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Fragility Curve Construction for Low-Rise Reinforced Concrete Buildings Affected by Debris Flow

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In landslide risk research, the majority of past studies has focused on hazard analysis, landslide zonation, and modeling, but there is limited amount of work on the concept of vulnerability, with no consensus on a generalized methodology. However, assessment of vulnerabilities along with the associated uncertainties are of utmost importance from a quantitative risk analysis point of view.

This study aims at estimating the vulnerability by developing fragility curves, specifically for low-rise reinforced concrete buildings affected by debris flows. The effect of debris flow on structures is modeled as an impulsive load. The behavior of a structure under an impulsive load is in many ways is similar to that of an earthquake excitation. Based on this similarity, and using a well developed approach from the field of earthquake engineering, corresponding fragility curves are constructed for three structural damage limit states: serviceability, damage control, and collapse prevention. This is achieved by (1) representing the buildings as equivalent single degree-of-freedom systems, and conducting nonlinear time history analyses of these systems, (2) obtaining response statistics in terms of maximum displacement, (3) obtaining the conditional probability of attainment or exceedance of each limit state at a specific debris flow intensity level, and (4) plotting the computed conditional probability with respect to the selected debris flow hazard parameter. The resulting fragility curves give the damage state probability as a function of debris flow velocity. The uncertainty in the structural parameters, such as the natural period, are considered by using a building database from the city of Duzce, Turkey, which was affected by two major earthquakes in 1999. The comparison of the results obtained from this study with those obtained using a different database employing the same methodology, will highlight if the country-specific characteristics of the fragility curves are significant for debris flows.