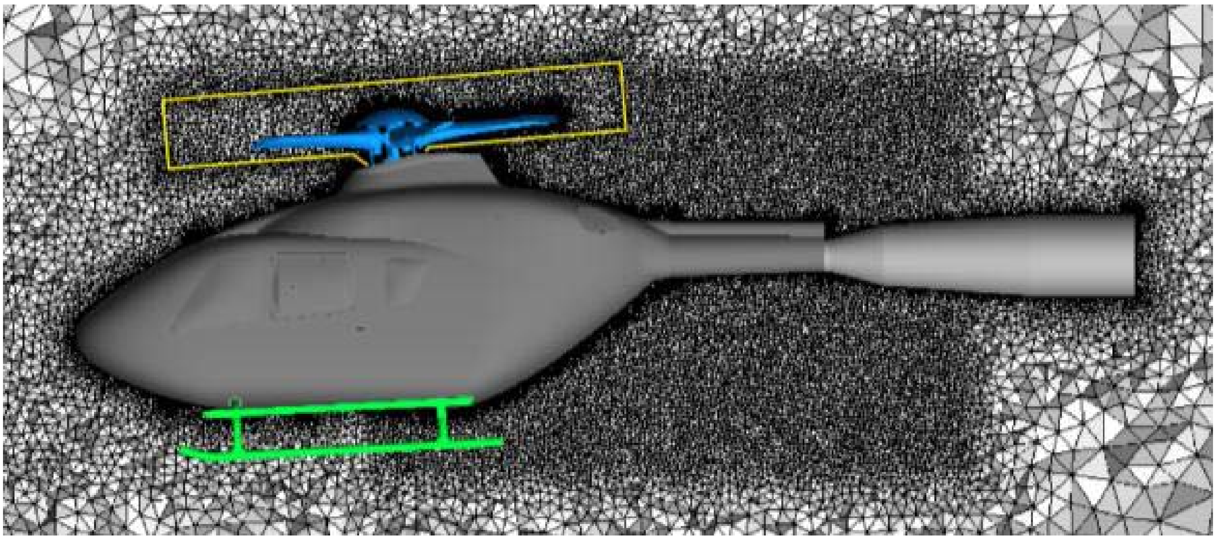

Figure 3: Mesh topology in symmetry plane, unstructured mesh including a sub-domain for modelling rotation of the rotor head