SEISMIC EVALUATION OF STEEL DUAL SYSTEMS AGAINST ARTIFICIAL EARTHQUAKES

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Dual systems in form of steel moment frames accompanied with chevron bracings (SCBF) are among commonly used systems in high seismicity regions in the world. Therefore, the recognition of their seismic behavior is of high importance. Since SCBF systems allow buckling and yielding of braces as well as yielding of connections, they dissipate energy easily. Due to reduction in required steel and welding, these systems are more economical in comparison to special steel moment frames. Except a few parts of the world that have sufficient earthquake records, artificial accelerograms can be used in other regions.

In this paper, the seismic performance of steel moment frames accompanied with chevron bracings are investigated by FEMA-p695 instruction. Wavelet transform method is used in order to generate artificial accelerograms. The mother wavelet function used in this article is proposed by Suarez and Montejo (2005), and is a wavelet based on the impulse response of an underdamped oscillator. Spectra matching process is performed for 44 earthquake records proposing by FEMA-p695, with design spectrum prescribed by ASCE/SEI 7-05 for high seismicity regions and soil type D.

5-, 10-, 15- and 20-story planar building frames are studied. These frames are selected from three-dimensional structural modeling in which, to avoid the effects of geometrical asymmetry, plans are considered symmetric and similar. Each frame constitutes of five identical spans with width of 5 m and story height in all of them is 3.2 m. They are designed in accordance to ASCE7 and AISC360-05 requirements.

Frames are modeled in OpenSees. Inelastic seismic demands of the superstructure are considered using concentrated plasticity model. Braces are modeled with two elements with an initial eccentricity in the middle of each brace to model buckling. Fracture in braces is modeled with proposed method by Uriz and Mahin (2008), and gusset plates are modeled with proposed method by Hsaio (2012). This model is shown in Figure 1.

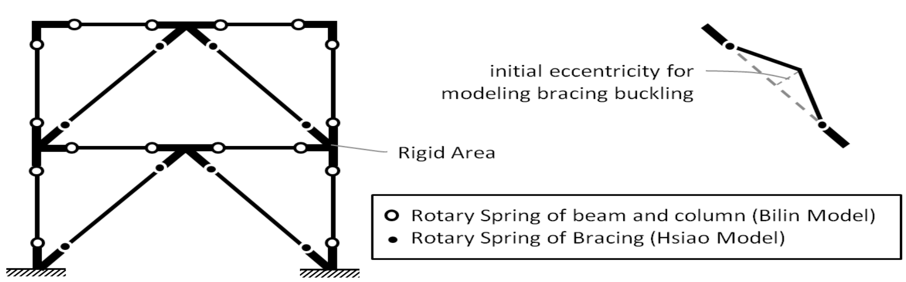


Figure 1. The bracing end hinge model introduced by Hsiao (2012)

In order to check the structural capacity of each frame nonlinear static analysis is performed. Nonlinear time history analysis is done in order to investigate seismic behavior of this system against real and artificial earthquake records. It can be concluded that responses against artificial records has far less dispersion, while the average responses in these two sets of records are approximately the same (Figure 2).

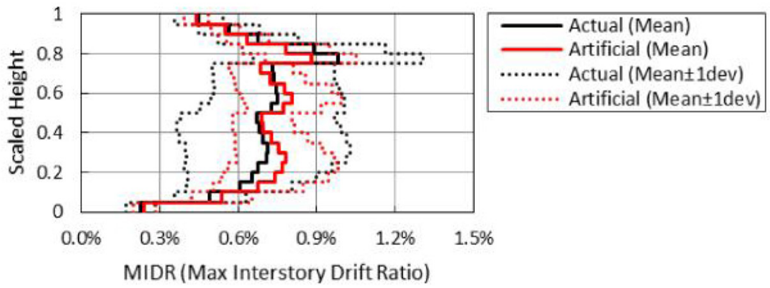
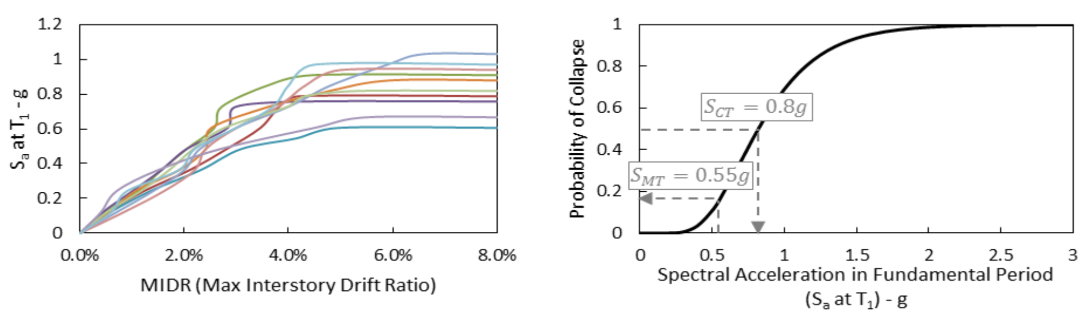


Figure 2. Average MIDR according to artificial and real earthquakes

Incremental dynamic analysis using artificial records is performed to calculate adjusted collapse margin ratios as suggested by FEMA-p695. Results show that each individual frame and all of them as a group satisfy the FEMA-p695 criteria (Table 1). Additionally, fragility curves are calculated to show the probability of collapse for each frame (Figure 3).



a: IDA Curve

b: Fragility Curve

Figure 3. IDA curve and Fragility curve for 20 story frame

Table 1. Adjusted collapse margin ratios

Story	S_{MT}	S_{CT}	CMR	SSF	ACMR	ACMR accp. (20%)	
5	1.5g	2.6g	1.67	1.33	2.32	1.73	PASS
10	1.1g	1.8g	1.63	1.41	2.30	1.73	PASS
15	0.7g	1.1g	1.57	1.46	2.29	1.73	PASS
20	0.5g	0.8g	1.50	1.51	2.27	1.73	PASS
			ACMR avg.		2.29	PASS	
			ACMR accp. (10%)		2.30		

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