Seismic Protection of Adjustable Pallet Racking Structures with Isolation Systems

Novel devices for practical uses

Abstract:

The importance of storage facilities along the supply chain is something that is becoming vital to a sector that has seen a skyrocketing increase in demand during the past decade. Yet, designing reliable and functional racking systems does still pose a great challenge to the engineers due to the lack of specifications that clearly address their extremely fragile mechanisms for resisting seismic-induced lateral forces. The aim of this work is to portray a clear picture of the performance of selective pallet racking systems in the presence of lateral actions, often induced by ground shaking. This research proposes two new strategies for the retrofit of non-compliant pallet racking, moving in the panorama of the current hardware know-how, but at the same time pushing the limits of sensible solutions based on consolidated principles. The results of experimental shaking table tests performed using real-time earthquake records are used to investigate the suitability of tailor-made devices to create isolation systems for standard pallet racks. A curved-surface sliding (CSS) bearing is considered for the physical tests, which had been engineered and preliminarily tested by FIP Industriale (Padua, Italy) under the patented name IsolGOODS. The tests were carried out in the FIP Laboratory. A first investigative study has considered the system response under six ground motions and has allowed drawing first and useful conclusions on the practical effectiveness of the novel device. Numerical modeling techniques have given clear indications on when and where CSSs can provide the best economic-to-performance ratio. A novel concept, based on well-recognized seismic principles, was therefore conceived with the aim of providing a middle-range solution for improving the performance of pallet-racking systems along the cross-aisle direction. The proposed base-plate connection, designed for promoting upright uplift when the lateral forces exceed a certain threshold, was tested in the NTUA Laboratory of Steel Structures (Athens, Greece) using monotonic and cyclic protocols. A more comprehensive picture of the behavior of upright frames when equipped with the proposed device is formed as the result of numerical investigation.