THE SELENA–RISE OPEN RISK PACKAGE – TOWARDS THE NEXT GENERATION OF ELE SOFTWARE

Sergio MOLINA
Professor, University of Alicante, Alicante, Spain
sergio.molina@ua.es

Dominik H. LANG
Senior Advisor, NORSAR, Kjeller, Norway
dominik@norsar.no

Abdelghani MESLEM
Research Engineer, NORSAR, Kjeller, Norway
abdelghani@norsar.no

Keywords: SELENA, Open Risk Package, ELE

The computation of losses of any type that result from the shaking effects of an earthquake basically requires tool that is able to process available information on ground motion characteristics, inventory and building structural capacity-related data. Nowadays, a great deal of ELE tool exists that make use of different approaches. Though many of these tools pretend to be ‘open’ only a few actually are. Open-source tool basically implies that the source code is openly available to the users at no charge and that it can be studied, changed, improved and at times also distributed. After the development of HAZUS (FEMA, 1999, 2001, 2002, 2003), an U.S.-specific multihazard tool which is free but not open-source, NORSAR (Norway) and the University of Alicante (Spain) worked together in the development of an open-source seismic risk estimation tool (Molina and Lindholm, 2005, 2006) named SELENA (Seismic Loss Estimation using a Logic Tree Approach; Lang et al., 2008, 2010; Molina et al., 2010). SELENA is coded in MATLAB and compiled as a stand-alone version which is independent of any Geographic Information System (GIS).

Based on required input information on the seismic hazard, soil conditions and site amplification characteristics of the considered test bed, building stock inventory disaggregated by model building typologies, building damage estimates as well as economic and socioeconomic characteristics, SELENA computes a multitude of geo-referenced output that can be illustrated by any GIS or the GoogleTM Earth-based illustration tool *RISe* (Risk Illustrator for SELENA). In addition to damage probabilities, Absolute Damage (in terms of numbers of buildings or building floor area) and Mean Damage Ratios, SELENA also derives connected economic losses, casualties as well as estimates on expected debris, required shelters and displaced households, hence making the tool not only interesting for researchers but also for local decision-making authorities and disaster management organizations.

The main innovation of the SELENA tool is the implementation of a logic tree computation scheme, allowing the consideration of aleatory variability and epistemic uncertainties in any input parameter so that the final results are provided with corresponding confidence levels. Until now the method has been successfully applied to a multitude of test beds worldwide, e.g. Oslo (Molina and Lindholm, 2005), Naples (Lang et al., 2008), Bucharest (Lang et al., 2011), the Romanian-Bulgarian border region (Erduran et al., 2012), and several cities in Central Asia or India (e.g. Lang et al., 2012).

A major shortcoming of the current generation of analytical ELE software tools is the fact that surface topography contribution is not considered; hence applying these tools in hilly regions represents a significant/or maybe gross simplification. In order to address these effects in ELE, the site-specific geometry and subsoil conditions of the various building assets has to be properly considered. In addition to a more complex definition of the seismic ground motion, buildings located at slopes are generally characterized by strong irregularities in plan, elevation and foundation design. These features lead to a complex structural behavior which cannot be addressed by nonlinear static-based procedures.

In a newly developed version of SELENA, the conduct of ELE for hilly regions is allowed through the implementation of a user-selectable analysis procedure addressing topographical amplification and the peculiar vulnerability of hill buildings.

REFERENCES

Erduran E, Lang DH, Lindholm C, Toma-Danila D, Balan SF, Ionescu V, Aldea A, Vacareanu R, and Neagu C (2012) Real-Time earthquake damage assessment in the Romanian-Bulgarian border region, *Proceedings of the 15 WCEE*, Lisboa, 2012, 10 pp

Federal Emergency Management Agency FEMA (1999) HAZUS99 Earthquake Loss Estimation Methodology, User Manual. Federal Emergency Management Agency, Washington, DC, United States, 314 pp

Federal Emergency Management Agency FEMA (2001) HAZUS99-SR1 estimated annualized earthquake losses for the United States (FEMA 366), Report of the Federal Emergency Management Agency, Washington, DC, United States, 33 pp

Federal Emergency Management Agency FEMA (2002) HAZUS99-SR2 (Service Release 2), Technical Manual. Federal Emergency Management Agency (FEMA) and National Institute of Building Sciences (NIBS), Washington, DC, 708 pp

Federal Emergency Management Agency FEMA (2003) HAZUS-MH - Multi-hazard Loss Estimation Methodology, Technical Manual, Washington, DC

Lang DH, Molina S, and Lindholm CD (2008) Towards near-real-time damage estimation using a CSM-based tool for seismic risk assessment, *Journal of Earthquake Engineering* 12, Special Issue 2: 199–210

Lang DH and Gutiérrez C, FV (2010) *RISe* — A Google Earth-based tool to illustrate seismic risk and loss results, Technical note, *Earthquake Spectra* 26(1): 295–307

Lang DH, Molina S, Lindholm CD, and Balan S (2011) Deterministic earthquake damage and loss assessment for the city of Bucharest, Romania, *Journal of Seismology* 16(1), 67–88

Lang DH, Singh Y, and Prasad JSR (2012) Comparing Empirical and Analytical Estimates of Earthquake Loss Assessment Studies for the City of Dehradun, India, *Earthquake Spectra* 28(2): 595-619

Molina, S and Lindholm CD (2005) A logic tree extension of the capacity spectrum method developed to estimate seismic risk in Oslo, Norway, *Journal of Earthquake Engineering* 9(6): 877–897

Molina S and Lindholm CD (2006) A Capacity Spectrum Method based Tool developed to properly include the uncertainties in the seismic risk assessment, under a logic tree scheme, *ECI. Geohazards–Technical, Economical and Social Risk Evaluation*, 18–21 June 2006, Lillehammer, Norway

Molina S, Lang DH, and Lindholm CD (2010) SELENA – An open-source tool for seismic risk and loss assessment using a logic tree computation procedure, *Computers & Geosciences* 36(3): 257–269