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Using structures of the August 24, 2016 Amatrice earthquake affected area as seismoscopes for assessing ground motion characteristics and parameters of the main shock and its largest aftershocks

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On August 24, 2016 an Mw 6.0 earthquake struck Central Apennines (Italy) resulting in 299 fatalities, 388 injuries and about 3000 homeless in Amatrice wider area. Normal faulting surface ruptures along the western slope of Mt Vettore along with provided focal mechanisms demonstrated a NW-SE striking and SE dipping causative normal fault. The dominant building types in the affected area are unreinforced masonry (URM) and reinforced concrete (RC) buildings.
Based on our macroseismic survey in the affected area immediately after the earthquake, RC buildings suffered non-structural damage including horizontal cracking of infill and internal partition walls, detachment of infill walls from the surrounding RC frame and detachment of large plaster pieces from infill walls as well as structural damage comprising soft story failure, symmetrical buckling of rods, compression damage at midheight of columns and bursting of over-stressed columns resulting in partial or total collapse. Damage in RC buildings was due to poor quality of concrete, inadequacy of reinforcement, inappropriate foundation close to the edge of slopes leading to differential settlements, poor workmanship and the destructive effect of vertical ground motions.
Damage in URM buildings ranged from cracks and detachment of large plaster pieces from load-bearing walls to destruction due to poor workmanship with randomly placed materials bound by low-strength mortars, the effect of the vertical ground motion, inadequate repair and/or strengthening after previous earthquakes as well as inadequate interventions, additions and extensions to older URM buildings.
During field surveying, the authors had the opportunity to observe damage induced not only by the main shock but also by its largest aftershocks (Mw 4.5-5.3) during the first three days of the aftershock sequence (August 24-26). Bearing in mind that:
(a) soil conditions in foundations of the affected villages were more or less similar,
(b) building damage induced by the studied earthquakes indicated the predominant effect of the vertical ground motion on buildings based on already reported building damage induced by recent destructive events in the Mediterranean region,
(c) the conventional dynamic parameters of buildings did not play a significant role in their seismic response against the vertical component, due to its impact type of loading,
(d) structures and materials presented similar response to ground motions almost independent from type and existing quality, and carried memories from previous large shocks of this sequence,
(e) the main shock and its largest aftershocks caused building damage including spatial homothetic motions that reached statistically significant levels,
it is concluded that the main shock and its largest aftershocks had similar focal mechanism parameters (normal faulting), were shallow events and were near-field earthquakes with short duration but high amplitude and the vertical component of the earthquakes' ground motion has prevailed.
The aforementioned approach based solely on macroseismic observations was applied in the case of the 1755 Great Lisbon earthquake in order to determine its mechanism and epicenter location. Thus, it is suggested that the aforementioned methodology can be applied either in past historic earthquakes or complementarily in cases when the available seismological data are insufficient.