

## 10. Passively-Controlled Rack for Automatic Warehouse

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The 2011 off the Pacific coast of Tohoku Earthquake shook many automated storage and retrieval systems and caused palletized goods to fall down from the storage racks. If palletized goods fall down from storage racks, the goods may not only be damaged but also get in the way of the automatic carriers so that the distribution of goods is hampered. Measures taken to protect storage racks from earthquakes include the method of strengthening storage racks by installing braces or other reinforcements and the method of installing tuned mass dampers at the top of the storage rack system. These antiseismic techniques, however, may not be as effective as expected if the natural period of vibration of the rack system fluctuates under the influence of such factors as the quantity and distribution of goods in storage. As a seismic response control method whose effectiveness is less affected by the condition of goods stored in racks, therefore, the authors have developed an antiseismic technology of passive response control racks in the direction of rack opening.

**Key words:** automatic warehouse, passively-controlled rack, roller bearing, viscous damper, shaking table experiment, simulation analysis