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

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EXPERIMENTAL VERIFICATION OF DAMAGE DETECTION BASED ON PROPER ORTHOGONAL DECOMPOSITION ON A PLATE STRUCTURE

Abstract

Structural components in different fields of engineering have to be in continuous use, despite aging and the unavoidable risk of damage growth and consequent possible failure. Monitoring the structural health status of engineering systems in a non-destructive way is becoming increasingly important, for safety, reliability and economy reasons. In the aerospace industry, safety is paramount and successful detection of damages (due for example to a space debris impact) is vital. Damage detection has always been a well researched area in which new techniques are continuously developed. There are many methods that can be used locally for the detection of defect on a narrow area on a structure, so to study a whole structure may require several applications of the non-destructive techniques (NDT). It is desirable to have global NDT methods to reveal, quickly and possibly cheaply, the presence of damage in a zone of the structure to which a local technique would then be effectively applied for a more precise assessment. In the past the variations of vibration properties (modal frequency, modal shape, damping factor) were selected as damage indicator and constitute one of the few damage indicators capable of monitoring the whole structure simultaneously. The reasons why the practical application of modal-based methods is limited are related to the need to develop a reliable mathematical model of the structure that correctly represents the damage. Furthermore the damage initial phase (when it has to be detected) is typically a local phenomenon and may not significantly influence the low-frequency global response of a structure, which is usually measured in vibration tests. This paper presents the experimental verification on a plate structure of a new vibration method based on proper orthogonal decomposition (POD): this method is emerging as a powerful experimental tool in structural dynamics, that does not require the development of a reference model for damage detection on the structure. POD provides the most efficient way of capturing the dominant components of an infinite-dimensional process with only a finite number (and, often, surprisingly few) of modes. The proper orthogonal modes captures more energy per mode than any other orthogonal complete basis and can be easily applied also for nonlinear systems. The results, obtained with POD technique using acceleration and deformation measurements, are presented for various damage locations and dimensions.