Towards an integrated assessment strategy for masonry structures: Minor destructive in-situ tests and analytical-based multiscale model

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Due to the new sustainability challenges for our cities, the assessment of existing masonry structures is becoming one of the most important tasks for engineers who need to preserve historical heritage, renovate existing infrastructures, and refurbish existing buildings to promote their reuse.

Despite the relevance of structural assessment, often analysis methods require input parameters that cannot be easily determine on-site. One example can be the use of nonlinear finite element analysis based on continuum damage models. These models usually require the determination of elastic, strength and toughness properties of masonry under tension, compression, and shear loading for at least two orthogonal directions (perpendicular and parallel to bed joints). The characterisation of the entire set of properties on-site is currently not possible with limited invasiveness to the structure. This is especially crucial for masonry considering that fabrication process, workmanship and aging phenomena result in a large variety of masonry types worldwide and variability of masonry properties even within a single building. As a consequence the uncertainty in structural assessment increases when mechanical characterisation is not performed or provided limited information.

To tackle this problem, I aim at developing an integrated structural assessment strategy considering an analysis method based on a limited number of input parameters, which can be obtained with minor invasive in-situ testing methods.

In this presentation, I will show past and current work of my team for the development of this integrated assessment strategy. From the point of view of material characterisation strategy, recent developments and challenges on the minor destructive core testing method and the creation of a national database of properties of typical Dutch masonry buildings will be discussed. From the point of view of developing a new analysis method based on limited input parameters, preliminary results of an analytical-based multiscale model and challenges related to the identification of independent input parameters are presented.

Bibliography

Rita Esposito is assistant professor on Mechanics of Masonry in the section of Applied Mechanics at the faculty of Civil Engineering and Geosciences at TU Delft (The Netherlands).

She obtained her M.Sc. degree in civil engineering at University of Parma (Italy) in 2010 with a dissertation on modelling of reinforced concrete elements subject to cyclic loading. In 2011, she joined faculty of Civil Engineering and Geosciences at TU Delft (The Netherlands) where in 2016 she obtained a Ph.D. degree in structural mechanics with study on multiscale modelling of fracture processes in concrete. Between 2015 and 2018, she continued her research work in the same group as postdoc with focus on seismic vulnerability assessment of unreinforced masonry buildings. The work provided input to the newly developed Dutch building code for structural assessment due to induced seismicity (NEN-NPR9998:2018) and supported the development and validation of numerical modelling approaches daily employed for structural assessment.

Through her research, she hopes to contribute to the preservation and reuse of existing structures by understanding and modelling fracture processes in quasi-brittle materials and structures. Fascinated by the effect that a tiny defect can have on the entire response of a structure, she carried out research in different fields including mechanics of quasi-brittle materials (concrete & masonry), computational & experimental mechanics, and structural assessment with the scope of being able to describe the link between phenomena occurring at the level of material's constituents (sub-mm/mm scale) and performance of structures (m scale).