Paper ID: 68809
oral
student

IAF MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Space Structures - Dynamics and Microdynamics (3)

Author: Mr. Thomas Hughes
University of Auckland, New Zealand

Mr. Mattia Marcello Longato
University of Auckland, New Zealand
Dr. Vladimir Yotov
University of Auckland, New Zealand
Prof. Guglielmo Aglietti
University of Auckland, New Zealand
Mr. James Barrington-Brown
South Africa

REACTION WHEEL ASSEMBLY EXPERIMENTAL IMPACT DYNAMICS CHARACTERISATION

Abstract

Reaction wheel assemblies (RWAs) are attitude control devices which allow in-orbit satellite maneuvers by torque application to the spacecraft. RWAs consist of a flywheel, DC motor and housing. Due to imperfections and tolerances in the mechanical parts, such as flywheel bearings, micro-vibrations can emanate during the function of the RWA. A suspension system can be integrated within the wheel to reduce the transfer of these vibrations into the satellite structure. However, for a soft suspension system, the launch environment can cause the flywheel to contact the housing, introducing a dynamic impact problem to be addressed. These impacts between the flywheel and housing can cause significant damage to the bearings in the reaction wheel assembly. A novel experimental procedure has been developed to characterize the impacts and the loads that the bearings experience due to them. Firstly, the complex vibro-impact dynamics are reduced to a practically tractable 1D equivalent. The latter is reproduced by an experimental setup involving a floating mass, representing the flywheel, suspended using an air pressure pocket with springs, representing the soft suspension, between the mass and the frame, representing the case. The assembly is mounted to a 1D shaker onto a slip table and sine sweep and random vibration testing is completed, in correspondence to the launch environment. Variable gap size between the floating mass and the frame as well as variable spring stiffness is investigated to provide valuable data to produce reliable analytical models. The experimental approach underpins the development of mathematical and finite element models which were subsequently extended to the 2D and 3D impact dynamics case. Future research is planned to develop experimental procedures considering 2D and 3D impact dynamics for a reaction wheel assembly to verify and calibrate these analytical models.