PERFORMANCE OF IMPORTANT BUILDINGS IN THE 2012 VARZAGHAN-AHAR EARTHQUAKE

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The northern part of East Azerbaijan Province was the scene of many earthquakes in the past. On August 21st, 2012 two earthquakes struck East Azerbaijan Province, Iran with a magnitude 6.2 and 6.0. The first event was close to the city of Ahar with a maximum PGA of about 478 cm/s/s. Only 11 minutes after the first event, the second event occurred. The maximum PGA for the second event was recorded of about 534 cm/s/s (ISMN, 2012). In these two events, it has been reported that more than 330 people lost their life (Miyajima et al., 2012). Buildings in the stricken area experienced different levels of damages. Most of the adobe buildings in villages were collapsed and several masonry and framed buildings were damaged. The earthquake affected three medium-size city centers; Varzaghan, Ahar and Heris. Most urban buildings in the stricken area had suffered minor or moderate structural damages combined with major non-structural ones. Furthermore, the two main hospitals in the stricken area; in Heris and Ahar, were highly damaged after the earthquakes. Both hospitals were two-storey concrete buildings. The Heris hospital building sustained different degrees of structural damages, while Ahar's hospital sustained no such damages. Furthermore, the two earthquakes did great damage to the non-structural parts and the facilities (IIEES, 2012).

For design purposes, IS 2800 code has specifies a horizontal ground acceleration of 0.3g for this part of the country. For low-rise buildings of high importance (e.g. hospitals), with fundamental periods around 0.63 located on medium compacted soils, the design base shear would be a little bit more than 0.1 of the building weight (Consulting Engineers of Fadak, 2013). The fourth edition of the IS 2800, that suppose to be published in 2014, is expected to maintain the same design base acceleration value of 0.3g for this region. However, stricter regulations for the design of non-structural components would be specified (BHRC, 2013).

In Heris's main hospital, one of the important buildings in the region, the damage observed in infilled frames varied from small cracking to severe damage and collapse. Furthermore, some of the columns experienced shear cracks. In most cases, the absence of suitable frame-infill connection details was the main reason for such phenomena. In this building, the practice of infill wall separation from the frame at the interface had been also observed in some walls. The 10 cm thick non-structural walls were separated from both sides and attached to upper and floor beams. Furthermore, double angles were used at both edges of the wall. To prevent out-of-plane failures, additional double angles were used for long span walls. Despite these measures, many cracks had appeared near the frame-wall regions leading to the spalling of plaster there. This phenomenon was observed near the mid-span double angles as well. The absence of gaps or the use of small gaps between walls and frames were the main reason for such failures. The use of heavy masonry materials and thick coatings of plaster in the infill walls had also contributed to such damages (Consulting Engineers of Fadak, 2013).

The other major types of failure observed in important buildings involved, failure of facades, failure of parapets, failure of the exterior architectural elements, failure of suspended ceilings, damages to partitions and internal walls, breakage of glass panels and shuttering of glasses, damages to stair wells, damages to building contents, damage to gas distribution network, damage to electricity network and breakage of gas and water systems. Furthermore, overturning of medical equipments was also observed as one of the major failure modes in some hospitals (EERI, 2012; Zare et al., 2012). On the other hand, and in spite of the shortcomings observed in the restraint systems of equipments in the electrical and mechanical room in Heris's main hospital, none of these equipments was affected by the quake.

In the author's opinion, the lack of clarity of the present specifications on important buildings, the inadequacy of the non-structural provisions, and the lack of proper supervision were among the main reasons that caused extensive damage to these buildings and their components.

REFERENCES

BHRC (2013) Final Draft Regulations for Seismic Design of Buildings: IS 2800-92 (in Persian)

Consulting Engineers of Fadak (2013) A Comprehensive Evaluation Report on Imam Hussein (AS) Hospital in Heris City (in Persian)

EERI (2012) The Mw 6.4 and Mw 6.3 Iran Earthquakes of August 11, 2012

IIEES (2012) Varzaghan- Ahar Earthquake IIEES Report, www.iiees.ac.ir

ISMN (2012) Ahar – Varzaghan Earthquake of 11th August 2012**,** http://www.bhrc.ac.ir/portal/Default.aspx?tabid=1209

Miyajima M, Fallahi A, Sadeghi A, Ghanbari E, Soltani H, Amiraslanzadeh R, Vakilazadsarabi A, Forouzandeh FJ and Sheikhalizadeh R (2012) Site Investigation of the Ahar-Varzeghan Earthquake in NW Iran of August 11, 2012, http://committees.jsce.or.jp/eec205/system/files/Quick%20Report%20of%20Iran%20EQ.pdf

Zaré M, Kalantari A, Ansari A, Haghshenas E, Davoodi M and Mostafazadeh M (2012) Preliminary Reconnaissance Report on Dual Varzaghan-Ahar Earthquakes, www.iiees.ac.ir (in Persian)