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Building damage induced by the 2017 June 12, Mw 6.3 Lesvos (North Aegean Sea, Greece) earthquake and application of the European Macroseismic Scale 1998

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On June 12, 2017 (12:28 GMT) an Mw 6.3 earthquake struck Lesvos Island (Northeastern Aegean, Greece) with focal depth of about 13 km and epicenter located offshore southeastern Lesvos. The earthquake was generated by a NW-SE striking and SW-dipping normal fault comprising the northern margin of the offshore Lesvos basin. The earthquake claimed the life of a woman and 15 injured.

The dominant types of structures in the affected area are: (a) unreinforced masonry (URM) buildings and (b) reinforced-concrete (RC) structures. The URM buildings comprise the majority of the building stock and consist of masonry load-bearing walls composed of stonework often bound with mortars of poor and inadequate quality. Their construction is dated back to the late 19th and early 20th centuries. Their high vulnerability is attributed to the fact that they were at the end of their conventional life cycle and faced decay problems affecting the seismic response of their structural elements. The second category comprises recent RC buildings with brick infill walls constructed according to the Greek Seismic code for earthquake resistant structures. Masonry monumental buildings including post-byzantine temples and industrial structures were also observed.

Building damage was observed in southeastern Lesvos with very heavy structural damage, limited in the traditional settlement of Vrissa. Taking into account that Vrissa is located inland, further from the epicenter than other settlements with less damage, it looks like an earthquake impact paradox. For interpreting this paradox, a rapid field macroseismic reconnaissance was conducted performing not only the classical building-by-building inspection but also use of Unmanned Aircraft Systems (UAS) and Geographic Information Systems (GIS) online applications before any intervention done by the competent authorities and with the highest possible detail. It is concluded that many URM buildings in its northwestern part and in damage islets of its southern part suffered damage grade 5 and 4 (47.2% and 18.1% of the total buildings of Vrissa respectively) based on the EMS-98, while the rest of the village remained relatively intact. Thus, a seismic intensity XI+EMS-98 was assigned to Vrissa.

Taking into account the geological and geomorphological structure of Vrissa, it is concluded that its worst affected part is founded on Holocene alluvial deposits (gray and red clays, sands, gravels), while its slightly affected part on Pleistocene deposits (fluvial sands, clays, conglomerates) with about 100 m thickness. Moreover, the occurrence of these damage islets is attributed to the generation of earthquake-induced landslides along geotechnically unstable zones characterized by relatively steeper slopes.

Based on the correlation of all available data, it is concluded that the geological and geomorphological setting, the occurrence of geotechnically unstable zones, the geotechnical properties of the foundation soils and the building characteristics are factors controlling the spatial distribution of building damage in Vrissa. More specifically, the occurrence of buildings characterized by old construction age and high vulnerability founded on recent deposits and on slopes in an area that it is bounded by significant faults in combination with observed directivity phenomena and possible amplification resulted in destruction.