THE DECEMBER 29TH 2013 MATESE (SOUTHERN ITALY), MW=5, EARTHQUAKE: EVIDENCE FOR LOCAL SITE EFFECTS CONTRIBUTION TO DAMAGE
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Introduction. The Matese massif extending between the provinces of Isernia, Caserta and Benevento, is a portion of the South-Central Apennines that are characterized by a high seismic hazard level. The seismic potential of the Matese seismogenetic area has also been recognized in several studies of seismic events occurred in historical times. The 1349, 1456, 1688 and 1805 earthquakes with magnitude evaluated around 7 and the related huge number of casualties, testify how frequent and hazardous are the seismic events occurring in the area. In recent years, except for isolated low energy events (magnitude about 3) and the 1997-98 seismic sequence with M <4.2, no particular phenomena have occurred.

In this context, the 29 December 2013, M\(_{\text{w}}\) 5 (Imax VI-VII MCS) earthquake (Convertito et al., 2014, 2016; De Gori et al., 2014; Ferranti et al., 2015), could thus represent an important test to analyse what could be future scenarios in terms of expected damage.

From the analysis of the survey performed just after the seismic event and in the next months, a strongly differentiated damage among the edifices, located at small inter-distances, have been observed. This observation leads us to investigate the origin of such differentiation.

To this aim, we have analysed structural typology of the edifices showing...
different damage levels and local site response of the soils where the structures lay.

**Analysis and results.** The map of the observed damage (Fig. 1) shows that the inhabited centres most affected by the event are in the area of VI MCS degree, at different distances from the epicenter and located on loose deposits. This is the case, for example, of the centres located in the municipalities of Piedimonte Matese and Faicchio.

This result seems to suggest that the damage distribution originated from ground motion amplification effects both at large-scale and small-scale, and from the structural typology of the buildings. While large-scale site effects can be ascribed to the contact between soil deposits (e.g., clastic and alluvium deposits,…) and the limestone characterizing the Matese massif, the small-scale effects can be due to the fact the buildings foundations lay on alluvial fan and debris. To test this hypothesis, we have selected two edifices that present large damage (Fig. 2). For both of them we have computed the structural response and the transfer function of the soil where they are located. We have performed the H/V ratio analysis using seismic noise recorded at the ground flour and the top flour of the considered edifices (Nigro *et al*., 2015). From the comparison of the observed dominant frequencies resulting from the H/V ratios (Fig. 3) and those obtained from a model of the buildings, two clear points arise: the first dominant frequencies indicated with 1 in Fig. 3, are ascribed to the local seismic response, whereas the frequencies of the second peak, indicated with 2 in Fig. 3, are the frequencies related to the structural oscillations of buildings. Note that, the dominant frequencies of the soils range between 1-2 Hz, which is very close to the corner frequency of the seismic event (Convertito *et al*., 2016), whereas those of the buildings, taking into account for all the uncertainties, range.

**Fig. 2 -** a) Picture of the damage affecting building B and b) those affecting building D.

**Fig. 3 -** H/V ratio analysis of the two buildings shown in Fig. 2 and the correspondent site response functions.
between 3 and 7 Hz. Thus, for the building D the structural frequencies do not coincide with the dominant soil frequencies. However, for the building B with plane pilotis (Fig. 2a) the structural frequency is very close to that of the soil, and this could justify the larger damage level. In addition to a site effect contribution, a correlation between the location of the damaged structures and the rupture direction presented in the study of Convertito et al. (2016) cannot be excluded.

**Conclusions.** From the results of the analyses described above, it seems reasonable to conclude that the anomalous damage levels observed in the area under study, following the low-to-moderate 29 December 2013, \(M_w 5\), event may be due to several concomitant factors concerning both site effects and seismic source effects. In particular, two different seismic amplification phenomena, one operating at large-scale (power of the layer 100-200 m) and one at a small-scale (power of the layer 10-30 m) and the vulnerability of non-antiseismic buildings with pilotis plan. From the present work important evidences emerged on the distribution of the damage and their origin that can help to implement actions aimed at mitigating future effects.

**References**


