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Building damage induced by Mw 4.0, August 21, 2017 Ischia (Italy) earthquake: A light event with high intensities

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On August 21, 2017, at 18:57:51 (UTC), an M 4.0 earthquake struck Ischia Island (Italy) with epicenter located onshore close to Casamicciola Terme, with focal depth of 1.73 km and focal mechanism indicating strike-slip faulting (INGV). Despite its small magnitude, 2 fatalities, 42 injured, 2600 displaced residents and 1061 temporary displaced tourists were reported. It also caused heavy structural damage to the building stock of the northern part of the island.

A field macroseismic survey was conducted by the authors in order to interpret the fact that this light earthquake caused heavy structural damage to buildings. The dominant building types comprise: (a) mainly 1- to 3-storey unreinforced masonry (URM) buildings with load-bearing walls of vulnerability class A and B according to the EMS-98 and (b) 2- to 4-storey reinforced concrete (R/C) buildings with R/C frame and infill-partition brick walls of vulnerability class C.

Building damage was observed in an area of small extent in the northwestern Ischia and more specifically in Fango, La Rita, Maio and Bagni areas. The masonry buildings suffered damage varying from slight non-structural damage including cracks in the load-bearing walls and detachment of small pieces of plasters from the walls to very heavy structural damage comprising total or near total collapse. The masonry seismic resistant structures behaved relatively well due to the fact that the wooden frame sustained successfully the vertical loads despite of the partial collapse of the perimeter masonry walls. The R/C buildings suffered only non-structural damage. Based on the differentiation and classification of structures into vulnerability classes and the classification of damage to grades, the highest intensity assigned to the affected area is VIIIEMS-98 due to the fact that many buildings of vulnerability class A suffered damage of grade 4; a few of grade 5, while many buildings of vulnerability class B suffered damage of grade 3; a few of grade 4. Taking into account DInSAR analysis performed by CNR-IREA (https://goo.gl/bYBMi7), it is indicated that damage was observed in an area which suffered subsidence of the order of 4 cm detected close to Casamicciola Terme.

The observed damage is attributed to a synergy effect of the following factors: small focal depth, highly vulnerable buildings, prevailing vertical component of the ground motion deduced from field observations and possible amplification of the ground motion due to the type of the basement in the affected area. Moreover, due to the half-period wave, the impact type and the high frequency of this wave, the extremely small duration of the seismic motion of the outcropping basement and the larger self-resonance of the loose soils as well as the higher absorptivity that they present in high-frequency motions, the parts of the affected area founded on loose soils did not suffer building damage. The loose soils in this case acted as shock absorbers, while the parts comprising outcropping basement suffered the most damage as they receive the seismic motion of the basement without any loss. This phenomenon of the shock absorber is not mentioned in any antiseismic regulation.