MODELLING SEISMIC DAMAGE ACCUMULATION AND RECOVERY IN AFTERSHOCK SEQEUNCES

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Civil structures' life-cycle may entail performance degradation, due to point-in-time events such as earthquakes and/or continuous aging, as well as the enforcement of maintenance and/or retrofitting policies. The current performance-based approach to the life-cycle analysis requires consistent modelling of uncertainty involved in the degradation and healing. Recent research efforts, based on the theory of age- and state-dependent stochastic processes, has explored modelling structural deterioration[1] and structural recovery;[2] only a few were devoted to a unified approach addressing the two jointly.[3,4] The presented study, focussing on the case of structures subjected to a possibly-damaging major seismic event (i.e., the mainshock), addresses a discrete-time discrete-state Markovian process to model both damage accumulation during the aftershock sequence and the damage restoration; i.e., the resilience of the structure. To this aim, the paper first discusses the considered phenomena acting on the structure, especially the peculiarities of the recovery, as observed after recent major seismic sequences; then, it shows how a Markov-chain, already adopted to model seismic damage accumulation,[5] can be adapted to also describe the resilience curve. Finally, a single transition matrix is developed to describe the combined effects of both damage progression due to aftershocks as well as recovery. An illustrative application, calibrated on data from the Italian L'Aquila seismic sequence of 2009 (mainshock magnitude 6.3), and referring to a code conforming reinforced-concrete building, shows the capabilities of the holistic model.

Keywords: Resilience, Markov-chain, performance-based earthquake engineering, earthquakes, aftershocks, structural reliability.

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Proceedings of the 31st European Safety and Reliability Conference
Edited by Bruno Castanier, Marko Cepin, David Bigaud, and Christophe Berenguer
Published by Research Publishing, Singapore.
ISBN: 978-981-18-2016-8