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## Evaluation of the seismic response at the Arquata Del Tronto hamlet through 3D numerical analyses

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The 2016 Italian seismic sequence showed, once again, the relevant role of the differentiated seismic effects at short distance in varied geological environments. In the case study of Arquata del Tronto hamlet, several response analyses have been performed in order to reproduce the ground response through 2D finite element numerical codes (Primofiore, 2019; Pagliaroli et al., 2019). According to the Italian Guidelines for Seismic microzonation ICMS (2010), in the case of hills, the topographic effects of seismic amplification must be studied by numerical methods. In those cases, when the relieves are made up of soil deposits, 2D numerical analyses are used, indeed. Instead, when rocky hills are considered, the amplification effects due to the topography are considered by means of 1D simplified analyses or at most, 2D ground response analyses. The recent damages of old settlements located on the top of rocky hills, such as Arquata del Tronto hill, put in evidence the relevant role of three-dimensional movements of asymmetrical isolated rocky reliefs in generating heavy disruptions during the seismic shaking. In addition, on surface there are commonly fracturing layers of rocks, which played an important role in amplifying seismic waves according to their thicknesses. 3D numerical analyses at Arquata del Tronto hill have been carried out through the spectral element method implemented in SPECFEM3D code. Results suggested that an accurate simulation of the topographic effects of isolated asymmetrical rocky hills can be appreciated only through 3D numerical analyses, because they capture the out-of-plane bending moment (torsional effect) that asymmetry induces. The results showed that seismic behaviour of articulated morphology of the isolated relieves cannot be simulated by means of 2D seismic response analyses.

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