Databases characterization for urban seismic risk studies. Application to lifelines (electricity) of the metropolitan area and Barcelona municipality.

**Author:** Anna Berenguer i Canet

**Tutors:** Nieves Lantada Zarzosa and Lluís G. Pujades Beneit

Earthquakes are natural phenomena able to damage large areas, causing important human and economic losses. Unlike other meteorological phenomena, like for example clouds that let people know when it will rain, there does not exist earthquake predictors advertising about a soon seismic event. Certainly, main properties of these natural phenomena are their destructive potential and instantaneous occurrence.

Three main ways may be used to reduce any geological risk. Reducing the hazard, reducing the vulnerability and designing and constructing to resist the expected hazardous actions. Prevention and protection planning to be used during the emergency are other measures reducing the social and economic impact of this kind of disasters.

In the event of earthquakes nothing can be done to reduce the hazard, but its quantification may help to advise the urban planning for geographical areas. Vulnerability can be reduced mainly using seismo resistant design. The main concern of this work is on the seismic planning, because any seismic risk analysis, like the one here presented, is a basic tool for seismic risk prevention and protection, permitting to quantify the potential damages and therefore, advising to civil administrations for planning.

Catalonia, and in particular the metropolitan area of Barcelona, mainly because of its low seismic hazard, has neglected any precaution for seismic events, and has not applied any seismic design to their buildings and facilities. Great modern cities are characterized by increasing population, buildings and, therefore the need of new and expensive facilities. Consequently the seismic risk is dramatically increasing, in particular in moderate seismic hazard regions, where the expected damage in the event of earthquake may greater that what would be reasonable. According to Spanish seismic code, the study area is located in a VI MSK intensity for a 500 years return period, although, additional and accurate studies, including seismic zonation, prevent intensities up to VII-VIII in particular places of the studied area and for the same return period.

The method here used, which is based on the Hazus'99 program, establishes that, in the electric system, transformer stations are the most vulnerable elements of the whole system. Any way the light damage state is the most probable expected state in the studied area, because of its moderate hazard. This damage state represents failures of the 5% of some of their elements, with a 4% of the total cost of the station. The probability of this damage state is about 45% but the corresponding to the moderate damage is greater than 10%. The obtained results indicate less damage for the electricity production centers but we should consider that the economic and social consequences of such damage would be more important. The reposition cost is evaluated over the 3%, which may be greater, in absolute value, than the corresponding to the stations. The transportation and distribution lines, are the less vulnerable elements of the electric system. It is not expected any damage for such lines. Any way, it is also interesting to note, that in the event of an earthquake one intensity grade over the expected for a 500 years return period would cause a catastrophic scenario in the city. Damage for stations and sub-stations could reach the severe damage state, with over 70% of failure in their components and the reparation economic cost would reach about the half of the reposition cost.

We believe that it is very convenient to go on the analysis of seismic damage, like the one here presented, because it is the best way to improve the seismic emergency planning and to advise the seismic protection of the most vulnerable elements and in particular those located in the most hazardous areas.