Earthquake response sensitivity of complex infrastructure networks

Llera Martin, Juan Carlos de la; Monsalve, Mauricio; Ferrario, Elisa; Allen, E.; Chamorro, A.; Castro, S.; Alberto, Yolanda; Arróspide, Felipe; Poulos, Alan; Candia, G.; Aguirre, P. (2020) Earthquake response sensitivity of complex infrastructure networks En 17th World Conference on Earthquake Engineering. September 13th to 18th. Sendai, Japan. https://wcee.nicee.org/wcee/article/17WCEE/2e-0007.pdf

Abstract

Resilience of complex infrastructure networks is critical in achieving earthquake resilience in urban environments. Perhaps due to their modeling complexity, very few research studies have addressed sensitivity of the network response to a severe earthquake hazard field. This research aims to characterize earthquake response sensitivity as a function of different topological parameters of 5 critical complex networks in central Chile, covering the electric, transportation, and drinking water networks. Central Chile was selected because it amounts for almost 50% of the country's population. What is also particular about this setting, is that the seismic characteristics of the region lead to extended (essentially) N-S strike fault ruptures, which run along the subduction margin defined by the E-W convergence between the South American and Pacific Ocean plates at an unusual rate of about 68 mm/year, thus involving in the strong-motion hazard field geographic scales in the hundreds of kilometers. It is concluded that node and link topological structures differ considerably between these complex systems, which are characterized by several different well-known centrality parameters and other interesting indices and network-class discriminators. Secondly, a component criticality analysis under an earthquake hazard field is also presented just in terms of connectivity/service loss, which enables, at least, a rough identification of the robustness of each network as nodes and links are removed. Results from these topological analyses are useful to identify which components are essential in generating larger earthquake resilience. This is the first time such results are obtained for central Chile using very detailed models of these complex networks

Keywords: Complex infrastructure networks; Earthquake resilience; Centrality indicators; Component criticality.