Damage assessment of current buildings at territorial scale: a mechanical model calibrated on a macroseismic vulnerability model

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Abstract

The results of damage and risk scenario analyses are more and more used in support of the definition of risk management strategies, for urban and territorial scale areas.
The considerable developments of research in the field of modelling of mechanisms of source, of the propagation of waves and of the seismic microzoning, allow, in the framework of a seismic risk analysis, the definition of the hazard in physical-mechanical terms (PGA, displacement spectrums and acceleration, synthetic accelerograms). Coherently, the building vulnerability should be assessed by mechanical-based vulnerability models.
Several vulnerability models exist in literature where the seismic capacity of buildings is represented in terms of force-displacement or period-displacement correlations obtained from simplified mechanical approach or via pushover analyses on prototype buildings, assumed representative of building typologies. For both the cases, a non-negligible number of hypotheses are required that could invalidate the reliability of the models. This paper is devoted to the presentation of a vulnerability approach defined both on the basis of a mechanical approach and on the basis of a macroseismic-observational one. In particular, making reference to a typological classification, representative of the distinctive features of the European built-environment, a simplified mechanical-based approach has been used for the definition of capacity curves for masonry typologies. Capacity curves for reinforced concrete typologies, designed according to seismic codes, have been, on the other hand, drawn via a code-based approach. Limit states have been identified on these curves in order to estimate the damage to the buildings, and the related consequences, once the expected hazard is provided in terms of spectral ordinates.
Setting up the relationship between the limit states and the observed damage and the relationship between the mechanical measure of the input and the macroseismic intensity, the authors have derived an analytical correlation between the capacity curves and the building vulnerability observed after earthquake events and represented in terms of vulnerability curves within a macroseimic approach. This has allowed to verify the reliability of the force-based capacity curves, assumed for the proposed mechanical method.
The mechanical approach has been proposed by the authors within the EC financed Risk-UE project “An advanced approach to earthquake risk scenarios with application to different Europeans towns”, devoted to the development of a comprehensive modular methodology for creating earthquake scenarios and to its application to seven European cities.
In particular, the application to Catania town (Sicily, Italy) is presented, implementing the method with poor statistical data (information on: material, class of age, class of height, maintenance condition and aggregate context) for the whole town and with data specifically surveyed for limited areas.

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