Recent earthquakes have demonstrated the vulnerability of storage tanks in industrial installations and how their failure can trigger severe cascading effects that damage the community as well as the environment. Due to the seismic protection of tanks and their connected piping systems being an ongoing issue, new technologies and ideas are needed in the realm of seismic engineering. Based on this sentiment, a new type of foundation system based on locally resonant metamaterials is conceived herein. Metamaterials can be regarded as materials with 'unusual' wave propagation properties, where the most relevant property is the so-called band-gap phenomenon, which prohibits waves from propagating through the material. Exploiting this particularity, the novel foundation system is able to reduce the seismic action imposed on fuel storage tanks without applying excessive displacement on connected pipeline systems. Furthermore, the complete coupled system has been designed according to common building codes and subsequently optimized under consideration of the superstructure as well as the expected ground motion. However, since a feasible system resulted in large foundation dimensions, a negative stiffness mechanism was also conceived and studied herein. The proposed mechanism was implemented in the periodic structure, significantly amplified the band-gap behavior and reduced the foundation height to 1/3 of its original size, while maintaining its performance. Additionally, a study on wire ropes as resonator suspension yielded a more realistic foundation setup and may, in the future, provide the foundation with additional vertical resonant behavior. In sum, this thesis conceives and develops a foundation for the protection of tanks with connected pipelines, highlights the governing factors of metamaterial-based foundations, and points out where this type of system could potentially outperform traditional base isolation solutions.

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