EXPERIMENTAL IDENTIFICATION OF MODAL PARAMETERS IN A SEMI AEROELASTIC HINGED WING DEMONSTRATOR

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ABSTRACT

The introduction of a semi-aeroelastic hinge (SAH) is motivated by the need to increase wingspan while preserving favorable aeroelastic characteristics, leading to an efficient aeroelastic load redistribution and deformation behavior. These hinges have two possible states: free or locked. During flight, the wing is set to locked in the extended position for increased aerodynamic efficiency. However, in the event of a gust encounter, the wing tip may be released and free to flap, serving as a load alleviation device. When on the ground, the hinge can be set to the folded position so that the aircraft meets the dimensional requirements for standard airport gates. Moreover, the changes in hinge stiffness and fold angle cause the system's modal parameters to vary significantly because of different stiffness and mass distributions, respectively. The aeroelastic assessment of the stability of such a variable system is more challenging than on conventional wings. Computational studies have shown that flutter instabilities might arise under certain flight conditions due to significant coupling between the first bending mode of the wing and the rotational rigid body motion of the wingtip [1]. However, the detailed experimental identification of such a system is yet to be done. This paper presents modal identification results of a laboratory wing with an actuated hinge, which is designed to emulate the in-flight dynamic behavior of a SAH.

Figure 1: SAH demonstrador

A laboratory wing structure fitted with a SAH demonstrator has been previously designed to de-risk flight testing of aircraft fitted with SAH. Here, the hinge fold angle and stiffness can be controlled independently from each other, simulating changing flight conditions. The present research proposes tracking modal parameters with respect to changing hinge angle and stiffness conditions to experimentally characterize the system. Furthermore, online monitoring (OLM) functionality, which involves online modal analysis and tracking of modal parameters, is evaluated under reconfiguration of the hinge. From this study, insights into flight test data correction procedures will be obtained.

Keywords: system identification, semi-aeroelastic hinge, flight testing.

[1] A. Castrichini, V. Hodigere Siddaramaiah, D. E. Calderon, et al., "Preliminary Investigation of Use of Flexible Folding Wing Tips for Static and Dynamic Load Alleviation", The Aeronautical Journal, 121(1235):73–94, 2017, ISSN 0001-9240, https://doi.org/10. 1017/aer.2016.108.