STRUCTURAL ASPECTS OF THE PROGRESSIVE COLLAPSE OF WAREHOUSE RACKING

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SUMMARY

In this dissertation, the design and the use of conventional pallet racking is introduced, and the problems associated with progressive collapses of racking are explained and partially solved.

A method of analysis was needed to simulate a progressive collapse in which the salient features of the collapse could be identified. A multi-degree of freedom dynamic analysis of a collapsing rack was thus developed in chapter 2. The resulting computer analysis was used to identify the changing distribution of internal forces and geometrical changes of racks as they collapse.

Following bottom leg failure by truck collision, a 'Joint Rotation Mechanism' in the two bays supported by the failed leg, is identified. The importance of the pull-out strength of the deforming joints in this mechanism is investigated using the computer program and a number of test collapses in the laboratory. A joint test was also specially devised to quantify the pull-out strength of racking joints in a collapse.

The experimental collapse tests were designed primarily to identify actual collapse mechanisms, but they also provided a calibration for the computer program. The tests confirmed that if the joints are incapable of sustaining the large axial forces set up in the 'Joint Rotation Mechanism', then the joints pull-out and the two collapsing bays separate from the adjacent bays. The experimental tests also confirmed that if the joints do not pull-out, then the tension in the beams may induce mechanisms in the bays adjacent to the Joint Rotation Mechanism. These induced mechanisms, called 'Bottom Leg Sway' if the collapse initiation is close to a free end, and 'Successive Leg Buckling' if the initiation is far from a free end, include the failure of several bottom columns. Consequently, the rack, which remains an integral unit through the unyielding joints, rotates as a rigid body into the aisle and can initiate the collapse of other racks.

Recommendations are presented which include simple formulae for the design of racking with low pull-out strength joints. These would ensure that any [illegible] will probably be confined to the region of initi[illegible]