COLLAPSE CAPACITY ASSESSMENT OF REGULAR TALL BUILDINGS UNDER PULSE LIKE NEAR FIELD GROUND MOTIONS

Ali SAFFAR
Graduate Student, Civil Engineering Department, Sharif University of Technology- International Campus, Kish Island, Iran
saffar@kish.sharif.edu

Fayaz R. ROFOOEI
Professor, Civil Engineering Department, Sharif University of Technology, Tehran, Iran
rofooei@sharif.edu

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Structural response to near fault ground motions has received significant attention in recent years. Such ground motions are different from ordinary ones and are characterized by a large, long period, velocity pulse caused by the forward directivity. These velocity pulses could potentially impose sever demands on structures and increase their risk of seismic collapse. The situation could even be worse for tall buildings with fundamental periods close to the period of the velocity pulses, thus requires special consideration in design process.

Prediction of seismic-induced collapse potential of structures has been among the main concerns in Performance Based Earthquake Engineering (PBEE). The results could be used as an important measure in designing new structures, or evaluating the seismic performance of existing ones. Not surprisingly, much effort has been made in accurate prediction of collapse capacity of structures due to its importance in estimation of the human and monetary losses during and after an earthquake episode.

In this paper the collapse capacity of regular tall buildings under near-field ground motions with directivity effect will be investigated. A number of 15, 20, 25 story building models are considered. Using a sufficient number of near field ground motions [Baker (2007), PEER NGA database], the effect of near fault ground motion on the models will be evaluated. In order to recognize the strong pulses in velocity time histories, all the pulse like ground motions in database have been rotated to the fault normal direction. Seismic collapse risk of each archetype buildings is evaluated using incremental dynamic analysis (IDA) (Vamvatsikos and Cornell, 2002). The procedure will be repeated for the far field earthquake excitations to compare the effect of near field and far field earthquake excitations on the collapse capacity of tall buildings. The far-field earthquake records are selected from the records suggested by FEMA P695. The work is to be presented here is part of a comprehensive research on collapse capacity of irregular tall buildings subjected to near-field ground motions. The hypothetical site of the buildings located in down town Los Angeles, California, USA with the longitude = -118.25 and latitude= 34.05 that is near to several known faults.

In order to evaluate the collapse risk of the structural models, this study utilizes the λ_c to calculate the probability of collapse of the buildings in 50 years to estmaite the potential collapse of the considered structural models in order to determine if they fulfills the ASCE7-10 target design collapse level requirement which is 1% in the 50 years. Seismic hazard curve and collapse fragility curve of buildings are two main component to compute the λ_c. The procedure to estimate the λ_c and deaggregation is presented in the Figure 1 for the 20 story building model. Figure 1(c) shows deaggregation λ_c for the 20 story model along with the slope of hazard curve for the hypothetical site shown in Figure 1(a) and collapse fragility curve of the model presented in Figure 1(b). Regarding to the λ_c deaggregation, the maximum value in Figure 1 which is corresponding to the highest collapse risk contribution, occurs when Sa(T1=3.14,5%) equals 0.1765 for aleatory uncertainty which is related to the collapse probability of only 11%.

The collapse assessment of structural models under near fault directivity excitation shows a higher value than expected by the code which is 1% in 50 years but in the case of the farfield sites, the result are almost consistent with the design collapse level defined by the code.

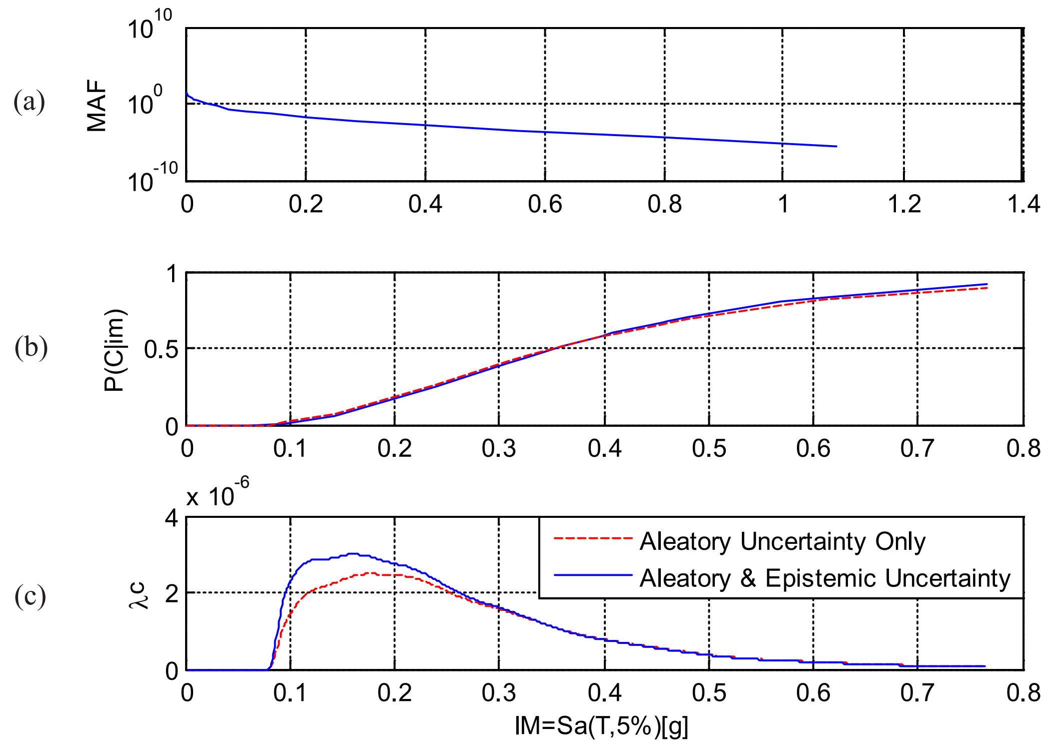

Figure 1. Depicting of λc deaggregation procedure: (a) seismic hazard curve numerical derivative for the hypothetical site, (b) collapse fragility curve, and (c) λc deaggregation

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