C07

Seismic Capacity of High Rise Steel Buildings Under Long Duration Earthquakes

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Recent earthquakes in Japan [Hyogoken-Nanbu (Kobe), 1995] and United States (Northridge 1994 earthquake) illustrated that intensity of ground motions can reach more than two times the design level earthquake stipulated in seismic design codes.. Moreover, occurrences of large earthquakes having a magnitude larger than eight along subduction zones in Southwestern part of Japan (Nankai) have been reported. Due to a large number of inelastic cycles of such ground motions, the effect of cumulative damage on structural components (deterioration) of high rise buildings becomes critical particularly for buildings of old construction in Japan but may also become critical for newly designed buildings in US .

The objective of this research is to evaluate analytically the seismic behavior of high rise buildings designed in Japan, United States and Europe when they are subjected to long duration records. The goal is to make informed decisions in the best interest of society reducing casualties, financial losses and to set priorities for seismic retrofitting. State-of-the-art analytical models are built that incorporate complex failure modes, such as component deterioration and fracture due to cumulative damage. The effect of steel connection fractures on the seismic redundancy of high rise buildings is investigated when they are subjected to long duration records. In order to validate these numerical models that are able to simulate responses of high rise steel structures at large deformations, unique experimental data is used from recently conducted earthquake simulator tests of a high-rise building (see Figure 1) at a large shaking table facility (E-Defense).

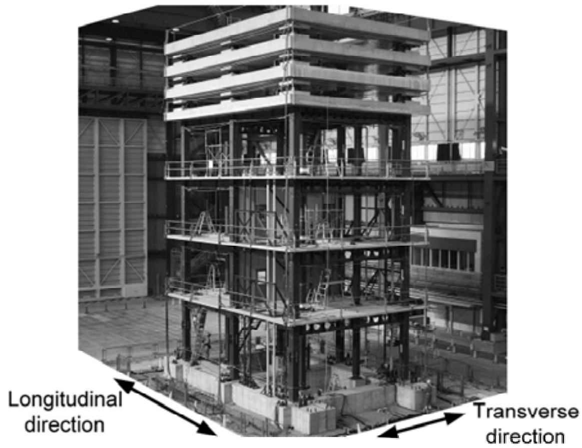

Figure 1. E-Defense earthquake simulator test for seismic evaluation of high rise buildings (Chung et al. 2009).

From preliminary assessment of results, it is concluded that these analytical models are able to simulate well the response of high rise buildings (see Figure 2).

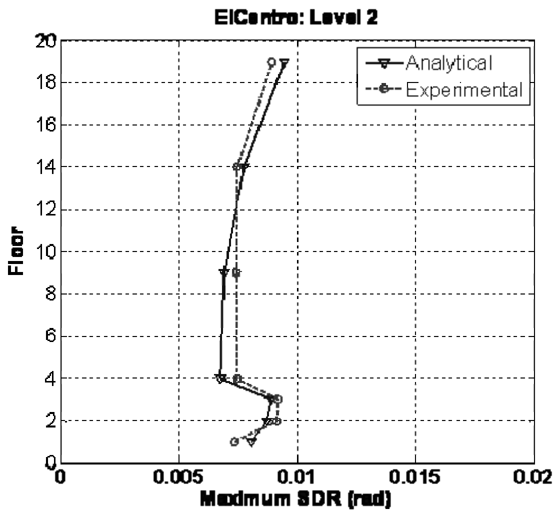

Figure 2. Experimental versus analytical response of a high rise building at a Level 2 earthquake