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Semi-active mitigation of free and forced vibrations by means of truss-frame nodes

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This contribution reviews a recently proposed control strategy for mitigation of vibrations based on the Prestress-Accumulation Release (PAR) approach [1]. The control is executed by means of semi-actively controllable truss-frame nodes. Such nodes have an on/off ability to transfer bending moments: they are able to temporary switch their operational characteristics between the truss-like and the frame-like behaviors. The focus is not on local energy dissipation in the nodes treated as friction dampers, but rather on stimulating the global transfer of vibration energy to high-order modes. Such modes are high-frequency and thus highly dissipative by means of the standard mechanisms of material damping. The transfer is triggered by temporary switches to the truss-like state performed at the moments of a high local bending strain. A sudden removal of a kinematic constraint releases the locally accumulated strain energy into high-frequency and quickly damped vibrations.

The first formulation investigated global control laws [1]. Recent approaches generalized it to decentralized control with a local-only feedback, which was tested in damping of free vibrations [2] as well as forced vibrations [3]. Recently, a global formulation was proposed that aims at a targeted energy transfer between specific vibration modes [4], and attempts were made to go beyond skeletal structures [5]. Numerical and experimental results will be presented to confirm the high effectiveness of the approach in mitigation of free, forced random and forced harmonic vibrations.

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