

Development of post-installed mass damper for automated warehouse

Machiko Yasukawa, Masayoshi Takaki

Taisei Corporation, Kanagawa, Japan

Haruyuki Kitamura, Yoriyuki Matsuda

Tokyo University of Science, Chiba, Japan

Daiki Sato

Tokyo Institute of Technology, Tokyo, Japan

Contact: yskmtk00@pub.taisei.co.jp

Abstract

A vibration control system for an automated warehouse was developed that can be applied to existing warehouses as well as newly built ones. The device used for this system is the “post-installed mass damper” that can be post installed on the cargo storage space in an automated warehouse. This damper has a large mass that causes a sustainable effect of reducing the response across a wide range of natural frequencies of an automated warehouse, which vary depending on the number of stacked cargoes and their weight. The results of the shaking table test demonstrated that the fall of cargoes by the earthquake ground motion could be prevented by using this damper because the accelerations of the rack were reduced to 50%-70%. Moreover, this effect was confirmed by the analysis conducted with the proposed model. The acceleration of the rack top was reduced to 80% and the maximum slip displacement of the cargoes was reduced to 25%.

Keywords: automated warehouse; post install; mass damper; cargoes fall; vibration control; shaking table test; response analysis.

1 Introduction

Fig. 1 shows the overview of an automated warehouse. The warehouse is the steel structure that consists of racks and automated conveying equipment. It can automatically control the storing and shipping of a large number of cargoes within a small floor space. The cargoes are corrugated cartons stacked up on plastic pallets for easy transportation by automated conveying

equipment in the automated warehouse (Fig. 2). The pallet with the corrugated cartons (cargoes) is stacked on but not fixed to the steel bracket of the rack column. Hence, the cargoes slip by the earthquake ground motion and may fall from the storage space due to the strong motion.

In the 2011 off the Pacific coast of Tohoku Earthquake (The 2011 Tohoku earthquake) and the Hyogoken-nanbu Earthquake, 1995, cargoes in warehouses fell on the floor and it caused