Probabilistic Seismic Risk Assessment of Process Plants

Fabrizio Paolacci, Department of Engineering
Roma Tre University, Italy

Abstract

The vulnerability of the urbanized territory against Na-Tech events represents a strategic issue because of the general unpreparedness of the countries in predicting effects and consequences in the aftermath of a disaster. Unfortunately, despite the continuous evolution of the knowledge on this matter there is lack of information about possible procedures to predict damage propagation within a process plant and in the surrounding areas, and the quantification of the risk under Na-Tech events. The effects of earthquakes on chemical plants may be important, as demonstrated by the recent 2011 Tohoku Earthquake, where many industrial plants suffered to important damages and losses. It is known that the classical Quantitative Risk Assessment (QRA) methods cannot be applied to evaluate consequences in case of earthquakes, because of the presence of multi-damage conditions in more than one equipment, and generation of multiple-chains of events and consequences. In literature, several attempts to modify the classic QRA approach have been formalized but without converging toward a unified approach. In this seminar a new tool for the probabilistic risk assessment methodology for petrochemical plants under seismic loading is illustrated, which is based on Monte Carlo simulations. In particular, starting from the seismic hazard curve of the site, a multi-level approach is proposed, in which the first level is represented by the components seismically damaged, whereas the following levels are treated through a classical consequence analysis, but including propagation of multiple simultaneous and interacting chains of accidents. The procedure has been implemented in the PRIAMUS software, which assumes that the accident may be represented by a sequence of propagation "levels". With a series of automatically generated samples of damage propagation scenarios, the risk of the plant can be easily quantified The application to a petrochemical plant shows the potentiality of the method and envisages possible further evolutions.

Cosmo Refinery, Chiba, Japan – 2011 Tohoku Earthquake

Recent Publications

1. M. De Angelis, R. Giannini, F. Paolacci, (2010), Experimental investigation on the seismic response of a steel liquid storage tank equipped with floating roof by shaking table tests, *Earthquake Engineering & Structural Dynamics*, 39: 377–396.
2. Paolacci F., Giannini R., De Angelis M., (2013), Seismic response mitigation of chemical plant components by passive control systems, *Journal of Loss Prevention in Process Industries, Volume 26, Issue 5: 879-948*
3. Bursi O.S,, Shahin MR, Paolacci F., Kumar A., (2014), Performance of non-standard bolted flange joints in industrial piping systems subjected to seismic loading, *Journal of Loss Prevention in Process Industry, Vol. 30: 124–136.*
4. Reza M.S., Abbiati G., Paolacci F., Bursi O. S., (2015), " Performance-based Earthquake Evaluation of a Full-Scale Petrochemical Piping System," *Journal of Loss Prevention in the Process Industries*: 33, 10-22
5. Paolacci F, Uckan E., Akbas B., Shen J.J, Corritore D. (2016) Seismic vulnerability mitigation of liquified gas tanks using concave sliding bearings, *Bulletin of Earthquake Engineering* Volume 14, Issue 11, pp 3283–3299

Biography

Graduated in Civil Engineering in 1992 at the University of Rome "La Sapienza" and Ph.D. in Structural Engineering in 1997, He is currently Assistant Professor in Structural Engineering at University Roma Tre – Department of Engineering. His main scientific interests are focused mainly on: a) Performance-based design of steel-concrete composite bridges, b) Assessment and reduction of the seismic risk of reinforced concrete buildings and bridges, c) Seismic risk of major-hazard industrial plants and applicability of innovative protection systems (base isolation and energy dissipation), e) Seismic vulnerability of high-voltage electric networks and substations and applicability of innovative seismic protection systems, f) Passive and semi-active control of structures. He gained a long standing experience in the management of research projects about experimental assessment of the seismic response of structures. He is currently PI of many European projects. From 2008 to 2013 He assumed the role of scientific coordinator of the Laboratory of Testing Materials and Structures of the Department of Structures of the University Roma Tre. He received a fellowship provided by CNR (National Research Council) for a research activity of six months at the Department of Civil and Environmental Engineering of University of California at Berkeley from September 1999 to February 2000 as visiting scholar. He is author of more than 100 publications on International Journals and conferences.

Email:fabrizio.paolacci@uniroma3.it