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Seismic soil liquefaction under shallow founded structures and its mitigation in urban environments

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The large majority of existing studies of seismic liquefaction effects on structures considers them isolated, i.e., far from other structures. The same holds for design methods for liquefaction mitigation techniques. Hence, there is very little consideration for structure-soil-structure-interaction (SSSI) effects that appear unavoidable in urban environments. This paper explores numerically these SSSI effects for structures on surface foundations by performing fully coupled non-linear dynamic analyses with the finite difference method (FLAC) and a state-of-the-art constitutive model (NTUA-SAND) for the liquefaction response of loose, saturated granular soils. It shows that SSSI effects may prove both beneficial (e.g., settlement reduction) and detrimental (e.g., tilt apparition) depending on the dimensions, distance and static loading of the neighboring structures. These SSSI effects become more complex when ground improvement methods are used in one of the structures, but not its neighbors. By considering three alternative types of ground improvement that have a completely different rationale (perimetric walls, colloidal silica grouting, gravel columns), this paper also shows numerically that, regardless of its type, ground improvement in one structure may potentially prove detrimental to its neighboring unimproved structures (e.g., increase of tilt).