Développement des courbes de vulnérabilité probabiliste des structures dégradées soumises aux actions sismiques

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Abstract

Seismic fragility analysis is essential in engineering to assess structural responses to earthquakes, helping reduce infrastructure vulnerability by identifying weaknesses and environmental factors, like soil conditions and material degradation, which impact immediate and long-term resilience. Fragility analysis provides a comprehensive framework, applicable from individual buildings to urban zones, guiding design and risk management strategies. Chapter 2 introduces nonlinear static analysis (NSA) to evaluate structural behavior under seismic loads, generating capacity curves that represent structures' ability to withstand seismic forces. Additionally, the chapter addresses critical factors like soil-structure interaction and corrosion degradation. Using the Winkler model, soil flexibility is simulated, showing how softer soils amplify seismic deformations. A uniform corrosion model reveals that degradation reduces structural stiffness, emphasizing the need to include both factors in fragility evaluations. Chapter 3 explores surrogate models as an alternative to Monte Carlo simulations for generating fragility curves, which estimate the likelihood of specific damage states based on seismic intensity. The PC-Kriging (PCK) model accurately and efficiently captures rare events, combining polynomial chaos expansion with Kriging, making it well-suited for practical applications. Chapter 4 presents an advanced approach to seismic fragility by integrating soil-structure interaction and corrosion. These factors, traditionally omitted, offer a more realistic view of structural responses under seismic loads. The PCK model enables detailed and computationally feasible assessments of various seismic and degradation scenarios, overcoming limitations of conventional methods. In conclusion, this research enhances seismic fragility assessment by combining nonlinear modeling, degradation factors, and computational efficiency through surrogate models. The study highlights the importance of soil flexibility and corrosion in evaluations. This methodology enables precise, practical assessments, optimizing design and maintenance resources, thereby boosting structural resilience to earthquakes