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A NEW STRATEGY FOR ADAPTIVE IMPACT ABSORPTION (AIA)

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Summary: This contribution proposes and discusses a new strategy for Adaptive Impact Absorption (AIA), as well as illustrates it using numerical examples. The process of AIA, as understood here, consists of two phases: (1) semi-actively controlled reception of an impact and (2) semi-actively controlled damping of the resulting structural vibrations. In both phases, various measures of optimality and constraints are possible, including minimum peak or rms accelerations, minimum damping time, maximum dissipation rate, maximum displacements, etc.

The proposed strategy of absorption is based on semi-active management and dissipation of structural kinetic and potential energy. The potential energy is managed using the Prestress Accumulation – Release approach (PAR), which employs specialized structural nodes with a controllable moment-bearing ability that are capable of a quick transition between a truss-like state and a frame-like state. Such a transition allows a part of the locally stored potential energy to be quickly transformed into the energy of high-frequency local vibrations that are quickly damped by means of the standard mechanisms of material damping. In parallel, the kinetic energy is managed by first storing it in specialized structural members involving worm-like gears and spinning discs with considerable rotational inertia and then, if deemed necessary, reusing the energy in a controlled manner. All the control process is performed semi-actively, that is only by controlling structural characteristics and configurations of selected structural members, without introducing any significant external forces into the system.

Besides the determination of the optimum control strategy, an important point is the initial process of topological optimization of the underlying structure, as well as finding the optimum placement for the available controllable nodes and members.

We will present numerical examples, which will involve simulations of truss-like and frame-like structures. The impact will be simulated in the form of an inelastic impact.