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SEMI-ACTIVE DAMPING OF FORCED VIBRATION UTILIZING CONTROLLABLE TRUSS-FRAME NODES

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Abstract

Semi-active control systems enjoy growing interest in the field of vibration damping in recent years [1]. This phenomenon was caused by the recognition of their advantages over passive and active damping strategies. Passive systems are characterized by the inability to adapt to changes of external conditions which affect the structure. This issue limits their applicability to systems subjected during their working time to loads of well-known and undiversified characteristics. Active systems allow to avoid the limitations of the passive ones. Utilization of the actuators, sensors and a controller lets the control system adapt in real time to changing external conditions. Despite the tremendous advantages of using the actuators for vibration damping, there is a very important drawback associated with this type of control systems. External control forces introduced to the controlled structure can achieve large magnitudes, which may lead to instabilities and consequently to its destruction. Semi-active systems combine the advantages of both, passive and active systems: they do not introduce notable forces to the structure and adjust to variable environmental conditions. This justifies the rapidly growing popularity of the semi-active damping systems.

This research adopts the idea of complex, semi-actively controlled nodes which can change in a controllable way their behavior from a frame-like state to a truss-like state. This means that they can either transmit moments (in the frame-like state) or not transmit it (in the truss-like state). Incorporation of this type of nodes into a frame structure allows for its semi-active control in such a way that enables a very efficient mitigation of vibrations [2]. The proposed algorithm utilizes measurements of the locally accumulated potential energy, what makes it a very good tool, both for global and local vibration damping. Local reconfiguration of the controlled structure can cause global changes of its behavior, which can lead to vibration suppression. Local energy measurements provide also the opportunity to utilize local damping mechanisms. Combination of these two damping methods yields very good results for a wide spectrum of working conditions of the structure. A properly developed control algorithm has been proved to be effective for different mode shapes used as the initial deformation of the elementary frame structure [3]. In this work, the algorithm is used to mitigate continuous forced vibration caused by variable external conditions. It is demonstrated that it is possible to achieve satisfactory reduction of strain energy and vibration amplitude.

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