Seismic retrofit of structures using shape memory alloys – application to masonry structures

Summary

This study focused on the development and validation of a SMA based device, which could be easily used in seismic retrofit of existing structures, taking advantage of the superelastic property of small diameter NiTi wires. A series of experimental tests were conducted to evaluate the thermo-mechanical characteristics of this material, which were considered for the design of a superelastic damper, which was then tested in two stages. First it was tested as the reinforcement of a composite wood-masonry reaction wall in quasi-dynamic cyclic tests and afterwards as part of ties controlling the displacement of a mass on top of a steel cantilever subjected to a series of shaking table tests. From both tests, the level of energy dissipation and reliable cyclic behavior show the potential of this type of devices as a viable seismic retrofit solution for existing structures.

After the characterization of the material, a numerical framework was developed which could replicate the superelastic behavior of the NiTi alloy in isothermal conditions. To this purpose a thermo-mechanical model was adopted and adjusted to better suit the experimental results obtained. The numerical model was validated by comparing its performance against each one of the experimental tests. Both the accuracy and robustness of the model were evaluated.

In conclusion, the NiTi alloy showed good dynamic properties that justify their potential use for seismic retrofit applications. Also the numerical model that was developed yielded results in the same range as the experimental results, which allow its use in the future design of this type of devices based on shape memory alloys.

Keywords

Seismic retrofit, shape memory alloys, masonry structures, transient non-linear analysis, superelastic damper.

Wall reinforced with superelastic damper.

Shaking table test set-up.

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