SEISMIC PERFORMANCE ASSESSMENT OF CONCRETE MOMENT-RESISTING FRAMES WITH CONSTRUCTION ERROR AGAINST NEAR-FAULT STRONG GROUND MOTIONS

Ehsan KHOJASTEHFAR
Assistant Professor, Vali-e-Asr University of Rafsanjan, Rafsanjan, Iran
e.khojastehfar@vru.ac.ir

Hamid GHANBARI
Ph.D. Candidate, Shahid Bahonar University of Kerman, Kerman, Iran
ghanbari.sazeh@gmail.com

Farzad MIRZAEI AMINIAN
M.Sc. Graduate, Vali-e-Asr University of Rafsanjan, Rafsanjan, Iran
farzad.aminian@ymail.com

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Man-made structures have always been subjected to construction errors. Although improvement of construction techniques decreases the mentioned errors; however, to achieve the reliable results regarding seismic performance of structures construction errors must be involved. Seismic performance assessment of sampled moment-resisting concrete frames with construction error is considered as the first goal of this paper. Besides, as the second goal, effects of near-fault strong ground motions on seismic performance of the sampled frames are studied.

To achieve the mentioned goals, three concrete moment-resisting frames with 4, 6 and 10 stories has been designed according to the national seismic design code (Standard No. 2800). Nonlinear modeling of the sampled frames was implemented assuming the concentrated plasticity model by OpenSEES tool. The hysteretic formulation of the concentrated hinges is based on Modified Ibarra-Krawinkler (Ibarra et al., 2005) hysteretic model. The modeling parameters have been verified based on relevant experimental results (Haselton et al., 2016). To involve the effects of construction errors, three scenarios are considered. These scenarios consist of frames with no construction error (with no initial drift); columns initial drifts equal to the allowable construction tolerance and columns initial drifts larger than the allowable construction tolerance. The modeled frames for each scenario have been excited with two sets of strong ground motions, which consist of 20 near- and 20 far-fault events.

Probabilistic seismic demand model (PSDM) shows the structural demand probability distributions against various strong ground motion intensities. The PSDM corresponding to the design-level intensity is used as the indicator of the seismic performance of the sampled frames. Therefore, the structural time-history analyses are implemented against the strong ground motions which are scaled to the design intensity. For instance, the cumulative probability distributions of structural demand (Maximum Inter-story Drift Ratio (MIDR)) for the 4-story intact frame are shown in Figure 1. The allowable MIDR is shown by the vertical green line. The corresponding probabilities show the probability of MIDR being less than the allowable threshold, which is used as the indicator of seismic performance of structure. Similarly, the relevant probabilities are presented in Table 1 for the sampled frames and various construction error scenarios.

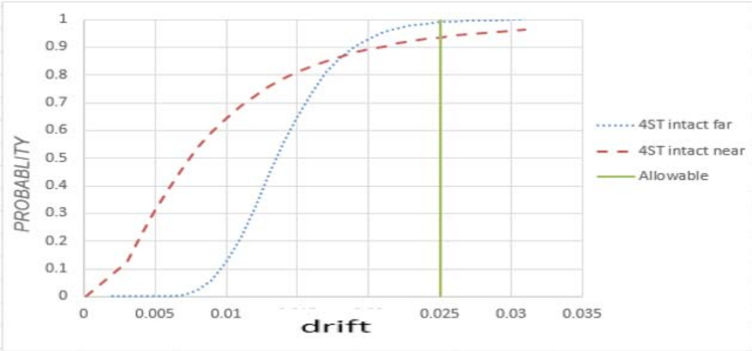

Figure 1. MIDR cumulative probability distributions for 4-story intact frame.

Table 1. Seismic performance of the sampled frames.

Probability of MIDR being less than allowable MIDR (far-fault strong ground motions)	**Probability of MIDR being less than allowable MIDR (near-fault strong ground motions)**	**Structure**
98٪	93٪	4-strory structure, the first scenario
97٪	90٪	4-strory structure, the second scenario
97٪	88٪	4-strory structure, the third scenario
84٪	91٪	6-strory structure, the first scenario
83٪	88٪	6-strory structure, the second scenario
81٪	88٪	6-strory structure, the third scenario
61٪	98٪	10-strory structure, the first scenario
61٪	98٪	10-strory structure, the second scenario
60٪	95٪	10-strory structure, the third scenario

According to the achieved results, it can be concluded that: For the 4-story frame which is considered as the representative for low-rise structures, the calculated probabilities considering the near-fault strong ground motions are less than those of far-fault strong ground motions in all three scenarios. As the construction error increases the calculated probability decreases considering the near-fault strong ground motions, while the calculated probabilities considering the far-fault strong ground motions are kept constant. This conclusion shows that the seismic performance of low-rise structures is mostly affected by near-fault strong ground motions. Furthermore, the deterioration of seismic performance of the low-rise structure due to construction deficiency is more noticeable while the structure is affected by near-fault strong ground motions.

In 6-story and 10-story buildings, which are considered as the representatives for mid- and high-rise structures, the calculated probabilities are lower for far-field strong ground motions.

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