© Nottingham University Press
Proceedings of the International Conference on Computing in Civil and Building Engineering
W Tizani (Editor)

Seismic fragility assessment of model buildings in Sharjah, United Arab Emirates

Khader Abu-Dagga, Samer Barakat & Abdullah Shanableh
University of Sharjah, UAE

Keywords: seismic risk, Sharjah City, United Arab Emirates, building seismic fragility, GIS

The United Arab Emirates (UAE) is located close to an active seismic zone; the Zagros folded belt region and Makran subduction zone, in addition to the local generally inactive fault lines crossing the UAE. The proximity of the Zagros and Makran seismic sources suggest that the UAE is not immune to seismic risk as a result of strong earthquakes from these sources. The seismic hazard of the United Arab Emirates (UAE) was investigated by few researchers (Abdallah and Al-Hmoud, 2004, Malkawi et al., 2007). The earthquake with magnitude of M_b5 on 11 March 2002 in Masafi also highlighted the important active local seismic sources in the UAE. Recently developed probabilistic hazard maps for the UAE suggest that the local seismic risk can be considered low to moderate for structural lifetime return periods of 50 to 100 years. Nevertheless, buildings should be designed to resist seismic loads. In Sharjah and the UAE, attention to designing building to resist seismic loads has gained significant attention during the past decade due to the rapid development and widespread construction of high-rise buildings, including some of the tallest buildings in the world. Due to the construction of high-rise buildings in the central eastern emirates of the UAE (Abu-Dhabi, Dubai, Sharjah and Ajman), the impacts of recent earthquakes were felt more than ever before. More recently, many people in tall buildings in Dubai and Sharjah evacuated their buildings due to an M_b5.9 earthquake in Qeshm Island that took place on 27 November 2005. However, most of the older buildings in Sharjah and the UAE, especially those below 15 meters in height, were not designed to resist earthquakes. The local regulations state that buildings with less than 5 stories do not need to be designed for lateral load resistance, but seismic design is required for 5-story buildings and taller.

The overall objective of this project was to assess the potential seismic structural risk for buildings in Sharjah, UAE. The specific objectives were to assess the structural systems of buildings in Sharjah in relation to resistance to earthquakes; evaluate the seismic vulnerability of typical buildings categories with distinct structural system types, height, and use; establish the corresponding fragility curves for each building category, and produce seismic risk maps for buildings in Sharjah City. In addition to the above, estimates of the associated human and economic losses for various earthquake scenarios were provided based on the ATC-13 loss rates.

To perform the study, Sharjah City was divided into areas, and the information about the buildings and the population were collected for each one of the areas. Buildings were classified according to their types, uses and heights, and a representative typical building was assigned for each area. A group of 13 representative model building types were used to represent, in an average sense, all building types, heights and categories in Sharjah City. Time history analyses were performed on these buildings using 42 real ground motion records from Iran, which formed the basis of a seismic hazard

assessment for the United Arab Emirates. The results of the analyses were used to establish fragility curves for the different buildings models. The fragility curves related the probability of reaching or exceeding one of four damage sates; slight, moderate, extensive, and complete to the peak ground acceleration (PGA). In addition, the performance of each building type under different seismic hazard scenarios was determined and the potential loss scenarios were analyzed. Finally, indicative seismic risk GIS-based maps were produced for different risk scenarios for the city of Sharjah.

Most of the buildings in Sharjah City are low-rise concrete frame (C3) buildings. These buildings were not designed for seismic loading. The fragility analysis of them suggested that these buildings were the most vulnerable among the different building types. In fact, the potential loss scenarios that were assessed revealed that these buildings would be responsible for most of the losses in Sharjah.

References

ABDALLA, J. and AL-HOMOUD, A., (2004), "Seismic Hazard Assessment of United Arab Emirates and Its Surroundings", Journal of Earthquake Engineering, Vol. 8, No. 6: 817-837.

MALKAWI, A. I. H., BARAKAT, S. A., SHANABLEH, A., AL BDOUR, W. M., OMAR, M., and ALTOUBAT, S., (2007), "Seismic Hazard Assessment and Mitigation of Earthquake Risk in the United Arab Emirates", Technical Report, A Collaboration Project on Capacity Building in Seismology Between the University of Sharjah and Jordan University of Science and Technology.