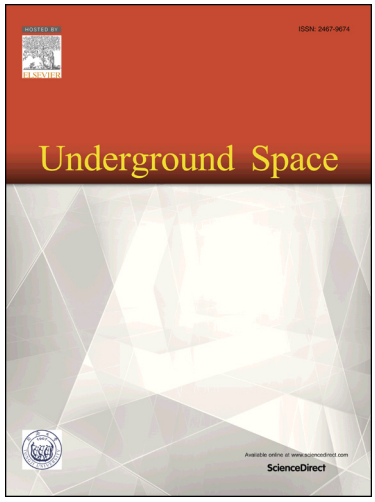


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# Prediction of the seismic behavior of an underground railway station and a tunnel in Napoli (Italy)

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**Abstract**

The assessment of the seismic safety of underground structures, either tunnels or large station boxes, should not be overlooked especially in densely populated areas, even with low to moderate seismicity.
For underground structures, an important issue is the estimation of the seismic actions acting on the structure; only few experimental evidences are available for multi-level propped walls. For tunnels, it is generally assumed that their seismic behavior in soft ground is governed by the surrounding soil, while the inertial load contribution of the underground structure itself is negligible. In both cases, recent numerical studies proved that advanced dynamic analyses can provide satisfactory interpretation of non-linear soil-structure interaction during earthquakes.
In this paper, a real case study, represented by a large open multi-propped excavation and a circular segmented tunnel in a densely urbanized area of the city center in Napoli, has been used to investigate some of the mentioned aspects.
Accurate geotechnical characterization and choice of the reference input motions lead to a first estimate of the free-field ground motion, which was subsequently used for pseudo-static decoupled analyses.
For the complexity of both excavation geometry and staged construction, a full dynamic analysis was considered neither affordable nor reliable for the multi-propped station box; thus two conventional pseudo-static analyses, applying either a displacement-based or a force-based approach, were carried out.
In the case of the tunnel, the seismic increments of internal forces in the lining could be calculated through both a simplified pseudo-static analysis and a full dynamic analysis, showing a satisfying agreement.
Overall, the results of the study demonstrated that the seismic increments of internal forces in the diaphragm walls of the station and in the segmented lining of the tunnel were quite significant. The case study encourages improving the reliability of simplified methods based on the more advanced dynamic approaches.

Keywords: underground structures; tunnels; diaphragm walls; seismic behavior; pseudo-static analysis; dynamic analysis; soil-structure interaction