Some Passive Damping Sources on Flooring Systems besides the TMD

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12. Damping of Structures

62 **Damping Methodology for Condensed Solid Rocket Motor Structural Models**
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ESA_s new small launcher _ VEGA _ has been designed as a single body launcher with three solid rocket motor stages and an additional liquid propulsion upper module. Part of the mission analysis is the launcher-satellite coupled loads analysis which aims at computing the dynamic environment of the satellite during the most severe load cases in flight. To allow such analyses to be processed in short time, all stages of the launcher finite element model are condensed. The condensed launcher mathematical model can subsequently be coupled to a condensed satellite mathematical model. To obtain accurate predictions of the satellite dynamic environment it is evident that the damping of the entire system has to be defined in a representative way. This paper explains a methodology to compute the modal damping matrix of a super element on the basis of the structural damping ratios assigned to the various materials in the associated finite element model and the associated complex strain energy of the modeshapes. The methodology turns out to be well suited for the computation of the modal damping matrix of condensed solid rocket motor structural models, as evidenced by correlation with firing tests conducted for the first stage motor of the VEGA launcher.

244 **Analysis and Optimization of the Current Flowing Technique for Semi-passive Multi-modal Vibration Reduction**
S. Manzoni, Politecnico di Milano; M. Redaelli, AgustaWestland; M. Vanali, Politecnico di Milano

This article deals with semi-passive multi-modal vibration control by means of piezo-benders, particularly on an already available method: the Current Flowing technique, which has a number of advantages with respect to the other methods presented in literature. Such a technique relies on the link between the bender and an electrical impedance, which allows mechanical energy dissipation. Though its analysis has already been discussed in the state of the art, many points are still open. The paper gives a deep analysis of this control technique and then presents an algorithm for the optimization of the electrical network linked to the bender.

172 **Some Passive Damping Sources on Flooring-systems Besides the TMD**
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Impulsive loads and walking loads can generate problematic structural vibrations in flooring-systems. Measures that may be taken to mitigate the problem would often be to consider the implementation of a tuned mass damper or even more advanced vibration control technologies. This in order to add damping to the structure. Basically also passive humans on a floor act as a damping source, but it also turns out from doing system identification tests with a floor strip that a quite simple set-up installed on the floor (cheap and readily at hand) might do a good job in terms of reducing vertical floor vibrations for some floors. The paper describes the tests with the floor strip, and the results, in terms of dynamic floor behaviour, are compared with what would be expected had the floor instead been equipped with a tuned mass damper.

303 **Constrained Layer Damping Test Results for Aircraft Landing Gear**
T. Collins, K. Kochersberger, Virginia Polytechnic Institute and State University

In aircraft, weight reduction represents one of the principal design goals, and landing gear design is no exception. Accounting for 3 – 7% of an aircraft's weight, the landing gear is essentially dead weight after takeoff, and so reducing this weight becomes a priority of aircraft design. In addition to keeping the weight low, fixed gear designs can add significant drag if the design has not been optimized. The ideal landing gear should be low weight and low drag, but these criteria are typically at odds with a requirement for absorbing landing loads and preventing rebound. The use of constrained layer visco-elastic damping on landing gear structural members is a new application since historic use of constrained layer damping has been found on thin plate-like structures. Benefits of low weight and low drag are achievable using the conformal treatment, and this paper investigates specific constrained layer damping applications for cantilever-loaded spring steel landing gear. The design of the damped system considers the high stiffness and low surface area typical on a cantilever landing gear leg. Damping levels are examined for a 163 kg. aircraft with and without a Dyad 606 constrained layer damping treatment on the main and nose gear members. A 29% increase in damping was observed on the main landing gear, and a 25% increase in damping was observed on the nose gear when the treatment was applied. A full aircraft drop test is performed that showed inconclusive results in damping.

337 **A Sloshing Absorber With a Flexible Container**
M. Gradinscak, S.E. Semercigil, Ö.F. Turan, Victoria University

Liquid sloshing may be employed for structural vibration control, similar to a classical tuned vibration absorber. For such a case, the sloshing frequency of the free-surface oscillations, is tuned at a critical frequency of the structure in order to gain the benefits of the pressure forces as control forces. A sloshing absorber has the benefits of being effective and practically free of maintenance. The work presented in this paper utilizes a sloshing absorber with a flexible container. All preceding work deals with rigid containers. There are no reported attempts in the literature to explore the possibility of employing a flexibility of the container, as a design parameter. Container flexibility adds another level of tuning, namely that of the container, to that between the sloshing liquid and the structure to be controlled. The objective of this paper is to present the effect of this additional tuning effect. Extensive set of numerical predictions have been completed in this direction. Selective cases from these trials are presented.

338 **Effective Vibration Suppression of a Maneuvering Two-link Flexible Arm with an Event-based Stiffness Controller**
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Vibration control of a maneuvering flexible robotic arm is a challenging task which has to deal with changing structural dynamics and inaccuracies from modeling and measurements. This paper offers a simple an effective alternative controller for a two-link flexible arm. The suggested technique is stable and suitable as an add-on feature, as it requires no additional hardware. It is based on a kinematic event, rather than needing a dynamic model of the structure to be controlled. Hence, it certainly represents a significant practical advantage. Both numerical predictions and experimental observations are presented, to compare the deviations from the intended trajectories with and without the control.