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Title

Flight Dynamics of Aircraft Incorporating the Semi Aeroelastic Hinge

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Abstract

The growing demand for 'green' aircraft requires a step change in aircraft performance to reduce fuel consumption and carbon emission, calling for the development of innovative aircraft configurations. Folding wingtip devices are often incorporated in the wing design to enable those large wingspan aircraft to meet with the ground operational conditions such as the gate size limit [1]. Unlike conventional folding wingtips, the semi-aeroelastic hinge refers to an active hinge control that allows the wingtips floating in-flight under severe load cases e.g. extreme manoeuvre and turbulence encounters to alleviate the wing loading [2]. It was shown in the past literature that more than 30% wing weight can be reduced by incorporating such device owing to its load alleviation performance [3]. Furthermore, such device enables a significant reduction in the roll damping, making it a good candidate to be considered in the high aspect ratio wing design.

SAH concept are not without concerns, for example the flapping motion of the wingtips often coupled with aircraft modes causing impact on the dynamic characteristics of entire aircraft [4]. To get greater understanding of the dynamic behaviors of such aircraft configuration, a 6 degree of freedom flight mechanics model incorporating flexible wings and SAH device has recently been developed in the DAWS (Design of Aircraft Wing Structures) IUK/ATI project to allow for a series of dynamic simulations of the aircraft under various wing/hinge configurations.

This paper will adopt the flight mechanics model developed in the DAWS project to discuss the impact of the SAH on the flight dynamics of aircraft undergoing gust excitation. A set of aircraft configurations will be considered in the study including the model with different levels of wing flexibilities, swept angles and wingtip sizes. The dynamic responses of each model such as the time simulation, aerodynamic derivatives, and short-/long-period frequencies will be assessed and compared before and after the hinge is released to gain insights into the effect on the flight handling qualities. Comparison will be made with previous studies [5].

1. References

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