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PANEL FLUTTER ANALYSIS OF COMPOSITE PANEL WITH NON CLASSICAL CONFIGURATION

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Panel flutter is an aeroelastic unstable phenomena that can cause failure of panels of wings, fuselages, missiles. It happens mostly at supersonic regime even though it can be observed in subsonic ranges. With respect to wing or missiles flutter, which involve the whole wing/missiles, panel flutter only involve at panel level, usually a panel bounded by two transverse stiffeners (ribs) and two longitudinal stiffeners (stringers).
The panel flutter phenomena involved mainly the aeronautic structures but it appears also on spacestructure during the coasting phase. Some non destructive aeroelastic phenomena wad detected on Saturn V rockets and analytical and experimental test was carried out Nichols [1]. The new launchers generations try to improve the performances by introducing new panels, they must protect the cryogenics stage during the coasting phase and after they are ejected in order to reduce the weight out of the atmosphere. These panels, called Versatile Thermal Insulation (VTI panel), are bigger than the common aeronautical panels and usually are connected with the main structure by means of pinched points (usually pyrotechnical nuts). The dimension, the boundary conditions (BC) and the weight requirements make the VTI panels very flexible and so they may easily occur in aeroelastic phenomena. In the open

literature very few works deal with the investigation of the effect of the boundary condition position on panel flutter, one of this is by Shanthakumar et al. [2] but only one is about the point supported configuration [3].
In this paper a new aeroelastic model is developed by using refined shell theories [4] for the structural model and the piston theory [5] in tis linear formulation for the aerodynamic loads.
A cylindrical shell finite element based on CUF [6] is adopted in this paper. The Mixed Interpolation of Tensorial Components (MITC) method has been extended to shell elements with nine nodes in order to overcome the membrane and shear locking. The performances of this element have been tested in [4] by solving discriminating problems from the literature, that involve very thin shells.
The aerodynamics models adopted is the one proposed by Ashley and Zartarian [5] and is commonly known as Piston Theory. This model provide a very simple formulation that considers the aerodynamic loads only function of the spatial derivatives (panel slope) and of the time derivative (velocity) of the displacements. This model can be considered reliable only in the supersonic range, because of that all the analyses will consider a Mach number bigger than 1.5.
The analyses are devoted to the investigation of the effects of the boundary condition on the aeroelastic behavior. Different material lamination are considered: isotropic, composite, and sandwich material. The results show that the boundary conditions configuration can afflict deeply the aeroelastic behavior of the panel. The results show also the effect of the use of the refined shell elements respect to the classical one. The advantages of these model are pointed out mainly in the composite and sandwich laminations.

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