Geophysical Research Abstracts
Vol. 14, EGU2012-7737-2, 2012
EGU General Assembly 2012

Time dependent seismic hazard

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Probabilistic seismic hazard is usually computed trough a homogeneous Poisson process that even though it is a time-independent process it is widely used for its very convenient properties. However, when a single fault is of concern and/or the time scale is different from that of the long term, time-dependent processes are required. In this paper, different time-dependent models are reviewed with working examples. In fact, the Paganica fault (in central Italy) has been considered to compute both the probability of occurrence of at least one event in the lifespan of the structure, as well as the seismic hazard expressed in terms of probability of exceedance of an intensity value in a given time frame causing the collapse of the structure. Several models, well known or novel application to engineering hazard have been considered, limitation and issues in their applications are also discussed.
The Brownian Passage Time (BPT) model is based on a stochastic modification of the deterministic stick-slip oscillator model for characteristic earthquakes; i.e. based on the addition of random perturbations (a Gaussian white noise) to the deterministic load path predicted by elastic rebound theory. This model assumes that the load state is at some ground level immediately after an event, increases steadly over time, reaches a failure threshold and relaxes instantaneously back to the ground level. For this model also a variable threshold has been considered to take into account the uncertainty of the threshold value. For the slip-predictable model it is assumed that the stress accumulates at a constant rate starting from some initial stress level. Stress is assumed to accumulate for a random period of time until an earthquake occurs. The size of the earthquake is governed by the stress release and it is a function of the elapsed time since the last event. In the time-predictable model stress buildup occurs at a constant rate until the accumulated stress reaches a threshold; then an earthquake occurs and a part of the accumulated stress is released. The renewal gamma assumes that the loading in the source has to go under a fixed number of steps to trigger an event. Moreover, because these models are hardly capable to capture earthquake clustering, ETAS models have been also investigated. Finally, after-shock occurrence has been considered and modeled with a more traditional non-homogeneous Poisson process.