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A propeller design and analysis capability evaluation for high altitude application

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ABSTRACT

The purpose of this research is the evaluation of a relatively simple minimum induced loss propeller design and a radially-graded momentum theory analysis method to provide the initial propeller design and analysis capability for predicting propeller performance of a High Altitude Long Endurance (HALE) flight vehicle. These design and analysis capabilities cover flight conditions from take off at sea level to the low air density, high true airspeeds and high blade Mach numbers of high altitude flight. A conceptual propeller was designed and its performance analysed within a time-stepped mission simulation code. Wind tunnel tests were carried out on a scaled model of the propeller comparing actual performance against theoretical predictions. The design method was shown to be capable of producing a propeller design that could provide sufficient thrust over a large range of advance ratios (0.12 to 0.4) and altitudes (0 to 15 000 m). Agreement between the predicted and measured results is particularly good at the lower thrust coefficients and advance ratios, at higher power coefficients and advance ratios increasing differences between the predicted and measured results became apparent.