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Numerical Modeling and Experimental Analysis of a Pallet Isolation Device to Protect Selective Type Industrial Storage Racks

Authors : Marcelo Sanhueza Cartes, Nelson Maureira Carsalade

Abstract : This research evaluates the effectiveness of a pallet isolation device for the protection of selective-type industrial storage racks. The device works only in the longitudinal direction of the aisle, and it is made up of a platform installed on the rack beams. At both ends, the platform is connected to the rack structure by means of a spring-damper system working in parallel. A system of wheels is arranged between the isolation platform and the rack beams in order to reduce friction, decoupling of the movement and improve the effectiveness of the device. The latter is evaluated by the reduction of the maximum dynamic responses of basal shear load and story drift in relation to those corresponding to the same rack with the traditional construction system. In the first stage, numerical simulations of industrial storage racks were carried out with and without the pallet isolation device. The numerical results allowed us to identify the archetypes in which it would be more appropriate to carry out experimental tests, thus limiting the number of trials. In the second stage, experimental tests were carried out on a shaking table to a select group of full-scale racks with and without the proposed device. The movement simulated by the shaking table was based on the Mw 8.8 magnitude earthquake of February 27, 2010, in Chile, registered at the San Pedro de la Paz station. The peak ground acceleration (PGA) was scaled in the frequency domain to fit its response spectrum with the design spectrum of NCh433. The experimental setup contemplates the installation of sensors to measure relative displacement and absolute acceleration. The movement of the shaking table with respect to the ground, the inter-story drift of the rack and the pallets with respect to the rack structure were recorded. Accelerometers redundantly measured all of the above in order to corroborate measurements and adequately capture low and high-frequency vibrations, whereas displacement and acceleration sensors are respectively more reliable. The numerical and experimental results allowed us to identify that the pallet isolation period is the variable with the greatest influence on the dynamic responses considered. It was also possible to identify that the proposed device significantly reduces both the basal cut and the maximum inter-story drift by up to one order of magnitude.

Keywords : pallet isolation system, industrial storage racks, basal shear load, interstory drift.
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