World Academy of Science, Engineering and Technology
International Journal of Civil and Environmental Engineering
Vol:12, No:01, 2018

Downtime Estimation of Building Structures Using Fuzzy Logic

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Abstract : Community Resilience has gained a significant attention due to the recent unexpected natural and man-made disasters. Resilience is the process of maintaining livable conditions in the event of interruptions in normally available services. Estimating the resilience of systems, ranging from individuals to communities, is a formidable task due to the complexity involved in the process. The most challenging parameter involved in the resilience assessment is the 'downtime'. Downtime is the time needed for a system to recover its services following a disaster event. Estimating the exact downtime of a system requires a lot of inputs and resources that are not always obtainable. The uncertainties in the downtime estimation are usually handled using probabilistic methods, which necessitates acquiring large historical data. The estimation process also involves ignorance, imprecision, vagueness, and subjective judgment. In this paper, a fuzzy-based approach to estimate the downtime of building structures following earthquake events is proposed. Fuzzy logic can integrate descriptive (linguistic) knowledge and numerical data into the fuzzy system. This ability allows the use of walk down surveys, which collect data in a linguistic or a numerical form. The use of fuzzy logic permits a fast and economical estimation of parameters that involve uncertainties. The first step of the method is to determine the building's vulnerability. A rapid visual screening is designed to acquire information about the analyzed building (e.g. year of construction, structural system, site seismicity, etc.). Then, a fuzzy logic is implemented using a hierarchical scheme to determine the building damageability, which is the main ingredient to estimate the downtime. Generally, the downtime can be divided into three main components: downtime due to the actual damage (DT1); downtime caused by rational and irrational delays (DT2); and downtime due to utilities disruption (DT3). In this work, DT1 is computed by relating the building damageability results obtained from the visual screening to some already-defined components repair times available in the literature. DT2 and DT3 are estimated using the REDITM Guidelines. The Downtime of the building is finally obtained by combining the three components. The proposed method also allows identifying the downtime corresponding to each of the three recovery states: re-occupancy; functional recovery; and full recovery. Future work is aimed at improving the current methodology to pass from the downtime to the resilience of buildings. This will provide a simple tool that can be used by the authorities for decision making.

Keywords : resilience, restoration, downtime, community resilience, fuzzy logic, recovery, damage, built environment
Conference Title : ICSRC 2018 : International Conference on Seismic Resilient Cities
Conference Location : Sydney, Australia
Conference Dates : January 29-30, 2018