



New seismic hazard map of Romania in MMI intensities by using probabilistic and deterministic approaches, linear and nonlinear methods

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The last zonation seismic map, existing since 1993, has areas where seismic intensities are sub-evaluated (Dobrogea, Banat etc.), and other areas are over-evaluated. Intensities I=IX on MMI scale, at which corresponds a 0.4 g level of acceleration, and 0.8 g at rupture/yielding, make Vrancea county to become an unsustainable development area for the future. Vrancea earthquakes, the main ones in Romania, are belonging to the biggest calamities that take place around the world. The fundamental unacceptable point of view is that last design code(2006) is in peak ground accelerations which generates a lot of drawbacks to civil structural designers and to insurance companies which are paying all damages and life loses in function of earthquake intensity. The concept of seismic intensity (or severity of earthquake ground motion) is at present a common concept for seismologists, structural engineers and other specialists, or even non-specialists. Persons working with this concept are recognizing at the same time its importance and some current shortcomings of it.

A special situation is represented by the Banat area where the last recorded earthquakes from Banloc, Voitec requires a change in the seismic intensities of this area. The seismicity of Romania comes from the released energy of crustal earthquakes, which have a depth not more than 60 km, and by the intermediate earthquakes coming from Vrancea region (the only European case) with a depth between 60 and 200km. An interesting particularity is the intensity deforming Vrancea zone, shows a quite enigmatic seismic pattern ("banana" shape, NE-SW directivity). The maximum intensity for strong deep Vrancea earthquakes is quite distant from the actual epicenter and greater than the epicenter intensity. In 1977 strong earthquake ($M_w = 7.4$) at its epicenter, in the Vrancea region, the estimated intensity was only VI (MMI scale), while some 170 km away in the capital city of Bucharest, the estimated maximum intensity was IX-IX½ (MMI). The intensely deforming Vrancea zone shows a quite enigmatic seismic pattern (peak ground accelerations/intensity one, characteristic response spectra with large periods of 1.5 seconds, no significant attenuations on Romanian territory, large amplifications away etc.).

To obtain the new seismic hazard map of Romania in MMI intensities in the paper are developed probabilistic and deterministic approaches, that are: (i)- Deterministic evaluation of the seismic hazard by using linear and nonlinear approaches, by developing the nonlinear seismology concept;(ii)-Probabilistic evaluation of the seismic hazard for Romania ;(iii)- Correlations of the results of deterministic and probabilistic hazard analyses.

The novelty and complexity degree comes from the fact that for the first time a seismic hazard map for Romania will be built to maximum possible Vrancea earthquake (M on Richter scale =7.5) by using probabilistic and deterministic approaches, linear and nonlinear methods, including a development of the nonlinear seismology concept, necessary to the deterministic analysis.