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Development of intensity compatible time-histories for dynamic analysis of structures

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The assessment of the functionality of critical infrastructures and lifelines after an earthquake strongly depends on an accurate assessment of the degree of damage exhibited during the earthquake. Usual engineering parameters like linear-elastic response spectra or linear-elastic uniform hazard spectra in terms of spectral accelerations are not suitable for predicting damage because the process of damaging is a non-linear process.
The only seismological parameter that implicitly contains the required information on the damaging impact of earthquakes is intensity. This parameter in different scales (EMS-98, MSK-64, MMI) is directly linked to physical observations including the damage of buildings. Additionally, intensity information directly captures spatial variation of ground motions related to the same or similar degree damage by construction of isoseismal lines. Therefore intensities are very suitable for predicting possible impacts of earthquakes on critical infrastructures or lifelines. For engineering applications intensity relevant information has to be converted into engineering characteristics. Because dynamic analyses (time-history analysis, frequently even nonlinear ones) became a standard approach for the design and for the validation of safety of critical infrastructures and lifelines it is reasonable to develop intensity-compatible time-histories for engineering application as an alternative to standard methods.
In the paper an approach how to develop intensity-compatible time-histories from recorded time-histories is presented. Based on published international data a set of intensity compatible time-histories covering the site intensity range between intensity V and VIII (EMS scale) is developed. The time-histories developed are compared with typical time-histories derived from spectral matching of a uniform hazard spectrum from a large scale PSHA corresponding to approximately the same intensity class. For this comparison in-structure floor response spectra for a typical building are developed and conclusions regarding the seismic response are presented.