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RAssessment of Iran Seismic Design Response Spectra (Standard No. 2800) Regarding Site-Distance Effects Particularly at near Fault Sites

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ABSTRACT: This article intends to investigate the effects of site-to-fault distance on the earthquake intensity measure (basic design acceleration, A, and response spectra, Sa) where is not taken into account in Iran standard No. 2800. Regarding that the relation between site-to-fault distance and the design-base acceleration (A) parameter (or Sa) in currently used attenuation relations is highly non-linear, thus assigning the same value of such parameters to different site-distances in big cities, particularly at near fault sites, seems to be quite challengeable. In order to make this problem clear, forty series of site specific seismic hazard analysis in the two cities, Ahwaz and Kerman, are performed over ten sites having four different site-soil conditions and the "A" parameters are calculated and discussed. The results of this study showed that the site-to-fault distance can significantly influence upon the site's intensity measure (A) parameter (about several times as distance become smaller) and have significant differences with those of the Standard No. 2800. This problem also highly affects the effectiveness of "N" parameter presented in thee 2800 standard as the representative of near fault directivity parameter.

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1- Introduction

In spite of the fact that ground shaking waves originating from the process of fault rupturing propagate through the site in the form of a random space components. These spacy components are recorded by a three-dimensional sensor of x, y, and z components with in a digitized process so called "time-history". It is quite postulated that strong motion time-history recorded at near field site (site-to-source distances of less than 20 km) may be influenced by forward directivity (FD) i.e., a pulse like motion appearing at the beginning of velocity time history associated with a large amplitude and corresponding period [1]. FD-pulse period varies from the periods of 0.5-0.6 s up to 4-5 s as the results of occurring earthquakes larger than 6 Richter. Note that the amount of FD-pulses influencing on the recorded two-dimensional x and y time-histories depend mainly upon the site-source geographic orientation. Therefore, ground shaking is not necessarily associated with maximum FD-pulse. In order to find the maximum directivity effects, two horizontal x and y components' data should be iteratively rotated by different small angles so that those associated with maximum FD-pulse effects would be found [2, 3]. Due to lack of sufficient strong motion data at the sites of interest for designing structures, we need to rely upon the probability models to estimate the ground motion effects at the desired site, so called "attenuation law" which necessarily require the information of mean and standard deviation values [4-6]. It is clear that estimation of the mean value of a suite of time-history is not possible due to unidentified acceleration values corresponding to the starting point of time-history acceleration effective values, similar to that of the standard deviation value. This disadvantage has been the main cause of changing the static form of designing structures into that of dynamic process in engineering practice meanwhile keeping the dynamic form of loading in performance assessment of structures. Converting the problem into static form i.e., using the five percent damping coefficient elastic response spectrum, permits the use of any type probability models. Regarding that strong motions are associated with two horizontal components while the strong motion prediction equations are basically developed with single component, it remains to convert the response spectrum into a single form. This is performable by using the Geomean(√xy), formulation at each period of the response spectrum pair $\left[S_a^x(T_i), S_a^y(T_i)\right]$, proposed by Boore [2, 3].

2- The role of site-to-fault distance in hazard analysis results

Reminding that the Iran code's seismic design spectral accelerations are estimated based on the multiplication of a parameter representing the site's hazard levelled target PGA denoted by "A" and a structure's fundamental period-dependent parameter named spectral shape denoted by "B", i.e. "AB" without accounting for the effect of site-fault distances. This article is aimed at focusing on the question that whether the currently used Iran seismic design code (standard No. 2800), in which the effects of site-to-fault distance are not taken into account, ends up with reliable

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hazard analysis information. To this end, two cities in Iran being associated with strong seismicity, Ahwaz and Kerman are selected for comparing the spectral accelerations obtained from a standard spectral amplitude-based method with those of the 2800's code.

3- Program Verification

The EZ-FRISK software is used to predict the seismic design spectral amplitudes at the site of interest regarding the site soil condition. For this purpose, the spectral acceleration at the two periods; 0.2 s (for identifying the constant spectral acceleration) and 1 s (for that of the spectral accelerations corresponding to the constant maximum velocity) are estimated using the site's faults seismicity information. The verification process is followed by selecting three sites in Tehran city associated with site soil shear wave velocity of 760 m/s, the same sites used at reference [1]. Figures 2-4 display the results of hazard analysis obtained from this study and those of Gholipoor et al. [9] in the form of ten percent probability of exceedance in fifty years. As seen, good agreements between the two series of data confirm the reliability of the model and permits to be used at another sites of interest.

4- Examples; hazard analysis study at six station in Ahwaz city

The first step in performing hazard analysis is to cut those M and R values that produce response acceleration less than five percent of the target value. The reason is that they occupy a space in the targeted probability value (say 10%) causing the final result to be factitiously larger. In this study six stations having different distances from the well-known Ahwaz fault are selected. Large differences between the results obtained from this study and those of the standard No. 2800, particularly at near fault sites, reveals that the belief that the 2800 give the results of hazard in average value of distances can't be reliable.

5- Conclusion

1-Regarding that the relation between the distance, D (from the desired site to the fault segment) in attenuation equations are non-linear, the results of hazard analysis (either in the form of PGA or Sa(T)), is very sensitive against the variation of D. The hazard results are more sensitive at near field sites so that it should be straightforward taken into account. These two points are not considered in the seismic design spectral response of Iran standard No. 2800. The results of 40 series of performed hazard analyzes in this study expose very large differences of acceleration values from those of 2800 at near fault distances.

2-The constant spectral acceleration values in the seismic design spectral response at near field site should expose larger values than those of the far field. Reminding that "N" factor in 2800 represents the FD-pulse and depends on the spectral acceleration at corner period $Sa(T_s)$, a point on the constant acceleration range where it starts. Therefore, the independent assumption of N factor from the $Sa(T_s)$, as is in 2800, causes a considerable decrease of its influence on the periods longer than Ts as the site-to-fault distance becomes smaller.

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