Classification of earthquake-induced building damage using innovative methods

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Abstract

In the event of an earthquake, damaged and destroyed buildings are of central importance. Using a combination of automatic approaches and human crowdsourced visual interpretation based on unmanned aerial vehicle (UAV) derived data for the classification of earthquake damage offers a fast and objective assessment of the damage situation. Earthquake engineering knowledge is transferred to these innovative methods by developing and implementing a damage catalogue. This damage catalogue includes typical damage patterns for five damage grades ranging from crack widths to failure modes and focuses on the two common building materials - reinforced concrete and masonry. This paper presents the structure of such damage catalogue, defines crack widths and gives examples for particular damage grades. Moreover, the application of the damage catalogue in automatic and crowdsourcing approaches for a classification into five damage grades is explained.

Keywords: earthquake-induced damage; damage patterns; reinforced concrete; masonry; damage grades; EMS-98; crack widths; automatic damage classification; crowdsourcing; interdisciplinary

1 Introduction

In the event of an earthquake, many lives are at risk and the impact on the built and natural environment is significant. Thus, earthquakes play a major role worldwide regarding social and economic aspects. For an effective planning and support of rescue and remediation measurements as well as an optimal use of available resources, a fast and accurate detection of the situation and an objective assessment of damage to critical infrastructures is indispensable. So far, estimations of damage and losses are based on the subjective assessment of experienced engineers and are available merely several days to months after the event.

To simplify and speed up the procedure, the interdisciplinary system LOKI (Luftgestützte Observation Kritischer Infrastrukturen – Airborne Observation of Critical Infrastructures) [1] combines expert knowledge in the field of earthquake engineering with automatic damage classification and human visual interpretation, covering a wide range of temporal and spatial scales. On the one hand, UAV-derived 3D point clouds and images are the basis for Machine Learning approaches to automatically analyse and classify the earthquake-induced building damage. On the other hand, these data are used to interpret visually damage details by creating easy tasks that can be solved by volunteers. To overcome the challenging task of assessing multiple building-specific damage grades, a so-called damage