Experimental analysis of steel panel dampers in replaceable coupling beams

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Abstract

This paper introduces the theory and design method of replaceable coupling beams on the basis of a real engineering project including five 29-storey residential buildings. Based on the original structure, several configurations of the replaceable dampers located in the center part of the replaceable coupling beams were designed. To study their inelastic seismic performance, full-scale low-cyclic loading tests were conducted in State Key Laboratory of Disaster Reduction in Civil Engineering at Tongji University, while finite element models were built using the general finite element program ABAQUS. The results of the experiments and analysis demonstrate the excellent energy dissipation capacities of the replaceable devices. Good correlations were achieved between the analytical and experimental results of the energy dissipation devices.

Keywords: Replaceable device; seismic performance; high-rise building; energy dissipation; RC structure.

1 Introduction

Shear walls are commonly used in high-rise buildings in order to provide sufficient lateral load resistance of the structures. When architectural openings are required, shear wall is divided into the wall piers and the coupling beams. Unlike frame beams, coupling beams are considered to be the first line of defence against the lateral loads such as winds and earthquakes. As yielding first in the structure, coupling beams dissipate the seismic energy through the plastic deformation and continue to tie the wall piers together to transfer lateral forces. Thus the ductility of the coupling beam is of great importance, which might not be achieved in the actual earthquakes. Figure 1 shows the "X" type shear failure easily occurred in the center of coupling beams during earthquakes, which is considered to be the brittle failure unable to transfer loads. Ductile failure is favourable with plastic hinges forming in the coupling beams. However, failure concentrated at the two ends of the coupling beams is difficult to repair.

(a) *(b)*

Figure 1. Photos of the coupling beam damage (a) in Chinese wenchuan earthquake (2008.05.12). (b) in Chilie earthquake (2010.02.27)

With the idea of earthquake resilient structure, an innovative type of replaceable coupling beam was designed to solve these problems. When replacing the conventional reinforced concrete coupling beams with shear yielding or flexural yielding

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