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Joint application of electrical resistivity tomography and single-station ambient vibration measurements for the geological and geophysical characterization of the "Duomo di Orvieto" area (Umbria, Central Italy)

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In the assessment and management of seismic risk, geological and geophysical studies are necessary for the prevention and mitigation activities especially in Italy where the seismic risk is also connected to high vulnerability and high historic values of the urban centers. Historic urban areas represent some of the most challenging environments for the subsurface investigation activities. As cultural heritage needs to be preserved, direct surveys (such as invasive drilling) must be avoided or, whenever possible, the impact should be minimized. In such a context, geophysical methods can play an important role for the assessment of the dynamic properties of the subsurface. The Orvieto Cathedral in Umbria Region, Central Italy, has successfully survived earthquakes. However some signs of damage rise uncertainties about its safety under future seismic events. A multidisciplinary approach based on the integration of in situ geophysical and geological techniques was applied to investigate the Orvieto Cathedral, its unknown foundation geometry and the dynamic characterization of the underlying subsurface structure. In particular, we focused our attention on two complementary techniques, the electrical resistivity tomography and the horizontal-to-vertical spectral ratio by single-station ambient vibration recordings. The joint analysis of different data allowed us (1) to determine the unknown foundation geometry of the Orvieto Cathedral, (2) to evaluate the main resonance frequencies of the monumental building, and (3) to estimate the resonance frequency of the site.