SEISMIC BEHAVIOR OF NON-SEISMICALLY DETAILED REINFORCED CONCRETE STRUCTURAL SYSTEMS AND COMPONENTS — WHAT HAVE WE BEEN LEARNING?

BING LI and TSO-CHIEN PAN

School of Civil and Environmental Engineering,
Nanyang Technological University, Nanyang Avenue, Singapore 639798

In regions of low to moderate seismic hazard and low wind speed, such as Singapore and Malaysia, buildings with relatively weak lateral load resisting structural system are likely to represent a large portion of the building inventory. Although ground motions, due to long distance earthquakes centered in Sumatra, have occurred in Singapore and Malaysia, there has been no record of earthquake damage locally. Recent post-earthquake investigations indicated that extensive damage has occurred as a result of excessive shear deformation and severe strength degradation of the structural components in non-seismically detailed buildings, thus leading to their full collapse. Therefore, it is of great concern that the strength, ductility, and energy dissipation capacity of these structures are adequate to sustain earthquake-induced loads in regions of low to moderate seismicity. The need for evaluating and improving the detailing of existing structures is obvious. Problems have been encountered when assessing the seismic behavior of non-seismically detailed buildings. They are mainly due to the absence of a theoretical basis for evaluating the element and joint behaviors which are supported by a comprehensive test data. This paper provides an overview of simulated seismic load tests conducted on reinforced concrete beam-column joint subassemblies; columns, and shear walls at the Nanyang Technological University (NTU), Singapore. These investigations attempt to gain a better understanding of the general behaviors of these structural components when subjected to seismic loading.

1. Introduction

It is beyond doubt that Singapore and the Malaysia Peninsular are in a low to moderate seismic hazard area. However, an active earthquake belt, comprising the Sumatra Fault and the subduction zone, is about 350 km away from the closest point. It is probable due to historical perception that no serious damage has been caused by earthquakes to Singapore and the Malaysian Peninsular. In addition, Singapore and the Malaysian Peninsular were once British colonies. As the United Kingdom is situated in an area of very low seismicity, there has not been any design provision for seismic loads on building structures in Singapore and the Malaysian Peninsular when adopting the design standards from the United Kingdom. This policy led to a large number of reinforced concrete structures meant for residential and commercial purposes being built using transfer beam systems to maximize open space at the ground story. While this open space can be used for parking, shops, restaurants and lobbies, it can lead to the seismic consequence of soft story behavior.