Predictive capacity of topological measures in evaluating seismic risk and resilience of electric power networks

Ferrario, E., Poulos, A., Castro, S., de la Llera, J. C., & Lorca, A. (2021). Predictive capacity of topological measures in evaluating seismic risk and resilience of electric power networks. Reliability Engineering & System Safety, 108040. https://doi.org/10.1016/j.ress.2021.108040

Abstract

Electric Power Networks (EPNs) play a fundamental role in the wellbeing of modern societies and recovery of societal functions after an earthquake. Risk and resilience analyses may identify useful network characteristics to improve EPN response and recovery during and after a severe seismic event. This work computes different functional measures in order to: (i) estimate the actual risk and resilience of EPNs; and (ii) evaluate the predictive capacity of different topological measures (TMs) relative to the EPN earthquake risk performance. The analysis is carried out on the Chilean EPN at the national, regional and substation level, by using a detailed model of the network. EPN operation was modeled using the DC optimal power flow model from the time of earthquake occurrence until full system recovery using the Seismic Probabilistic Risk Assessment framework. Seismic risk and resilience estimations of Energy Not Supplied (ENS) and number of hours with ENS have been correlated with six network TMs. Linear correlation results show that TMs provide, in general, limited insight into the criticality of the Chilean EPN. In spite of that, the strongest correlation was observed for the degree TM. Moreover, the Damage Consequence Index confirmed the rather uniformly distributed seismic risk along the country.

Keywords

Electric power networks; Seismic probabilistic risk assessment; Risk and resilience; Network topological measures; Component ranking; Monte Carlo simulation