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EVALUATION OF IRANIAN CODE NO.2800 FOR SEISMIC RESISTANT DESIGN OF NEAR SOURCE BUILDINGS BASED ON REAL RECORD OF IRAN

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ABSTRACT

In this paper characteristics of near-field earthquakes and difference of ground motion response key parameters in these earthquakes, based on real records of Iran are presented and efficiency of Iranian seismic building code for design of buildings subjected to near-field earthquakes is evaluated. The equivalent static method to calculate the lateral earthquake force exerted on buildings, is common and extensively used. Iranian code of practice for seismic resistant design of buildings, Standard No.2800-05, uses *V= (ABI /R)*W* relationship to calculate this lateral force. Where A (=design basis acceleration over the bedrock) and B (=the amplification factor) are related to earthquake, and near-field earthquakes may induce dramatically high response in fixed-base building. In this research peak ground acceleration over the bedrock & amplification factor suggested by Iranian Standard No.2800-05 are assessed according to near field earthquake records in Iran and also the results are compared with UBC97 code. The outcomes show the inefficiency of Standard No.2800-05 for calculating the near source structures. Furthermore, according to this study, a design spectrum is suggested for Iran which it can be used in both near field and far field regions.

INTRODUCTION

Iran is one of the most seismically active areas in the world. This activity primarily results from its position as a 1000-km-wide zone of compression between the colliding Eurasian and Arabian continents [Engdahl E. R et al. 2006]. In this country, there are many active faults, and a destructive earthquake occurs every several years.

The existence of many active faults in the Iran, this fact that Iran is one of the most seismically active areas in the world, and the occurrence of severe earthquakes in the past show that occurring of severe earthquakes are probable in the future in Iran. Fig. 1 represents the regionalized seismicity and active faults in the Iran region, and Fig.2 shows seismic moment release in the Iran region (1918–2004), Scaling by equivalent moment magnitude (Mw).

Because many important cities like Tehran, Shiraz, and many other cities are located in near active faults, and the occurrence of large earthquakes are probable in Iran, occurrence of large earthquakes close to important cities in Iran is inevitable, so the importance of this research is obvious.

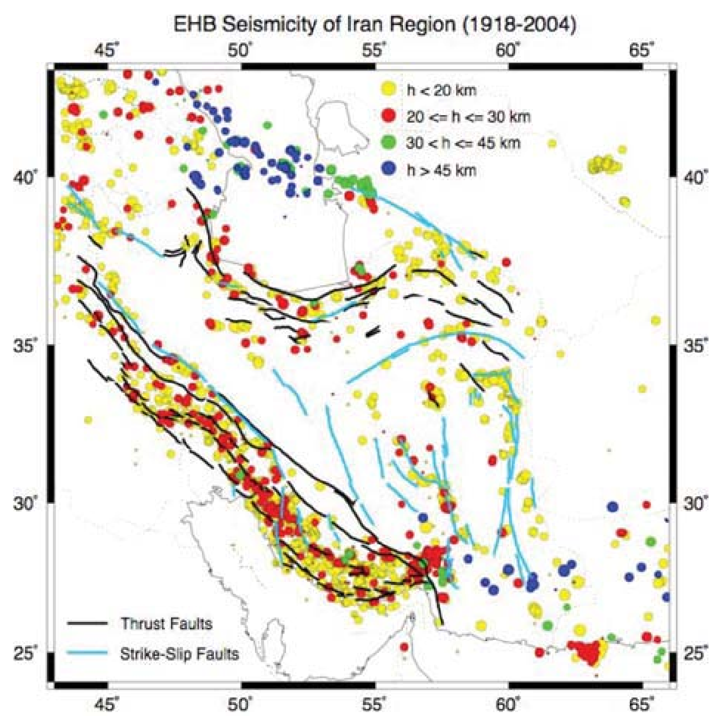

Fig.1. EHB regionalized seismicity in the Iran region (1918–2004). Also shown are thrust (black) and strike-slip (blue) faults. (Engdahl E.R. 2006)

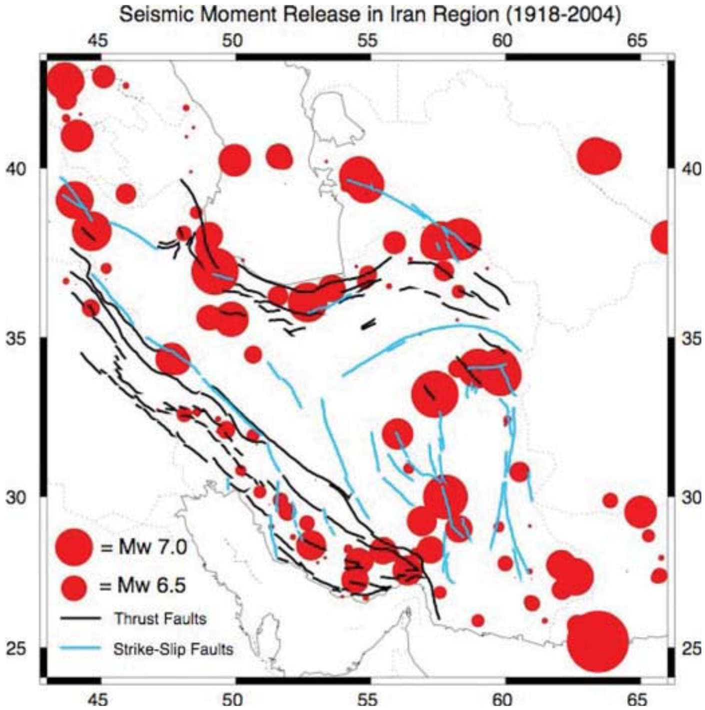

Fig.2. Seismic moment release in the Iran region (1918–2004). Scaling by equivalent moment magnitude (Mw) is indicated. (Engdahl E.R. 2006)

EARTHQUAKE DATA

Among all earthquakes recorded by Iranian building &housing research center (BHRC), the following six near-field ground motions were selected on the data basis of the following conditions:
1. The records with a site to source distance less than 20 km are selected in this study.
2. The records with a surface magnitude greater than 6 are selected in this paper.

In this study, the six earthquakes recorded by BHRC, were

(a) Zanjiran (1994): The 1994 Zanjiran ground motion was recorded during Ms6, at a soil type II site, according to Iranian seismic building code, located at 12 km from the surface projection of the fault. The peak values of ground acceleration, velocity and displacement (PGA, PGV, and PGD) are 1.16g, 40.5 cm/s, 2.34 cm respectively. The bracketed duration, the time that occurs between the first and last exceedance of .05g in the acceleration time history is 14.29 s.
(b) Naghan (1977): The 1977 Naghan ground motion was recorded during Ms6.1, at a site type I site, according to Iranian seismic building code, located at 5 km from the surface projection of the fault. PGA, PGV and PGD are .48 g, 55.1 cm/s and 12 cm respectively. The bracketed duration is 8.79 s.
(c) Ghaen (1976): The ground motion was recorded during Ms6.4, at a soil type I site, according to Iranian seismic building code, located at 10 km from the surface projection of the fault. PGA, PGV and PGD are .17 g, 24 cm/s and 6.5 cm respectively. The bracketed duration is 5.27 s.
(d) Mimand (1994): The ground motion was recorded during Ms6.1, at a soil type II site, according to Iranian seismic building code, located at 17 km from the surface projection of the fault. PGA, PGV and PGD are .46 g, 19.45 cm/s and 2.59 cm respectively. The bracketed duration is 9.75 s.
(e) Golbaf (1981): The Golbaf ground motion was recorded during Ms7, at a soil type III site, according to Iranian seismic building code, located at 13 km from the surface projection of the fault. PGA, PGV and PGD are .28 g, 28.5 cm/s and 5.42 cm respectively. The bracketed duration is 45.09 s.
(f) Bam (2003): The Bam ground motion was recorded during Ms6.7, at a soil type I site, according to Iranian seismic building code, located at 2 km from the surface projection of the fault. PGA, PGV and PGD are 0.795g, 123.5 cm/s and 34.3 cm respectively. The bracketed duration is 11 s.

SMOOTH ELASTIC RESPONSE SPECTRA

The smoothed Newmark-Hall type elastic response spectra (Green R. A. and Hall W., 1994) for six earthquakes including: Bam, Naghan, Ghaen, Zanjiran, Mimand and Gholbaf are plotted in Figure 3, and each plotted spectrum was compared with Iranian Code of Practice for Seismic Resistant Design of Building and with UBC 97.

In these plots, the middle region with constant pseudo spectral velocity is known as the velocity-sensitive region, the region to the right of it is known as the displacement-sensitive region and the region to the left of it is known as the acceleration-sensitive region. The spectral amplitudes in various regions depend on the values of PGA, PGV and PGD, while the widths of the various regions depend on the ratios between PGA, PGV and PGD (P. K. Molhotra, 1999). The PGV/PGA ratios for Bam, Ghaen and Naghan ground motions are 0.16s, 0.14s and 0.12s respectively, the acceleration-sensitive region expends up to 0.85s, 0.8s and 0.65s respectively. The PGV/PGA ratios for Bam, Ghaen and Naghan ground motions are higher than the other three ground motions. The width of acceleration-sensitive region for Zanjiran, Mimand and Gholbaf ground motions are 0.2s, 0.23s and 0.54s respectively. The widths of the acceleration-sensitive region for both second and third edition of Iranian siesmic building code are 0.4s for soil type I, 0.5s for soil type II and 0.7s for soil type III (BHRC – PN 253, 2005).

The acceleration-sensitive region for the Bam, Ghaen and Naghan ground motions are 2.2, 2 and 1.6 times as wide as the acceleration-sensitive region recommended by the Iranian siesmic building code.

The figures 3 to 8 show the plots smoothed Newmark-Hall type elastic response spectra for six selected earthquakes that have been compared with tripartite form of design spectra of both UBC97 and Iranian Code. Iranian Code has proposed the plots of amplification factor (B), so to plot design spectra of Iranian Code the plots of amplification factor (B) are multiplied by design basis acceleration over the bedrock (A).

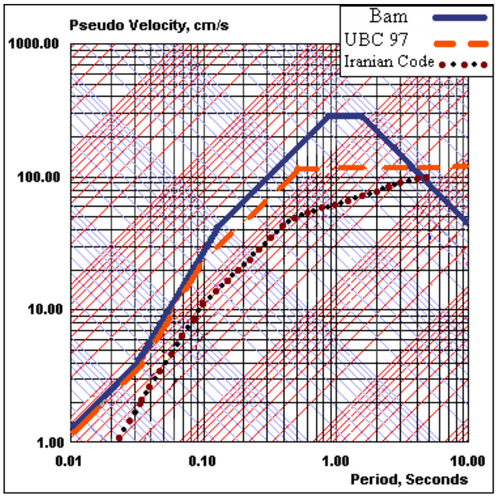

Fig.3. Tripartite plot of 5% damped elastic response spectra of Bam earthquake, UBC 97 and Iranian Code

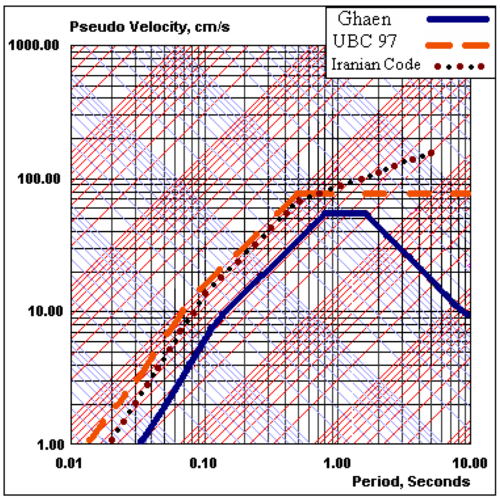

Fig.4. Tripartite plot of 5% damped elastic response spectra of Ghaen earthquake, UBC 97 and Iranian Code

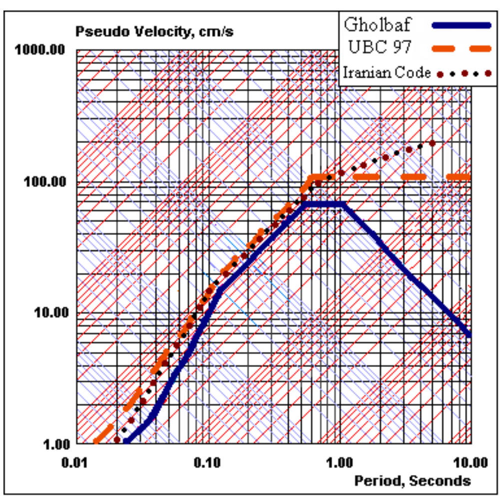

Fig.5. Tripartite plot of 5% damped elastic response spectra of Gholbaf earthquake, UBC 97 and Iranian Code

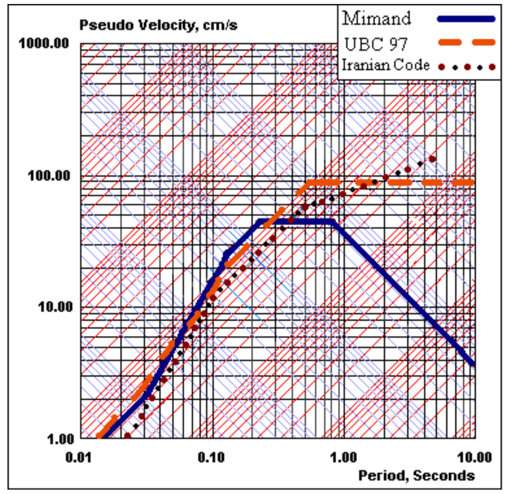

Fig.6. Tripartite plot of 5% damped elastic response spectra of Mimand earthquake, UBC 97 and Iranian Code

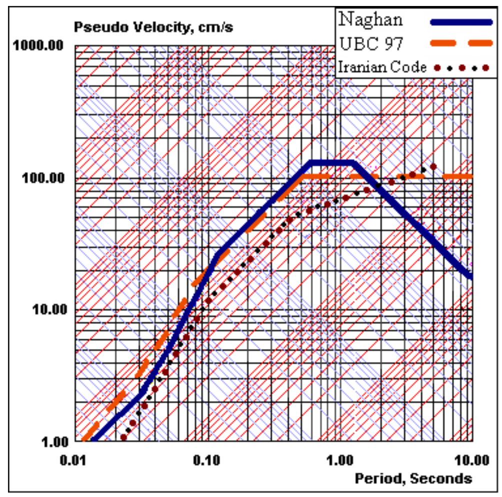

Fig.7. Tripartite plot of 5% damped elastic response spectra of Naghan earthquake, UBC 97 and Iranian Code

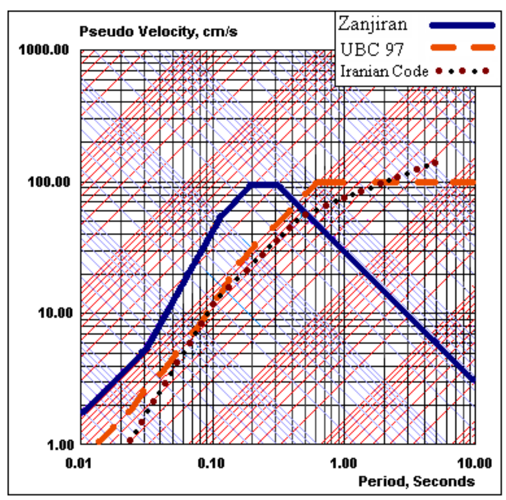

Fig.8. Tripartite plot of 5% damped elastic response spectra of Zanjiran earthquake, UBC 97 and Iranian Code

PROPOSING A DESIGN SPECTRUM FOR NEAR SOURCE BUILDING

The selected near-field ground motion tripartite response spectra along with plotted tripartite design spectra based on Iranian Code and UBC97 are assessed. Some the most important defects are according to below:

- The values of PGA, PGV and PGD of near-field earthquakes may increase severely.
- The values of Iranian code design spectra after 2sec are very careless, while the values of UBC97 spectra after 2sec are appropriate.
- The width of the acceleration-sensitive region for the near-field earthquakes may be more than twice as width as acceleration-sensitive region recommended by Iranian Code.
- In general, Design Spectra of Iranian Code, used to design building located in the regions with very much hazard level and much hazard level according to Iranian Code and distance to source less than 20 km, are inappropriate.
- Figures 3 and 7 show that design spectra of Iranian Code couldn't cover the spectra of Bam and Naghan ground motions, located at 2km and 5km from the surface projection of the ground motions' sources, while design spectra of UBC 97 covered the spectrum of Naghan ground motion. These figures also show that the values of Iranian code design spectrum more far from the spectrum of Bam earthquake than the values of UBC 97 design spectrum.

As mentioned above, the results of assessment of Iranian Code to design near-source structures show the inefficiency of Iranian Code. Because proposing an accurate design spectrum for Iran requires to comprehensive studies that are not included in this research, we suggest the use of design spectrum recommended by UBC 97 in order to design near-source structures that are located less than 20 km far from earthquakes' sources.

CONCLUSIONS

The significant results of this study can be summarized as below:

- ✓ Design Spectra recommended by Iranian Code for design of near-source structures are not suitable.
- ✓ Among six selected near-field earthquakes, the spectra suggested by Iranian Code just cover the spectra of Ghaen and Gholbaf earthquakes.
- ✓ In order to calculating of near-source buildings against to earthquakes, the use of UBC 97 is more effective than Iranian Code.
- ✓ The width of the acceleration-sensitive region for the near-field earthquakes may be more than twice as width as acceleration-sensitive region recommended by Iranian Code.
- ✓ The values of PGA, PGV and PGD of near-field earthquakes may increase severely.

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