Development of seismic isolation systems for industrial racks

(Higher-level apprenticeship contract, GS-Industry; Supervisor: Prof. Francesca da Porto)

Background. In the last decades, metal systems for shelving have been more and more optimized in order to reduce their cost. Industrial racks have been increased in height and complexity, using only cold-formed thin-walled profiles. In addition, these systems are originally conceived and designed as simple structures, with few requirements for static capacity only. All this clearly reveals the great seismic vulnerability of such structures, which are generally contained within each production building.

The 2012 Emilia Romagna earthquake dramatically shown this vulnerability of rack structures, increasing awareness of this problem in the industrial and research field. As a result, to date, industrial racks have acquired the same respect as the primary structures, having to guarantee new and higher levels of structural performance, which include the seismic capacity. This is a matter of considerable importance if we consider that, in addition to representing a safety problem for workers, the vulnerability of such structures is heavily linked to the expected seismic losses of the company, both direct (stored goods) and indirect (due to downtime).

This new vision has recently motivated great improvements in the conception and realization of industrial racks, also greatly increasing their trade. However, further research on the seismic behaviour of industrial racks and additional technological developments, e.g. anti-seismic systems, are still necessary to effectively reduce the vulnerability of such structures and, therefore, the seismic risk for business.

Aim. This research is addressed at evaluating the seismic behaviour and vulnerability of industrial racks. Various types of geometric configurations, load combinations, and levels of seismic hazard should be examined. Specific site seismic response, soil-structure interaction and content-structure interaction should be taken into account. The objective is to identify the range of applicability of strengthening solutions and isolation/additional dissipation systems for the use of industrial racks in seismic areas, on the basis of technical and economic evaluations.

When isolation or additional dissipation systems show to be the optimal way to reduce the shelving seismic vulnerability, innovative prototypes should be developed, realized and tested. Experimental and numerical analyses should be used as a basis for drafting design and application guidelines for the industrial racks in seismic areas.

Expected results

- Parametric non-linear analyses of the seismic behaviour of industrial racks, for the evaluation of their seismic vulnerability;
- Identification of optimal mitigation strategies (strengthening solutions or isolation/additional dissipation systems) depending on the type of rack and the seismic demand;
- Development of isolation or additional dissipation systems with the requirement to be effective and economically competitive;
- Experimental testing and numerical modelling of the new technological solutions; validation and drafting of guidelines for design and application of industrial racks in seismic areas.

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