MECHANICAL ENGINEERING MSc SEMINAR (30 min.)

Thursday, November 5 2026 at 13:30-14:00, D. Dan & Betty Kahn Building, Auditorium 1

Intermodal Targeted Energy Transfer in three-dimensional setting

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Passive mitigation of engineering structures subjected to extreme loads is of considerable interest in real life applications for preventing structural damage and human loss. Several linear and nonlinear absorbers have been investigated in the literature for this purpose. A new approach was introduced recently for blast mitigation using intermodal targeted energy transfer (IMTET). This approach suggests transferring the energy from blast excitation between the modes of the structure in order to improve mitigation with a smaller characteristic time. IMTET reduces the energy of the structure by directing the energy of low frequency structural modes to high frequency structural modes. IMTET is achieved by integrating nonlinear properties into the structure, using vibro-impacts. IMTET was first implemented on a one-dimensional blast-excited system with two-DOF using a single impact clearance. Another implementation extended the IMTET mechanism in a multi-DOF system and explores the mitigation of blast loading on a nine-story steel structure. In this work, the IMTET is implemented to a three-dimensional structure, with the principle to channel the energy from "weak" directions to "strong" directions.

This work explores the implementation of the intermodal targeted energy transfer (IMTET) mechanism for passive mitigation of a three-dimensional asymmetric linear oscillator subjected to blast excitation. We consider a mechanism for redistribution of the excitation energy among the oscillatory modes. The model under consideration is a three-dimensional oscillator with six degrees-of-freedom - three independent directions of translation, and three independent rotational directions. To achieve the IMTET behavior, a semi-ellipsoidal cavity is introduced. In addition, the vibro-impacts are achieved by placing an internal fixed rigid rod inside the ellipsoidal cavity. At rest, the base of the rod coincides with the center of the canonical ellipsoidal cavity, and the tip of the rod coincides with the center of mass. Asymmetry is achieved by tilting the semi-ellipsoid cavity with respect to the principal axis of the mass. The impacts between the tip of the rod and the cavity are the only nonlinear interactions in the system; between the impacts, the dynamics will be assumed linear, for the sake of simplicity.

The numerical exploration revealed that channeling the blast energy within the modes improves the mitigation of the overall system response and reduces the characteristic damping time significantly. It is a step towards a new approach in research on constructive utilization of different directions for possible displacement of the structure, in particular channeling energy from “weak” to “strong” direction by means of the IMTET.

Seminars Coordinator: Prof. Sefi Givli