Next Generation Rapid Visual Screening for RC Buildings to Assess Earthquake Resilience

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Extended Abstract

Due to a demographic population shift, the United Nations Office for Disaster Risk Reduction states that 70% of the world's population will be living in urban areas by the year 2050 (UNISDR, 2014). In the last 20 years, catastrophes caused by earthquakes and their tsunami associate have been responsible for more fatalities than all the other natural disasters put together (CRED, 2015). It has been noted by several authors that vulnerable groups, such as people with disabilities, by far suffer the most during and after destructive earthquakes (Aroni and Durkin, 1985; Harada, 2013; Tierney et al., 1988). Faced with such facts, it has become increasingly obvious that society needs to be resilient to disaster. Resilience can be defined as the ability to cope with and adapt to change. Urban resilience involves preparing for, responding to and recovering from disaster. A resilient society would be little affected by and would recover quickly from a catastrophe. Figure 1 schematically presents resilience with regard to community recovery after an earthquake.

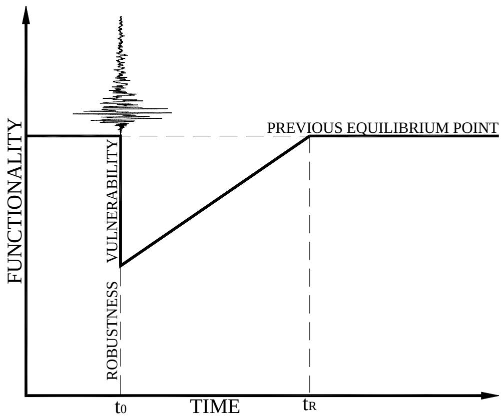

Fig. 1 Recovery after an earthquake

In figure 1, t_0 is the time of the disaster and t_R is the time taken for the affected society to recover functionality after the event. It can be seen from figure 1 that the loss of society functionality is initially dependent on how robust or vulnerable the infrastructure and society is. A further controlling factor to resilience is the time taken to recover. The area of the triangle in figure 1 is a measure of resilience, as the smaller the triangle the higher the resilience.

To date, efforts to offset the loss of life, injuries and destruction caused by major earthquakes have concentrated on assessing the existing infrastructure for vulnerability. Most earthquake prone countries have introduced some form of an evaluation procedure. Rapid visual screening is the first stage of some of these pre-earthquake assessment procedures. Recently, two efforts have been made to link screening procedures to resilience assessment. The United States Department of Homeland Security has developed an integrated rapid visual screening of buildings (BIPS 04, 2011). More specifically, the United States Resiliency Council has developed a building rating system for earthquake hazards (USRC, 2015). This building rating system translates these procedures into a five star rating for the three defined resilience parameters safety, damage and recovery.

This article introduces a new resilience assessment procedure that will apply to reinforced concrete buildings. Its background is based on the rapid visual screening procedures of the Earthquake Planning and Protection Organisation for structural and non-structural vulnerability (OASP, 2011; OASP, 2012), the American Federal Emergency Management Agency rapid visual screening procedure (FEMA P-154, 2015) and experience gained through developing the fuzzy logic rapid visual screening procedure (Dritsos and Moseley, 2013). As this new procedure is in its infancy, this paper is intended to provoke discussion and debate. It is also intended to introduce concepts beyond rapid visual screening procedures that have to be taken into consideration in order to encourage a society to be resilient to earthquake disaster. Figure 2 presents a summary of the proposed procedure.

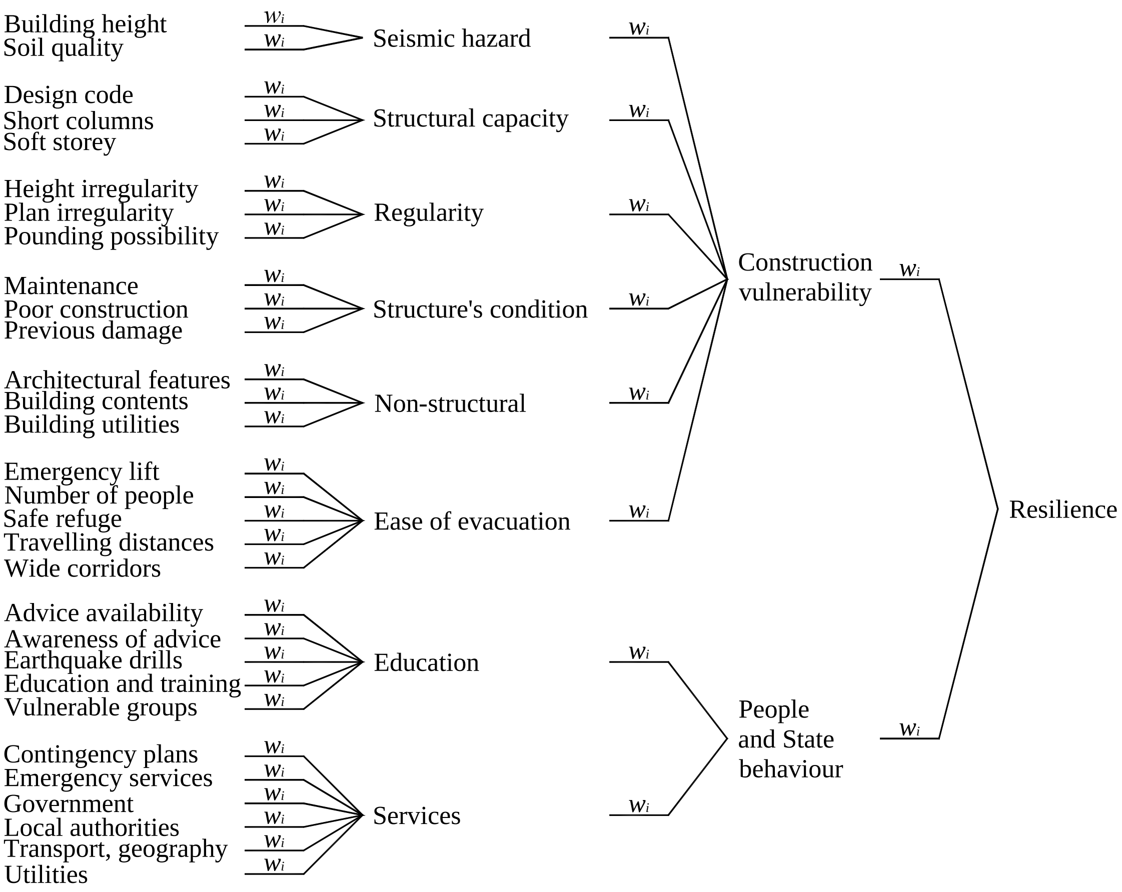

Fig. 2 Resilience assessment system representation

In the new procedure it is envisaged that screeners collect relevant information in the same way as for other rapid visual screening procedures. In figure 2, w_i represents a weighting factor, as all parameters may not affect resilience to an equal degree. From figure 2, it can be seen that relevant parameters are grouped together in order to obtain eight intermediate parameters. These in turn are used to assess the two parameters of construction vulnerability and people and State (as in government supported services and provided community services) that are considered to affect resilience.

Where the new procedure differs from other procedures is that screeners have the opportunity to assess the degree of existence of each parameter by allocating a value between 0 and 1, as it has been noted that it is difficult to decide yes or no as to whether a parameter exists and it has been found that assessing the degree of parameter existence produces more accurate results (Moseley and Dritsos, 2009).

A worked example based on an existing building is performed to illustrate the new procedure. From the example, it can be clearly seen where efforts should be concentrated in order to improve resilience. Worryingly, the building in question, its inhabitants and its supporting administration were found to be not very resilient.

It is concluded that it is time to move forward from merely assessing vulnerability and concentrate on resilience. Performing a rapid visual screening procedure will identify the weakest links in a society's resilience to earthquake disaster and identify areas for improvement to increase resilience.

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