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COMPARISON OF TWO CARBON FIBER REINFORCED POLYMER GRID TYPES WITH
RESPECT TO STABILITY, STIFFNESS AND MASS FOR THE USE AS INTERSTAGE STRUCTURE

Abstract

In this paper, two grid types are discussed for the use as interstage 1-2 structure of VLM (Veículo Lançador de Microssatélites). VLM is a launcher for microsatellites made of 3 stages arranged in tandem. The interstage 1-2 is an open structure because of the hot separation of the first stage. The grid is made of light yet stiff CFRP (carbon fiber reinforced polymer). The two discussed grid types for the interstage are the axial grid and the hoop grid. The axial grid consists of axial stiffeners, which are parallel to the axis of the launcher, and helical stiffeners arranged at a + angle and at a - angle. The hoop grid is made of hoop stiffeners which are circular and helical stiffeners similar to those of the axial grid. The mechanical behavior of the two grid types is discussed with respect to stiffness and stability. Finite element modelling is used to determine the impact of the grid components on the eigenfrequency of the launcher. In this analysis, the stiffeners of the interstage are smeared into a cylindrical shell and implemented into a shell element model of VLM. The net thickness of the smeared stiffeners is varied to determine the influence of each stiffener type on the modal analysis. The smeared stiffeners are then discretized into individual stiffeners and the resulting grid barrels are analyzed via finite element modelling using beam elements to determine the stability behavior of the grids. Here the influence of the width to thickness ratio of the stiffeners having rectangular cross sections is inspected. Having established an understanding of the mechanical behavior of the two grids, an interstage design for both grid types is developed using the above described analyses. It is found that the minimum mass of the axial grid, which fulfils the stiffness and stability requirements, is lighter than the hoop grid. The axial grid is therefore more suited as interstage structure for the VLM launcher application.