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Author: Mr. Rohan Chandra
University of Petroleum and Energy Studies, India, rohanchandra2316@gmail.com

Mr. Monish Mathur
Technische Universität Berlin, Germany, monish.mathur@campus.tu-berlin.de

COMPUTATIONAL AEROTHERMOELASTIC ANALYSIS OF A HUMAN CREW ENTRY VEHICLE IN EARTH-MARS ATMOSPHERES

Abstract

Human Crew entry Vehicles operate in a severe aerodynamic heating environment, which has a significant impact on their structural dynamic characteristics. While performing an aeroelastic analysis for a Human Crew entry Vehicle, aerodynamic heating effects and unsteady structural loads has been given utmost importance. While the severity of these loads is much greater for a complete entry mission, they do still exist for aeroassist missions and directly impact how the aeroshell design is conducted. This technical paper presents the aeroelastic analysis that can be efficiently performed by using the structural dynamic characteristics of the heated HCeV operating in thermodynamic equilibrium state wherein the vehicle experiences a hypersonic flight. The resultant effect of aerodynamic heating shows that the modal frequencies and modal shapes of the HCeV structure are bound to change and how the design should be optimized structurally to prevent deformation in comparison with the unheated structure. Finally, an example of an aerodynamic heated control surface structure is used to validate the effectiveness of the proposed aerothermoelastic design framework.