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EVALUATION OF FEMA P-58 METHOD FOR ESTIMATING RESIDUAL DRIFT DEMANDS IN BUCKLING RESTRAINED BRACED FRAMES

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Evaluating the performance of structures after an earthquake is a very important issue for structural engineers. One of the ways for performing such an evaluation is estimating residual drifts due to earthquake. Buckling Restrained Braced Frames (BRBFs) have low post-yield stiffness of brace core, and therefore, may experience large residual drifts after moderate to severe ground motions. In this study, the accuracy of FEMA P-58 method is evaluated for estimating residual drift demands in BRBFs. For this purpose, two BRBFs having 2 and 6 stories height are designed according to ASCE 7-10, AISC 360-10 and AISC 341-10, and three strain hardening ratios (i.e., α=0.003, 0.01 and 0.02) are assumed for each of them. A site located in California with soil class D according to ASCE 7-10 is assumed for the structures. The structures have a regular plan with six and four bays in X and Y directions, respectively. The story heights are 3.96 m and the widths of all the bays are 9.14 m. For each of the two structures, one of the four braced bays in Y direction is simulated using OpenSees software. Then, nonlinear dynamic analyses are performed on the BRBFs using a set of 78 far-fault ground motion records, scaled to five different intensity levels (i.e., R=1.5, 2.0, 3.0, 4.0 and 5.0). R is the ratio of pseudo-spectral acceleration at the fundamental period of structure to γ; where γ is obtained from dividing the base shear corresponding to yielding initiation to the seismic weight. After performing the analyses, residual drifts are computed for the BRBFs, and the accuracy of the method considered for estimating residual drifts is evaluated.

FEMA P-58 proposed an equation for estimating the median residual drift of each story of a structure as follows:

$$\begin{aligned} \Delta_r &= 0 && \Delta \le \Delta_y \\ \Delta_r &= 0.3(\Delta - \Delta_y) && \Delta_y < \Delta < 4\Delta_y \\ \Delta_r &= (\Delta - 3\Delta_y) && \Delta \ge 4\Delta_y \end{aligned} \quad (1)$$

where Δ_r is the median residual drift, Δ_y is the story yield drift and Δ is the median of maximum interstory drifts for the story of interest. Figure 1 compares the median residual drift profile obtained from the analyses and that estimated by the FEMA P-58 method for the 6-story structure with α =0.003. According to this figure, in most cases the FEMA P-58 method approximates median residual drift larger than the value obtained from the analyses. This result was observed for both the BRBFs given different values of α. Thus, it can be concluded that the FEMA P-58 method is usually conservative for estimating median residual drifts of BRBFs. Moreover, it can be clearly seen that by increasing the intensity of ground motion the values of median residual drift increase.

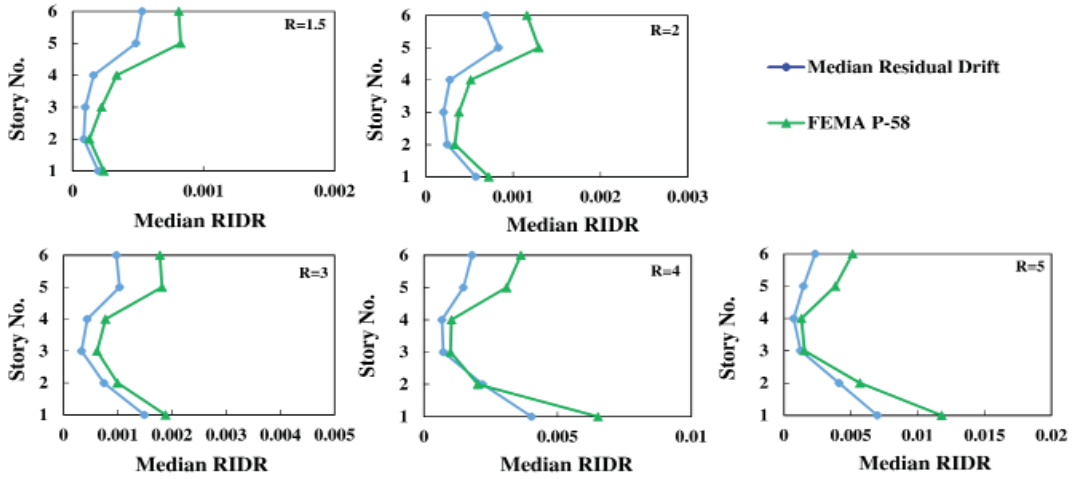

Figure 1. Median residual drift profile obtained from the results of analyses and that estimated by the FEMA P-58 method for the 6-story structure with α=0.003 given different values of R.

REFERENCES

ANSI/AISC 360-10 (2010). *Specification for Structural Steel Buildings.* American Institute of Steel Construction, Chicago, IL.

ANSI/AISC 341-10 (2010). *Seismic Provisions for Structural Steel Buildings.* American Institute of Steel Construction, Chicago, IL.

ASCE/SEI 7-10 (2010). *Minimum Design Loads for Buildings and Other Structures.* American Society of Civil Engineers, Reston, VA.

Federal Emergency Management Agency (FEMA) (2012). *Seismic Performance Assessment of Buildings Volume 1-Methodology. Rep. No. FEMA P-58-1.*

McKenna, F., Fenves, G.L., and Scott, M.H. (2015). *Open System for Earthquake Engineering Simulation.* University of California, Berkeley, CA.