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EVALUATION OF THE EFFECTS OF MODELING UNCERTAINTIES ON THE SEISMIC PERFORMANCE OF REINFORCED CONCRETE FRAMES

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In recent years, researchers have paid much attention to evaluate the effects of modeling parameters in steel frames; however this subject has been less studied in reinforced concrete frames. The modeling parameters are one of the important parts of the epistemic uncertainties in probabilistic assessment of structures that are obtained from physical and geometrical features of the structure; for example ASCE 41-13 (2014) introduces the parameters of nonlinear moment-rotation behavior of reiforced concrete's beam column elements as a function of longitudinal and transverse reinforcement and also axial and shear demand.

The modeling parameters are indeed the parameters obtained from backbone curves of the beam-column elements; which have been previously introduced by Ibarra et al. (2005) and include initial stiffness, capping point rotation (θ_c), post capping rotation (θ_{pc}) and etc. Some of the modeling parameters are shown in Figure 1.

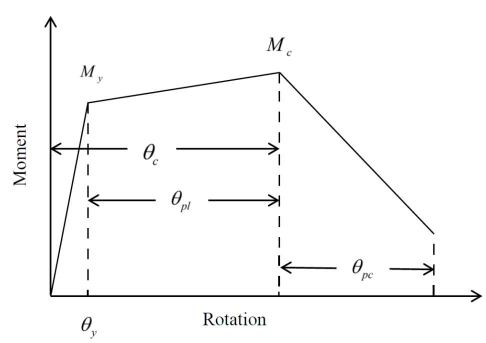

Figure 1. The backbone moment-rotation curve and some modeling parameters

Evaluating the effects of these parameters can be executed by analyzing several concrete frames under different values of the mentioned parameters. Besides, the possible dependency amongst different parameters should be taken into account. This study is aimed at evaluating the uncertainty effects in some of modeling parameters by analyzing two reinforced concrete frames, one of which is a one story-three bay frame and the other is a four story- three bay one. It should be mentioned that the result of only 4-story frame has been shown here and the result of the other frame is explained in the full paper.

Modeling parameters have been calibrated by Haselton et al. (2007) for the beam-column elements of reinforced concrete frame buildings; for instance the calibrated equation of total rotation capacity (capping point rotation) and post capping rotation are proposed by Equation 1 and Equation 2 respectively.

$$\theta_c = 0.14(1+0.4a_{sl})(0.19)^{\nu}(0.02+40\rho_{sh})^{0.54}(0.62)^{0.01c_{units}f_c'} \quad (1)$$

$$\theta_{pc} = (0.76)(0.031)^{\nu}(0.02 + 40\rho_{sh})^{1.02} \leq 0.10 \quad (2)$$

Where, θ_c is capping point rotation, θ_{pc} is post capping rotation, ν is the axial load ratio, ρ_{sh} is the area ratio of transversal reinforcement, a_{sl} is an indicator to signify possibility of longitudinal rebar slip to pass the column end and f_c' is concrete's compressive strength. The mean capping point rotation and post capping rotation are obtained from Equation 1 and Equation 2 and the reported coefficients of variation are 0.48 and 0.72 respectively.

In order to evaluate the effect of Equation 1 and 2 on the capacity curve of the structure, a number of modeling parameters of all beam-column elements have changed in $\mu \pm 0.5\sigma$ and $\mu \pm \sigma$ manner and the structure is analyzed to percept the variation of the structural response. For example, the analysis result of the variation of capping point and post capping rotation on the 4-story frame is shown in Figure 2.

Another important issue is the dependency of parameters on each other, in other words the correlation effect of the parameters on the final response should be evaluated. For example, the capping point and post capping rotation have been varied to multiple cases simultaneously. The results of this study are demonstrated in Figure 3. It should be mentioned that the mean values of θ_c and θ_{pc} are termed as μ and μ' as well as σ and σ' for the related standard deviations.

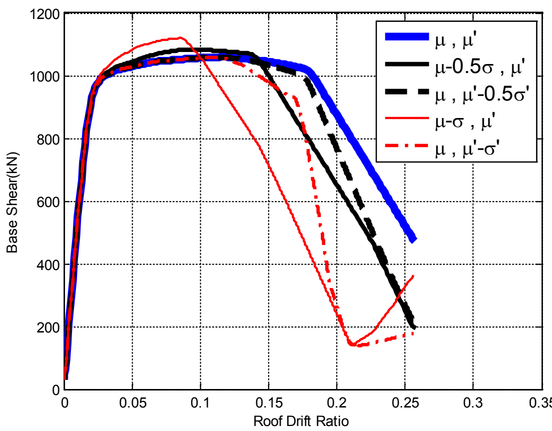

Figure 2. Comparison of capacity curves of multiple θ_c and θ_{pc} variation cases in the 4-story frame

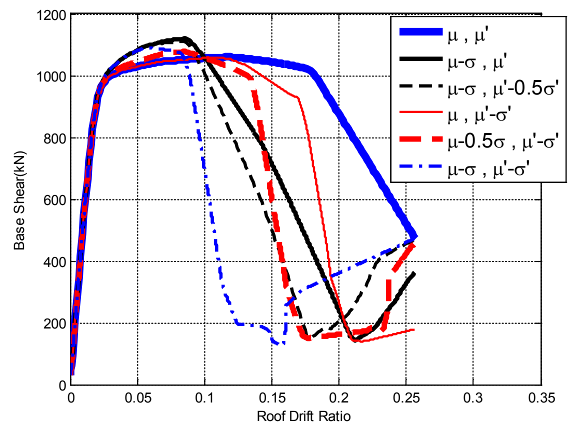

Figure 3. The effect of correlation between θ_c and θ_{pc} on the capacity curve of the 4-story frame

From the above figures, it is concluded that the capping rotation has much more effect than the post capping rotation on the capacity curve of the 4-story reinforced concrete frame. On the other hand taking the correlation between capping rotation and post capping rotation has a significant effect on the capacity curve of the structure, thus such correlations between uncertainties of modeling parameters should be considered in analysis.

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