Prestress Accumulation- Release (PAR) for damping of free vibrations in frame structures. Experimental study of a lab-scale demonstrator structure equipped with piezo-actuated semi-active nodes

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In the first part of this paper a method for mitigation of free vibrations is presented which utilize structural energy accumulated after impact in order to mitigate resulting vibrations. General aim for this type of methods is to use devices installed in the structure to introduce a control force which opposes the oscillatory movement initiated at impact, without a considerable additional energy sources. The control force is applied using as energy source either strain or kinetic energy of the vibrating structure itself, thus the methods are considered semi-active.
It is assumed that there is a certain device or devices installed in the structure capable of imposing kinematic constraints on some degrees of freedom of the system. Given such devices are in place, the strain accumulated in the structure could locally be released for a short period of time, converting part of the strain energy to the kinetic energy of local, higher frequency vibrations. This strategy, so called Prestress Accumulation-Release (PAR), has been shown numerically to have a very high efficiency in vibration mitigation.
In this paper an experimental stand is described which demonstrates PAR strategy on a frame test structure with semi-active nodes based on piezoelectric actuators. Friction based, semi-active, piezo-actuated structural nodes are discussed in terms of their efficiency in changing state from frame mode to truss mode, depending on the control signal. Characteristics of the semi-active nodes are shown in terms of maximum torque transferred both for frame and truss modes. Further, the global response of the structure is presented, in particular the vertical displacements before and after control activation.