

Progressive Collapse Simulations of Pallet Rack Systems Subjected to Impact Loads

Daigoro Isobe*, Bingqing Xie[†], Keiju Nakai[†], Unnikrishnan N. Narayanan^{††}
and Nagendiran Veeraraghavan^{††}

* University of Tsukuba, 1-1-1 Tennodai, Tsukuba-shi, Ibaraki 305-8573, Japan,
e-mail: isobe@kz.tsukuba.ac.jp, web page: <https://www.kz.tsukuba.ac.jp/~isobe/>

[†] Graduate School, University of Tsukuba, 1-1-1 Tennodai, Tsukuba-shi, Ibaraki 305-8573, Japan

^{††} Storage Solutions, Godrej & Boyce Mfg Co Ltd, Chennai, India

ABSTRACT

Pallet rack systems are widely used to store goods in logistics warehouses; however, the risk of collapse owing to forklift impacts poses significant safety and economic concerns. This study examined the effectiveness of plan braces and top links in preventing the progressive collapse of an assembled pallet rack system using the ASI-Gauss code [1], a finite element code that is widely used for structural analyses of framed structures. The code allows for the simulation of the collapse behavior of framed structures, including element contact and member fracture behaviors, with a minimal number of element subdivisions. The numerical model of a single-bay, five-level rack system was validated by comparison with loading tests. Furthermore, pushover and dynamic self-weight analyses were conducted on a rack system with a removed upright to clarify the effects of plan braces at different levels [2]. The numerical results indicated that plan braces, particularly at higher levels, significantly strengthened the rack system, with plan braces at the 3rd level offering the best suppression effect in heavier load-carrying situations. Dynamic analyses of a forklift colliding with an assembled rack system at various points and from various directions revealed that the optimal placement of plan braces for preventing progressive collapse varied with these conditions; however, the plan braces at the 3rd level consistently provided the best results, enhancing the stability of the rack system. Furthermore, an analysis was performed with the top link easily disconnected to verify the possibility of using such a method to prevent further progression of the collapse. The above analyses were conducted by substituting carrying loads as densities of lateral beams constituting the rack system. The numerical results by actually modelling the goods and by considering the interaction between those and the rack system are also to be shown in the presentation.

REFERENCES

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