Rotor Performance Enhancement using Flaps - A Computational Study
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The design of modern rotors is a complex task where performance in hover and forward flight must be balanced. Good hover performance can be obtained by using high levels of twist and by increasing the number of rotor blades. For heavy-lift rotors, good performance in hover is a necessity but this should be achieved without inducing penalties in forward flight. Starting from these considerations, new technologies such as Active Flap Control are being developed so that future rotorcraft can offer reduced vibrations [1], noise [2], cyclic control [3], and increased lifting capabilities [4].

The current work is concerned with a comprehensive study of a flapped rotor blade in hover and forward flight. This is achieved by using CFD and blade element methods. As a first step, the concept of having a fixed flap on a low twist blade was considered. The idea is to maximise forward flight performance and recover hover performance via the flap. To this end CFD was used to generate the aerodynamic characteristics of clean and flapped rotor sections as required by the blade element method. Due to the efficiency of CFD for 2D computations this task resulted in a detailed database of the aerodynamics of the HIMARCS rotor blade. Subsequently, the blade element method was used to assess the effect of flap and optimise its location, size and deflection angle.

Detailed CFD analysis of the HIMARCS rotor with various levels of twist was then undertaken along with a similar study of the optimised flapped blade. It was found, that the performance of HIMARCS blade with 7 degrees of twist and the optimised flap was comparable to a clean blade with 13 degrees of twist. Indicative results of this study can be seen in Figure 1, while the details of the study will be presented at the meeting.

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Figure 1: Left: Optimised figure of merit for the HIMARCS rotor with inboard flap deflected at $\delta = 10^\circ$. The optimum flap design was found to be 32%R in length, located at 36.4% blade span. Right: Optimised outboard flap at a deflection angle of $\delta = 10^\circ$. The optimum flap design was found to be 2% in length at 86% blade span. Flap chord is set at 32%c.

References

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