MID-RISE AND HIGH-RISE BUILDING REQUIREMENTS FROM THE PERSPECTIVE OF SEISMIC RISK REDUCTION MANAGEMENT

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Earthquakes usually affect large parts of the earth, and potentially can cause serious damage over large urban areas. The vulnerability to this natural disaster is increasing as urbanization and developments occupy more areas that are prone to the effects of significant earthquakes. Therefore, developing and implementing seismic risk reduction policies in the seismic-prone megacities are essential for local governments, to minimize the loss of life, property damage, and social and economic disruptions caused by any probable earthquakes. Mid-rise and high-rise buildings are one of the basic urban elements that play an important role in the seismic vulnerability assessment of megacities (Shakib et al., 2011). These elements cause an extreme demand on city services in case of collapse, instability, or need of evacuation. Therefore, these buildings should be designed to provide better performance than normal buildings, not only in terms of reliability against collapse, but also in terms of functionality. On the other hand, the architectural regulations for high-rise buildings are codified in many cities based on such factors as zoning, day-lighting and landscaping; without considering the seismic performance-ability requirements (Shakib et al., 2010). Generally, the city planning regulations limit the vertical expansion for mid-rise and high-rise buildings, due to the urban requirements such as admiting light and air to adjoing sites, the energy conservation purposes and the other aesthetic considerations. These factors can influence the structural form and configuration of tall buildings and may direct the architects and structural engineers to design vertically irregular buildings. As a result, the various types of setback configurations are visible in many mega-cities (Shakib and Pirizadeh, 2014).

This paper discusses the general requirements of city planning regulations for mid-rise and high-rise buildings from the viewpoint of seismic risk reduction management. To achieve this, the indirect effects of the Tehran tall building regulations (HCUPA, 1999) on the seismic performance of a case study building are assessed by using a reliability-based approach. The considered case study building is a ten-story building, located by-laws in the commercial-official zone of Tehran (TCP, 2007). The seismic performance of the structure is evaluated by using the incremental dynamic analysis method, in two statuses. In the first status, the building configuration is designed according to the Tehran architectural regulations (HCUPA, 1999 and TCP, 2007) but in the latter; the city architectural regulations are not applied in design of the building configuration. The 3-D views of the building configuration in these two-statuses (i.e. regular & setback) are shown in Figure 1. The similar characteristics such as bay widths and story heights are considered for the structures as stated in previous study of authors (Shakib and Pirizadeh, 2014). These structures are designed for a very high seismic zone on the basis of the linear response spectrum analysis method according to the Iranian seismic code (BHRC, 2010). The lateral force resisting system in the two orthogonal structural directions of the structures is special steel moment resisting frame. Both the regular and the setback structures are designed in such a way that the maximum estimated inelastic drift ratio response of structures under the design response spectrum is approximately close to 0.02 (i.e. the maximum allowable inelastic response lateral drift ratio according to the Iranian seismic code (BHRC, 2010)). The seismic performance of these structures under the simultaneous action of orthogonal ground motion components is assessed based on the incremental dynamic analysis. The median IDA curve of the structure in the setback configuration status is compared in Figure 2 to that of the regular configuration status. According to this figure, the median IM capacities of structure over the entire range of limit-states are decreased in the setback configuration status with respect to the regular configuration status. In other words, the capacity of resisting lower intensity seismic events is observed in the structure by applying the tall building architectural regulations, for the entire range of performance levels from the immediate occupancy (IO) until to global dynamic instability (GI). In addition, the confidence level of meeting the LS performance objective is calculated by the reliability analysis for the structures. The results showed that the confidence level of meeting the LS performance objective is decreased from 82% in the regular structure to 57% in the setback structure. Therefore, the nonlinear assessment of the structure showed that the expected seismic reliability requirements are not provided in the code-designed setback structures as satisfactory as in the code-designed regular structure. These results are discussed as a reflection of the city planning policies on the seismic performance of buildings. It is shown that the enforcement for compliance of the architectural regulations of tall buildings with the special guidelines for the seismic design of tall buildings is necessary.

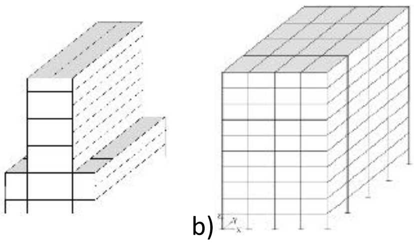

Figure 1. The 3D view of the case study building a) setback structure status, b) regular structure status

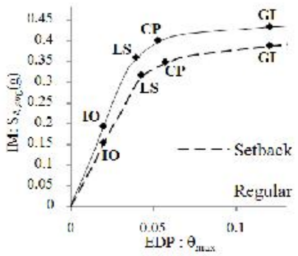

Figure 2. The median IDA curves of the case study structure in various designing statuses

Overall, by considering the requirements of the seismic risk reduction management, these items should be considered in defining the city planning regulations for mid-rise and high-rise buildings: (i) the expected seismic performance objective for these special types of buildings, (ii) adaptation of the city land use planning with the city seismic microzonation maps and the city fault bounds, (iii) the special building code developments, (iv) the building control systems, (v) the neighbourhood effects of tall buildings collapse or even cladding falling and, (vi) the evacuation management of able and disabled occupants in the disasters.

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Seismic fragility functions can be evaluated using the cloud analysis method with linear regression which makes three fundamental assumptions about the relation between structural response and seismic intensity: log-linear median relationship, constant standard deviation, and Gaussian distributed errors. While cloud analysis with linear regression is a popular method, the degree to which these individual and compounded assumptions affect the fragility and the risk of mid-rise buildings needs to be systematically studied.Â Gaussian Kernel Methods for Seismic Fragility and Risk Assessment of Mid-Rise Buildings. by. Somayajulu L. N. Dhulipala. Land use management is a newly emerging disaster reduction method.Â As seismic design is uniformly applied to all buildings in earthquake hazard-prone areas according to the type of seismic sources and soil structure, city governments can maintain the quality of seismic safety construction as long as the Code is followed. City governments are provided discretion in their operation of the Code and the provisions of buildings.Â However, from the perspective of earthquake disaster management, the cityâ€™s disaster reduction aspects are incorporated in the zoning ordinance but not in the comprehensive plan.Â â€¢ High-rise buildings in planned commercial areas. Areas of heavy population density are shown in Figure 3. Approximately a half of the area with a degree of PGA of 710 cm/s. 2. The high-rise building construction concept when compared with other buildings, possess certain features and characteristics that makes them unique and highlighting. The high-rise buildings are considered as the product of the modern evolution. It is filled and composed of sophisticated systems and essential components. Each of these systems carry out special roles either positive or negative.Â Most of the components in the high-rise construction focus on safety during emergency or fire risk. They are more focused on fire systems to protect the occupants. These will hence demand costlier building systems and unique fire safety codes. The fire and safety issues with different features available in the high-rise building is explained hereby. Probabilistic seismic risk analysis (PSRA) requires the identification of seismic hazards and analysis of structural fragility as well as calculations regarding the probability that limit states and/or damage states will be exceeded. Lin [8] presented a probabilistic framework for evaluating the probability.Â For example, the median values used to construct the fragility curves of a high-code, mid-rise reinforced concrete building (Label CM) for the limit states of slight, moderate, extensive, and complete are 0.33, 0.59, 0.71, and 0.8 g, respectively. The logarithmic standard deviations of the intensity of ground shaking for this case are equal to 0.5, 0.45, 0.4, and 0.4 for the limit states of slight, moderate, extensive, and complete, respectively. International Journal of High-Rise Buildings Volume 1 Number 3. 1. Book chapter/Part chapter 2. Journal paper 3. Conference proceeding 4. Unpublished conference paper 5. Magazine article 6. Unpublished.Â Keywords: High-rise buildings, Performance-based seismic design, Input earthquake motion, Performance criteria, Time-history response analysis, Additional damping device, Robustness. 1. Introduction.Â Among such requirements and criteria, some items deeply related to seismic design are introduced in the following sections, with the practices often taken by the structural engineers in Japan. Note that the performance evaluation also covers the effects by wind, snow, earth pressure, temperature change, etc., but they are not shown in this paper.