From rapid visual survey to multi-hazard risk prioritisation and numerical fragility of school buildings in Banda Aceh, Indonesia

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Regional seismic risk assessment is paramount in earthquake-prone areas, for instance to define and implement prioritisation schemes for risk mitigation. As part of the INdonesia School Programme to Increase Resilience (IN-SPIRE), this paper introduces the INSPIRE index, which is an empirical proxy for the relative seismic risk of reinforced concrete (RC) buildings within a given building portfolio. The index combines a baseline score, calibrated based on fragility curves in HAZUS MH4, and a performance modifier, calibrated through the Analytic Hierarchy Process (AHP) to minimise subjectivity. An ad-hoc rapid visual survey form is proposed, which allows to 1) calculate the proposed INSPIRE seismic risk prioritisation index; 2) calculate the Papathoma Tsunami Vulnerability Assessment (PTVA) index; 3) define one or more archetype buildings representative of the analysed portfolio; 4) derive detailed numerical models of the archetype building, provided that simulated design is used to cross-check the model assumptions. Such framework is demonstrated for 85 RC school buildings in Banda Aceh, Indonesia, the mostly affected city by the 2004 Indian Ocean earthquake-tsunami sequence. A multi-hazard prioritisation scheme is defined combining the INSPIRE and PTVA indices. Moreover, an archetype building representative of the entire portfolio is defined based on the collected data. Its seismic performance is analysed by means of non-linear static analyses, using both the analytical Simple Lateral Mechanism Analysis (SLaMA) method and numerical finite element pushover analyses to investigate the predicted plastic mechanisms and derive displacement/drift thresholds to define appropriate damage states. Finally, non-linear dynamic analyses using 150 unscaled natural ground motions (cloud analysis) are adopted to derive fragility curves for the archetype building. This paper demonstrates the effectiveness of the INSPIRE form and proposed index in providing a rational method to derive prioritisation schemes and in allowing the definition of archetype buildings for more detailed evaluations/analyses.