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**Mapping seismic vulnerability at urban scale for disaster risk reduction**

**Lorenzo Diana1,** Yves Reuland**1**

1 Ecole Polytechnique Fédérale de Lausanne, Lausanne, Switzerland

**Presenting author’s email address: lorenzo.diana@epfl.ch**

***Biography of Presenting Author* (80 words):** PhD Lorenzo Diana is researcher at EPFL, in the applied informatics and mechanics Lab (IMAC). Main fields of expertise are: seismic vulnerability assessment of towns, seismic vulnerability analysis of the historical buildings with particular regards to monuments and churches, dynamic of structures. He accomplished his doctorate at Sapienza University of Rome in 2015.

**Abstract:** Earthquakes do not kill people, buildings do. Transforming existing cities in earthquake resilient systems should be the main goal for researchers in the field of the seismic analysis of entire towns. Providing means for realistic disaster risk scenario can help decision makers in pre- and post-earthquake management and save lives and goods. Two main challenges regarding seismic resilience at urban scale are linked to determining seismic vulnerability before earthquakes and residual capacity following a seismic event.

In this way, ambient-vibration measurement is an interesting and non-destructive data source for the seismic vulnerability assessment of towns. It can help in the detection of the real seismic behavior of structure and in the introduction and definition of new construction types in regions with very limited construction data prior to an earthquake. A second measurement after the shock provide information about the possibility of occupancy of damaged buildings.

**Keywords:** Seismic vulnerability assessment, Earthquake resilience, Urban-scale vulnerability mapping,Post-earthquake decision making

**Extended Abstract**

Earthquakes continue to be a major source of human casualties and economic losses. In addition, it is a well-known fact that earthquakes do not kill people; buildings that collapse during earthquakes kill people. Thus, professionals in the field, such as architects, civil engineers and urban planners should work in this way: trying to transform existing cities in resilient systems that are able to withstand a seismic event with the least possible losses. Two main challenges regarding seismic resilience at urban scale are linked to determine seismic vulnerability prior to earthquakes as well as residual capacity following a seismic event.

Accurate detection of building types is a key topic for seismic vulnerability assessment at an urban scale. Knowing the real type of the resisting structure may help in the determination of the possible damage that may occur in a town due to seismic events. At global scale, a main challenge is related to the variety in building typologies and construction methods. Indeed, the world is a variety of culture and people as well as different approaches to construction of buildings.

Multiple methods have been proposed all over the world in order to assess seismic vulnerability at an urban scale (GNDT, 1993; FEMA 178, 1997; Otani, 2000; Onur et al. 2005). While some of them have been proposed in Europe (Lagomarsino and Giovinazzi, 2006), a common aspect of all methods is related to the fact that considered construction types are mostly related to a restricted geographic area, such as southern Europe. Thus, based on regional information and building plans, building types need to define to reflect local characteristics of the building stock. The introduction and definition of new types corresponding to the real building stock of a defined region is a continuous goal for researchers and consists in a necessary starting point for city-scale maps of seismic vulnerability (Luchini, 2016; Lestuzzi et al. 2017).

However, often the context is characterised by the absence of accurate information regarding buildings and material properties as well as precise construction drawings. This is especially true for less developed countries. In such contexts, ambient vibration measurements can provide useful indication to engineers (Hans et al. 2015, Tischer et al. 2012). Ambient vibrations are an attractive data source, because they are inexpensive, non-destructive and easy to measure. Based on the fundamental frequency, derived from ambient vibrations, yielding and ultimate displacements of the structure, the capacity to withstand earthquakes of a structure can be determined. Understanding the real behaviour of the resisting system of construction types analysed is a key issue for seismic resilience of towns.

Urban-scale approaches for seismic vulnerability assessment are therefore useful for two main goals: determining of urban maps of the expected damage prior to a seismic event; and concluding on the safety for occupancy of earthquake-hit buildings after a seismic event. Taking a second ambient-vibration measurement on an earthquake-hit building can help to assess safety for occupancy in a short period of time. It has been shown in the past, that the modal properties derived from ambient-vibration measurements are sensitive to structural damage and are thus an indicator of the building condition (Foti et al, 2014; Mirshafiei et al. 2017; Trevlopoulos and Guéguen, 2016). Thus, earthquake resilience is enhanced and needs for temporary housing are reduced. In absence of initial ambient-vibration measurements, refined three-dimensional models can be used to derive the residual capacity of earthquake-hit structures. Providing trustworthy urban disaster risk maps can save lives, can help decision makers in managing the post-earthquake circumstances and can increase the likelihood of stakeholders to preserve their assets.

While the general methodologies do not significantly alter between Europe and the global South, some challenges need to be met in order to successfully apply urban-scale seismic assessment in developing countries: tests are needed to identify wide-spread building types and determine their seismic properties (nonlinear displacement capacity); assess whether less stiff buildings can be analysed using similar methodologies than typically stiff buildings in central and southern Europe; train people to identify building types and quantify damage after an earthquake.

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