

## New tools for earthquake risk management in Slovenia

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The results of two inter-disciplinary research projects on earthquake risk estimation for the areas of the highest seismic hazard in Slovenia are presented. The most important innovative concept is web application for seismic risk estimation based on several layers (e.g. seismic hazard, microzonation, building and population register) and established relationships that assess building fundamental period, building vulnerability and damage category based on most common building parameters. The microzonation was done in terms of Eurocode 8 ground types and its corresponding soil factors, and in terms of European macroseismic scale (EMS). Published microzonation studies (Bovec valley, Breginj area, City of Ljubljana), data from the basic geological map and existing geophysical data were used. Microtremor measurements and their analyses were applied to more than 300 buildings in Slovenia. The ratio of amplitude spectra between the highest floor and the basement was computed for both horizontal components. The peak of this ratio determines the building's fundamental period. Regression equations for fundamental building period as a function of height were determined for masonry and reinforced-concrete type of construction, taking into account also residential or non-residential usage. Using regression relationships, the fundamental period of the majority of buildings in the Real Estate Register was estimated. Considering very large sample of buildings, relationships for determination of building vulnerability (RAN-Z method) based on height, structural type and year of construction were established. A correlation has been identified between the seismic vulnerability in terms of RAN-Z and the EMS vulnerability classification. EMS gives the classification of damage to buildings, divided into five structural damage grades. The probability for each damage grade for a building with a given RAN-Z vulnerability value, if exposed to an earthquake of a given intensity, is also assessed. This innovative procedure represents an important upgrade and allows rough vulnerability assessment of the entire building population from the Real Estate Register. Taking into account also the Central Population Register, number of people that would need temporary or long-term accommodation can be calculated. A comprehensive system for rapid earthquake damage assessment was for the first time developed for Slovenia as an easy to use web application. Through calculation of seismic risk based on scenarios of different earthquake intensity and epicentre location, the application can be used by civil protection authorities for assessing general damage, either immediately after an earthquake or as a tool for training and planning purposes on local or state level. In the frame of the projects several other tools were developed. A web application for citizens for rough assessment of expected damage to their building caused by an earthquake raises public awareness. The existing Slovenian form for post-earthquake building safety evaluation was improved. A new software tool for supporting post-earthquake building safety evaluation process was developed. The tool can run on any computer without internet connection which is vital after an earthquake and whole application is available on a single USB memory stick.