DETERMINATION OF THE DESIGN PEAK GROUND ACCELERATION BASED ON RISK-TARGETED APPROACH FOR IMPORTANT PORT CITIES OF SOUTHERN IRAN

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At present, the Seismic Code of Iran for the design of buildings against earthquakes (Standard No. 2800, Fourth Edition), such as most national regulations relies on seismic hazard maps which are based on a pre-defined return period (RP). The emphasis on the design of structures based on the intensity measures of ground shaking for a pre-defined RP leads to the design of structures with different values of annual probability of collapse, P_c, in a given location. This weakness has necessitated risk-targeted design and development of risk-targeted hazard maps. Designing a structure according to a "uniform" level of demand is an attempt to achieve the same annual P_c, for buildings, wherever they are. The concept of this approach has been firstly mentioned in the ATC-03 guidelines (NBS SP-510, 1987). Luco et al. (2007) presented an application of this methodology for the preparation of risk-targeted seismic design maps of conterminous United States. This methodology was also used by Douglas et al. (2013), Silva et al. (2016) and Vacareanu et al. (2018) to develop risk-targeted hazard maps respectively in mainland France, Europe and Romania.

The following classical convolution used for the calculation of the annual collapse probability, given by Kennedy (2011):

$$P_C = \int_0^{+\infty} H_a(a) . \frac{dP_{(C|a)}}{da} da \tag{1}$$

where $P_{C|a}$ is the fragility function and $H_a(a)$ is the hazard curve. In order to determine the fragility curve function and thus calculate the risk-targeted ground motion, achieving a specified magnitude of P_C, four input parameters are required: (1) the mean return period of the ground motion parameter selected for the analysis, RP, (2) the corresponding value of the selected ground motion for analysing on the fragility function curve, Pc_f, (3) the standard deviation of the lognormal distribution describing the fragility function, β, and (4) the target annual probability of collapse, Pc_t. These parameters are given in Table 1 for three indicator approaches derived from the articles of Luco et al. (2007), Douglas et al. (2013) and Silva et al. (2016).

Table 1. Four parameters needed to determine the fragility curve function in the process of calculating the risk-targeted ground motion (Luco et al., 2007; Douglas et al., 2013; Silva et al., 2016).

Approach	PR (year)	Pc_f	β	Pc_t
Luco (2007)	2475	$10^{-3}\times2.1$	0.8	$10^{-4}\times2$
Douglas (2013)	475	10^{-5}	0.5	10^{-5}
Silva (2016)	475	$10^{-5}\times2$	0.6	$10^{-5}\times5$

Iran is one of the highest seismic countries in the world and has experienced many casualties and financial losses in the past years due to earthquakes; therefore, research in this field is of great importance. Unfortunately, in the recent years, risk-targeted seismic design of structures has been less considered in Iran. In this paper, we are interested in determining the risk-targeted design peak ground acceleration in the strategic and important ports of Iran along the Persian Gulf (Bushehr, Assalouyeh, Bandar-e Abbas and Chabahar), using the parameters presented for the three approaches mentioned in Table 1. All of these port cities are in a zone with a high seismic hazard, based on the hazard map of Iran's seismic code (Standard 2800, fourth edition). In this paper, seismic hazard curves for these cities are extracted from the web-platform of European Facilities for Earthquake Hazard and Risk (EFEHR - www.efehr.org) based on the EMME14 earthquake hazard model for the Middle East countries (EMME14 - Erdik et al., 2012; Giardini et al., 2018).

In the other parts of this paper, a three story reinforced concrete structure with a medium moment-resisting frame system and with three types of span arrangement, has been analysed and then the β and Pc_f values are proposed in Table 1 based on the analyzed structures. Structures are designed based on the latest version of Iran's Seismic Code (Standard No. 2800, fourth edition) for high seismic zone (PGA_{design} = 0.3 g) according to the location of the studied cities. Then incremental dynamic analyses are performed on a specified frame of each type of structure and its fragility curves are extracted, then the mean values, log standard deviation and annual collapse probability for each of the fragility curves are determined. Finally, based on different approaches, the risk-targeted design peak ground acceleration, $PGA_{r\text{-}design}$, for these structures is determined in order to achieve a same annual probability of collapse

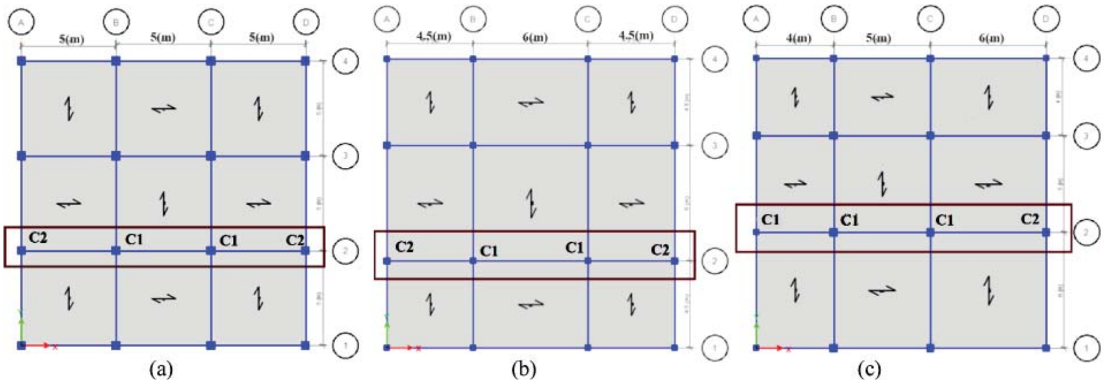

Figure 1. The plan of the studied structures, a) regular with equal spans, b) regular with unequal spans, and c) irregular, frame 2 of these structures has been used in dynamic analysis.

The results show that for the structures designed according to Iran's codes studied in this paper, Silva's approach is better than the other approaches. The lowest and highest $PGA_{r\text{-}design}$ was determined for Bushehr and Bandar-e Abbas, respectively. It is suggested that in the same way in other major cities of Iran, the risk-targeted peak ground accelerates will be determined and eventually the risk-targeted hazard map for the whole country will be presented.

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