



Modelling and calibration of seismic vulnerability on a regional scale

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Assessment of seismic vulnerability and seismic risk for buildings and built areas is a part of activity of the Center for Disaster Management and Risk Reduction Technology (CEDIM). The center (www.cedim.de), which was established jointly by the University of Karlsruhe and GeoForschungsZentrum Potsdam, conducts an interdisciplinary study aimed at assessing and comparing different kinds of risks for the territory of Germany, including the seismic risk.

The conceptual framework of the developed GIS-based approach includes consideration of the main factors contributing to risk (hazard, vulnerability and exposure) and their layer-by-layer evaluation on the scale of the federal states and the whole country. Taking into account the large scale of the problem we consider communities and their parts (zip-codes) as units at risk.

For the purposes of the study all communities of the country are classified into five population classes depending on the number of inhabitants and vulnerability analysis of the building stock is conducted in accordance with this classification. The methodology of structural vulnerability analysis is based on the vulnerability classification of the European Macroseismic Scale (EMS-98). Using visual screening procedures for a few selected prototype communities of different size (all located in earthquake-prone areas and assumed to be representative for the whole country) we collected information about the existing building stock. On the basis of the collected information and with the use of other available data we constructed vulnerability composition models for the building stock of communities of the five different population classes. Having combined vulnerability functions constructed for the different EMS vulnerability classes (A, B, C and D, which are representative for the country) and the vulnerability

composition models, we plotted the damage curves for the five classes of communities in terms of expected specific damage versus seismic intensity. The constructed vulnerability models are combined with the distribution of communities of different population classes and seismic hazard input, which allows estimating the expected damage to the existing building stock. Besides we estimate the distribution of seismic risk potential as the product of the specific damage, population of the communities and averaged construction costs per person. Obviously the estimates of risk are rough to a certain extent as they were obtained on the basis of several assumptions and preliminary vulnerability models, but they provide the apt illustration of seismic risk distribution over the whole Germany.

Besides, the scenario approach is also used in the study. This approach can provide estimates of probable losses from future strong earthquakes in the area under consideration, revealing the most vulnerable points of earthquake prone communities, and it is useful for developing and improving disaster preparedness and risk mitigation programs. On the other hand, this approach can be used for calibration of the vulnerability models, when for the scenario purposes real seismic events are considered.

For calibration of the vulnerability models we used available information from the past earthquakes caused damaging effects on the territory of Germany (Albstadt, 1978, Roermond, 1992, Waldkirch, 2004). The seismic input for the Albstadt and Roermond earthquakes was prepared with the use of information about actual distribution of macroseismic fields, which are available from publications. For the recent Waldkirch earthquake the seismic input was prepared using the reported parameters of the earthquake source and the Sponheuer relationship as well as the information collected in the affected area immediately after the earthquake. Besides, for the purposes of calibration of our models we compare the obtained estimates of damage and risk with results of other authors available from publications.