“Seisracks 2”

**Title:** Seisracks 2—Seismic behavior of steel storage pallet racking systems  
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**Summary**

Different configurations of steel storage pallet racks were examined under experimental and numerical analyses in order to clarify the seismic response of these structures and to propose a safer and a more sufficient design for racks especially in seismic areas. The steel structures laboratory of the NTUA was responsible for the numerical analyses of the project and the compiling of a Designer’s manual which includes further development of the existing norm of racking systems under seismic actions.

**Publications**

**Journals:**

**Conferences:**
1. Adamakos K., Vayas I., Static and Seismic behavior of steel storage pallet racks. 8th National Conference on Steel Structures, 2-4 October 2014, Tripoli, Greece.

**Description of Steel storage pallet racks**

The steel storage pallet racks are composed of thin walled sections which present limited ductility. These structures are designed to work perfectly under vertical loads; however the semi-rigid connections, between beam-columns and beam-base floor, and some types of bracing systems make these structures to present a sufficient response under horizontal seismic forces as well.
### Numerical investigations

- Calibration of the numerical models using experimental results
- Incremental dynamic analyses
- Nonlinear static analyses
- Linear and nonlinear Response spectrum analyses
- FEM analyses of the detailing of the structures
- Detailed analyses for the interaction between structure and merchandize

### Calibration of numerical models

![Fig.2 Calibration of the beam-end-connector’s cyclic behavior](image1.png)

![Fig.3 Calibration of the full scale test of an upright frame](image2.png)
Static and dynamic analyses

Fig. 4 Pushover curve of an unbraced racking system

Fig. 5 Fractile curve derived from an incremental dynamic analysis for an unbraced racking system

Fig. 6 Fragile curve of an unbraced racking system

Detailed analyses

Fig. 7 Analysis of a single upright member under monotonic loading

Fig. 8 Moment-rotation curve of the examined upright section

Fig. 9 Examination of the pallet-beam’s buckling length with the existence of pallets on the pallet-beams (friction elements)

Fig. 10 Load-displacement curves for different positions of the pallets and different friction coefficient values between pallet and beam
Analytical investigations

Development of a simple equation for the estimation of the maximum value of the sliding force which is developed on a beam under horizontal-eccentric seismic forces

\[ H_2 = \frac{Vb\mu}{2(b+2\mu e)} \quad H_1 = \frac{Vb\mu}{4(2-e\mu)(b+2\mu)} \]

Fig.11 Theoretical model

Fig.12 The maximum forces developed on two supporting beams during the sliding of a pallet

Fig.13 Numerical evaluation of the theoretical results