

MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Space Structures 1 - Development and Verification (Space Vehicles and Components) (1)

Author: Mrs. Claudia Di Trapani
AVIO Propulsione Aerospaziale, Italy, claudia.ditrapani@aviogroup.com

Mr. Emanuele Mastrella
AVIO S.p.A., Italy, emanuele.mastrella@aviogroup.com

Mr. Josè Luis Leofanti
ELV S.p.A., Italy, jose.leofanti@elv.it

Mr. daniele bartoccini
AVIO Propulsione Aerospaziale, Italy, daniele.bartoccini@aviogroup.com

SIMULATION OF VEGA DYNAMIC ENVIRONMENT BY USING PROPELLANT COMPLEX
CHARACTERIZATION

Abstract

VEGA launcher configuration foreseen 3 solid stages. The first VEGA qualification flight has been performed with success on the 13th of February 2012. During the launcher development 8 firing tests have been performed at Salto di Quirra (Italy) and Kourou (Guyana) with the objective to characterize and qualify of the Zefiros and P80 Solid Rocket Motors. One of the primary objects of the firing test is to correctly characterize the dynamic response of the SRM in order to apply such a characterization to the predictions and simulations of the launcher dynamic environment. Considering that the solid propellant is around 90% The visco-elastic characterization of the material can be generally performed identifying local and/or modal parameters which are typically time or, alternatively, frequency dependent quantities. The first kind of local description is performed in terms of frequency dependent visco-elastic parameters like complex Young modulus or shear modulus, or loss factor. The second kind of description typically utilizes global frequency-dependent quantities like the modal damping coefficient. The activity is articulated in four parts:

- consolidation of a method for the dynamic characterization of the complex dynamic modulus of elasticity of visco-elastic materials applicable to the SRM propellant operative conditions
- application of the selected method to the VEGA solid propellant at local and global level
- analysis of the effect of the introduction of the complex dynamic modulus of elasticity in the Zefiros firing test numerical simulations solver and experimental data reproduction
- analysis of the effect of the introduction of the complex dynamic modulus of elasticity in the VEGA flight simulations and flight data reproduction

After giving an overview of the experimental approaches, this work reports the propellant complex dynamic modulus of elasticity characterization and the numerical model used to introduce it in a FEM simulation. The validation process is performed at SRM level comparing numerical and experimental measurements for the VEGA Zefiros firing test. Finally its application on VEGA launcher demonstrated the increase in prediction accuracy induced by the complex propellant characterization implementation.