Building collapse during earthquake aftershocks

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Ruins from the 1906 San Francisco earthquake, remembered as one of the worst natural disasters in United States history. Credit: Public Domain

Earthquakes kill, but their aftershocks can cause the rapid collapse of buildings left standing in the aftermath of the initial quake. Research published in the *International Journal of Reliability and Safety* offers a new approach to predicting which buildings might be most susceptible to

potentially devastating collapse due to the ground-shaking aftershock tremors.

Negar Nazari and John W. van de Lindt of the Department of Civil and Environmental Engineering, at Colorado State University in Fort Collins and Yue Li of Michigan Technological University, in Houghton, USA, point out that it is relatively obvious that buildings that survive a main shock will be at varying degrees of risk of collapse as aftershocks travel through the earthquake zone. Aftershocks are usually several orders of magnitude less intense than the primary earthquake, but can nevertheless have high ground motion intensity, last longer and occur at different vibration frequencies. In addition, changes in the structure of a building and its foundations, whether crippling or not, mean that the different energy content of the ground acceleration can during an aftershock further complicates any analysis. This adds up to a very difficult risk assessment for surviving buildings.

In order to compute the risk of collapse, the probability, for building damaged by a main shock, the team has introduced a logical method based on two key earthquake variables: magnitude and site-to-source distance. They have carried out tests using different site-to-source distances with an incremental dynamic analysis based on simulated ground motions caused by the main shock and aftershocks and applied this to a computer modeled, two-storey, timber-frame building in a hypothetical town in California relatively close to a geological fault line, as a proof of principle. Full-scale structural data was available from an actual building.

The team found that collapse probability increased if there were a sequence of aftershocks following a main shock just 10 kilometers distant from the building. Stronger aftershocks mean greater risk that correlates with the actual magnitude of the shock. As one might also expect if the site-to-source distance is greater, risk is lower. Overall,

however, the analysis allows the team to quantify this risk based on the two variables, distance and aftershock magnitude.

More information: Nazari, N., van de Lindt, J.W. and Li, Y. (2014) 'Effect of aftershock intensity on seismic collapse fragilities', *Int. J. Reliability and Safety*, Vol. 8, Nos. 2/3/4, pp.174-195.

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