PHYSICS-BASED LOAD-IMPULSE DIAGRAMS FOR REALISTIC PROTECTED FACILITY ASSESSMENT

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ABSTRACT

Load-impulse (P-I) diagrams are graphic tools for quickly assessing the potential damage to building components caused by dynamic loading. The development load-impulse diagrams for simple structural elements under ideal loading conditions were introduced in the early 1980s. The method developed by this research team is based on a single-degree-of-freedom (SDOF) system approach and reliable dynamic behavioral and constitutive models. The damage levels in the approach are user-defined behavioral criteria within the program. For example, for reinforced concrete the P-I curves can determine if the element has reached initial cracking, rebar yielding, strain hardening, or steel fracture. We will discuss the characteristics and development of load-impulse diagrams with analytical solutions to idealized systems. The numerical results of the proposed procedure for idealized systems were verified with available closed-form solutions. Reinforced concrete beams, reinforced concrete slabs, buried reinforced concrete boxes, and wood frame panels were evaluated under transient loadings to generate load-impulse diagrams for both flexural and various shear modes of response. This study showed that the method provided accurate load-impulse diagrams, as compared with test data. The explosive safety community can use this approach to protect against blasts by retrofitting and designing structures to respond well below their failure threshold. This paper will describe the outcomes of the numerical investigations and present data from both dynamic tests and related computer simulations.