EVALUATION OF SEISMIC RESPONSE OF TALL BUILDINGS WITH FRAMED TUBE SKELETONS IN HIGH SEISMIC AREAS

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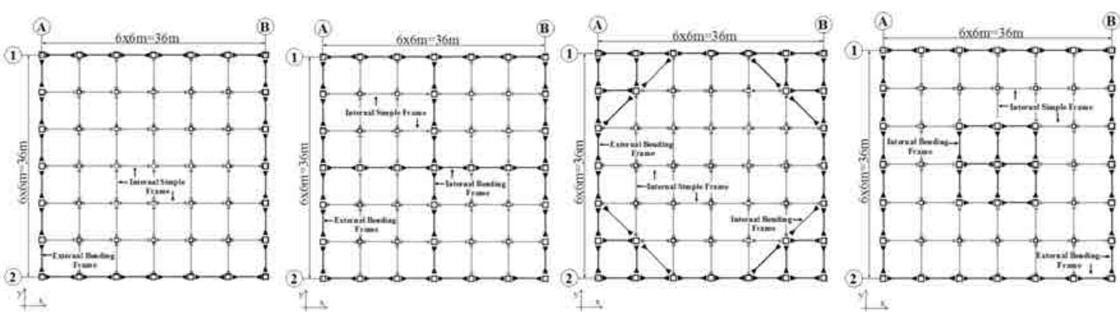
In this research, the performance abilities associated with tube type lateral load resistant framed systems are studied in order to assess the seismic response parameters of steel tall buildings subjected to both far and near-field earthquake records. For this purpose, four 30 story structural models with framed tube based skeletons were selected and designed. The plans of models are shown in Figure 1. The structural models have been designed according to the Iranian seismic code 2800(3rd edition). Findings from the study reveal that median maximum demands and the dispersion in the peak values were extremely higher for near-fault records than far-fault motions. The maximum story drift for the studied tubular rigid frames was determined and compared with the "life safety" and "collapse prevention" performance limits, as recommended by FEMA 356.



(a) (b) (c) (d)

Figure 1. The plans of the studied models: (a) Framed tube; (b) Bundled tube; (c) Castled tube; (d) Cellular tube

The ground motion database compiled for non-linear dynamic time history analyses constitutes a representative number of far-fault and near-fault ground motions from a variety of tectonic events. One of the most distinctive features that can be observed in nature of strong near field records is the ability to generate a relatively long-duration and high-energy pulses in the velocity time history. It must be mentioned that the figure, amplitude and duration of velocity pulses are depended on the type of fault mechanism and epicentral areas of earthquakes which will be emerge as different shapes.

The structural resistant system of tall buildings should be capable to dissipate high kinetic energy in a single or few excursions. Research results indicate that the typical configuration of such behavior is the appearance and rapid distribution of nonlinear hinges in the lateral load resistant system as well as an intensive entrance into the upper levels of nonlinear performance. According to studies on the special moment resisting frames, the seismic demands are extremely increased by the records contains velocity pulses (Movahed et al., 2014). Furthermore, the Fourier amplitude spectra and both acceleration and velocity response spectrums of the near-field earthquake records which contain forward directivity effects are completely different from those records at far-field stations (Kalkan 2006, Bray and Marek, 2004; Alavi and Krawinkler, 2000).

The illustrated outputs of the analyzed models show that the existence of high-amplitude coherent pulses in the velocity time history of damaging near-field records (Figure 2), causes a regime of severe inelastic demands in high-rise buildings as well as the emergence of intensive non-linear characteristics in the overall seismic behavior of the structural skeletons. When the ratio of the velocity pulse period to the structure natural period is greater than unit (Tp/T1 ≥1), it can cause the formation of a plastic mechanism with high levels of nonlinear performance, specially in the middle and upper stories of all four studied tall structures.

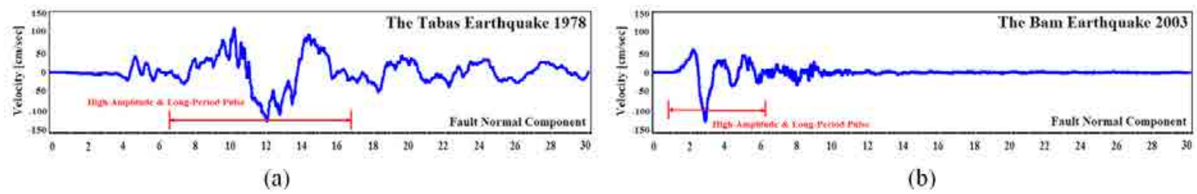
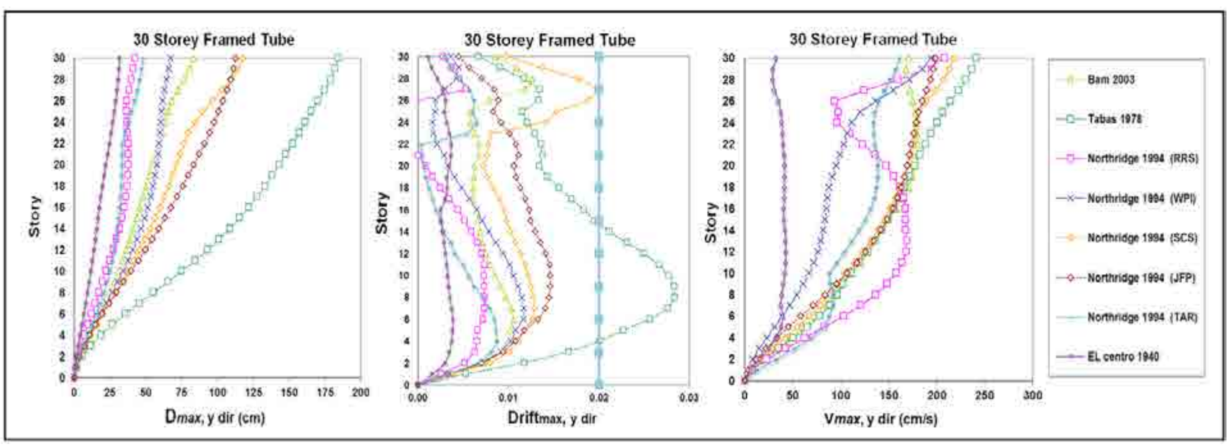


Figure 2. The velocity time histories: (a) Tabas-1978 (TAB-TR Component); (b) Bam 2003 (BAM-TR Component)

It is worth mentioning that based on the assessment of the analytical results of this research, the severity of the structural demands is extremely influenced by the ratio of the two aforementioned periods. Furthermore, the maximum computed displacement is about 180 cm (Figure 3a), the general drift demand is less than 0.02 of radian (Figure 3b) and the maximum value for velocity of stories is greater than 250 cm/sec (Figure 3c) in the direction of the y axis of the plan of all studied models.



(a) (b) (c)

Figure 3. The maximum seismic response parameters of 30 story Framed-Tube model: (a) The lateral displacement parameter; (b) The drift demand; (c) The story velocity distribution

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