

## **Abstract**

The dissertation presents the issue of strengthening historical structures with shape memory materials. They belong to a family of materials with controllable properties, called smart materials. Their most important representatives, in the context of their application in the strengthening of structures, are shape memory alloys (SMA). Their main characteristic is the ability to restore a predetermined shape upon a temperature change (shape memory effect) or force removal (superelasticity). This dissertation presents the benefits of the superelasticity phenomenon in the context of reinforcement of historical masonry structures aimed at mitigation of seismic actions.

Structural strengthening with ties that incorporate SMA was numerically simulated with COMSOL Multiphysics and Wolfram Mathematica software. The material model of the SMA was implemented as constitutive relations represented by multi-parameter rheological structures reflecting the phenomenon of superelasticity under isothermal conditions. This modeling approach results in the representation of material behavior with a system of non-linear ordinary differential equations. The necessary material parameters were determined based on the results of the mechanical property tests carried out by author.

The results of the analyses showed that the use of SMA in the strengthening of masonry structures is a beneficial solution. In comparison to SMA ties, classical steel one, designed based on the same criteria, could jeopardize the structure of modeled example. In addition, the author presented positive influence of SMA ties on vibration damping. It results from energy dissipation during phase transformations occurring in SMA. Considering the individual nature of the presented case, the results justify the use of modern materials in such strengthening of a historical structure. It remains in accordance with international doctrinal documents on the conservation of world heritage sites.

**Keywords:** shape memory alloys, SMA, historic masonry structures, rheological models, retrofitting of masonry structures, seismic excitation.