Risk analysis of transmission line systems to natural hazards with emphasis on earthquakes and extreme winds

Summary

The main goal is the analysis of the risks involved in transmission lines systems to natural hazards (with an exclusive focus on Earthquakes and Winds) and the development of practical vulnerability reduction measures. The scientific and technological objectives of this Research Plan include: 1) Structural health monitoring of a power transmission line case study (a specific type of supporting structure like a pole or a lattice tower). For that purpose, the utilization of vibration-based state monitoring equipment like radar interferometry (non-contact technique) and potentially other sensors (accelerometers, impact hammer and anemometers), creates opportunities to detect, localize and identify structural damage (fatigue, tower rotation, bolt loosening, etc.).

The use of operational modal analysis (with no known artificial excitation) to process ambient vibration data (*e.g.* wind) would allow the identification of structural dynamic properties (frequencies, mode shapes, damping ratios) in order to calibrate and update the finite element numerical model, as well as build a baseline for a future structural continuous dynamic monitoring system, which could enable the detection and location of possible damage in the structures; 2) Risk Analysis based on an engineering approach to natural hazards as earthquakes and extreme winds. Hence, Performance-Based Engineering that comprises the following four steps: hazard analysis, structural analysis, damage analysis, and loss analysis; will be adopted as a framework to quantify the risk inherent to the case study.

The suggested method permits to assess structures with a realistic and reliable understanding of risk to "life/occupancy/economic loss" that may result from a future earthquake/wind event. For the economic losses it would be important to address not only the direct cost on the structures (*e.g.* repair, downtime), but also indirect costs on the affected society due to the lifeline inoperability; 3) Study of strategies to reduce the vulnerability of structures, with eventual strengthening and rehabilitation (using control of vibrations damper devices) of these structures; and 4) Finally Benefit-Cost Analysis (or other analysis) oriented with the results of the Performance-Based Engineering methodology, provides a tool for the decision process of the different alternatives studied.

Keywords

Transmission line system (TLS), steel lattice tower, operational modal testing, dynamic behaviour, earthquake, extreme wind, risk analysis, performance-based engineering (PBE), fragility analysis, vibration control.

Example of a Transmission Line System.

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