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DAMAGE ASSESSMENT FOR RAPID RESPONSE: THE CENTRAL ITALY 2016 M6 EVENT

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In case of a seismic event, building damage is one of the main causes of fatalities [1]. For this reason, rapid estimation of expected structural damage in near-real time is of paramount importance to enhance and support rapid life-saving actions of emergency managers. In this framework, we have developed the Damage Assessment for Rapid Response (DARR) method [2,3], which allows us to estimate the expected damage in real time or near-real time using earthquake recordings and knowledge of the fundamental frequency and damping of the building. We simulate the linear dynamic behavior of buildings in a first-order approximation as single or multi-degree-of-freedom (SDOF and MDOF, respectively) oscillators depending on the complexity of the building under study. The relative displacement at the top of the building is estimated using the Z-transform [4] and compared with thresholds associated with damage states. Relative displacement thresholds are defined in the literature for different building typologies (e.g. low-rise historical masonry buildings) and allow evaluating the expected damage. DARR does not aim at the exact reconstruction of the dynamic behavior, but in evaluating if the relative displacement exceeds predefined damage thresholds. For this reason, we assume that linear SDOF/MDOF oscillators can successfully reproduce the peak relative displacement at the top of the building, and that the non-linear behavior does not need to be taken into account. The DARR method can be applied to individual buildings [3] or building typologies in target areas [2,5], using earthquake recordings from sensors installed in the basement of a building or on the ground nearby.

In this study, we apply DARR to four selected target areas (Amatrice, Norcia, Sulmona and Visso, Fig. 1) hit by the M6 event of August 24 of the 2016-2017 Central Italy seismic sequence [5]. The considered towns are located at different epicentral distances and are characterized by different predominant building typologies (e.g.low to mid-rise unreinforced masonry, low to high-rise reinforced concrete buildings) for which varying damage patterns were observed. The earthquake recordings of the M6 event are available from the Italian Accelerometric Archive (ITACA, [6]) and the Italian monitoring network OSS (Osservatorio Sismico delle Strutture, [7]) at different locations, including the four considered towns.

The DARR method assumes that the dynamic behavior of each building typology can be simulated by an SDOF oscillator. The fundamental frequencies are estimated using specific building-soil period-height relationships developed by [8]. The relationships are obtained from a database that collected the main characteristics of more than 300 buildings in northern and southern Italy, including empirically estimated fundamental frequencies. For all four considered tows, the foundation soil was classified as soft soil based on the literature (Amatrice: e.g. [9], Norcia: e.g. [10], Visso: e.g. [11] and Sulmona: e.g. [12]).

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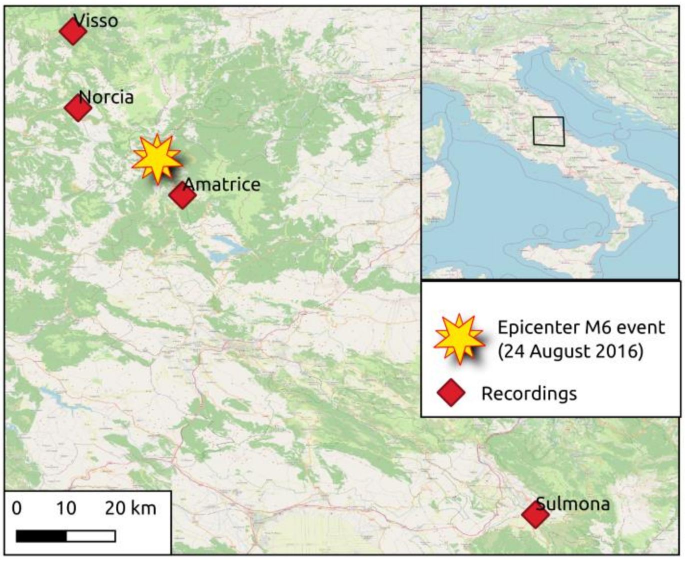

Figure 1. Locations of the considered towns, Amatrice, Norcia, Visso and Sumona, and the epicenter of the M6 event.

Expected damage is compared to and consistent with observed damage obtained from post-event surveys for most of the predominant building typologies (URM and RC frame buildings) in the four target areas considered. For example, expected damage was successfully estimated for mid-rise URM buildings in Amatrice, Norcia and Visso. However, for low-rise buildings in Amatrice, the DARR method did not estimate the observed damage. A possible explanation for this discrepancy is currently being discussed. Nevertheless, our results demonstrate the potential of DARR for rapid and cost-effective estimation of expected damage. An application of DARR in the aftermath of a destructive earthquake might therefore support rapid response and recovery strategies.

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