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Characterising the Performance Benefits of a 1/7-Scale Morphing Rotor Blade

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Abstract : Rotary-wing aircraft serve as indispensable components in the advancement of aviation, valued for their ability to operate in diverse and challenging environments without the need for conventional runways. This versatility makes them ideal for applications like environmental conservation, precision agriculture, emergency medical support, and rapid-response operations in rugged terrains. However, although highly maneuverable, rotary-wing platforms generally have lower aerodynamic efficiency than fixed-wing aircraft. This study takes the view of improving aerodynamic performance by examining a 1/7th scale rotor blade model with a NACA0012 airfoil using CROTOR software. The analysis focuses on optimal spanwise locations for separating morphing and fixed blade sections at 85%, 90%, and 95% of the blade radius (r/R) with up to +20 degrees of twist incorporated to the design.. Key performance metrics assessed include lift coefficient (CL), drag coefficient (CD), lift-to-drag ratio (CL / CD), Mach number, power, thrust coefficient, and Figure of Merit (FOM). Results indicate that the 0.90 r/R position is optimal for dividing the morphing and fixed sections, achieving a significant improvement of over 7% in both lift-to-drag ratio and FOM. These findings underscoring the substantial impact on overall performance of the rotor system and rotational aerodynamics that geometric modifications through the inclusion of a morphing capability can ultimately realise.

Keywords : rotary morphing, rotational aerodynamics, rotorcraft morphing, rotor blade, twist morphing
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