Practical Tools for the Assessment of Unreinforced Masonry Structures: COMPAS masonry

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ABSTRACT

Unreinforced Masonry (URM) structures represent some of humankind's longest-lasting constructions and most of the residential buildings all over the world, but much of this built heritage is vulnerable to collapse. The assessment of URM structures is an extremely complex topic, that is, an atypical mechanical problem: constructions are comprised of individual discrete elements; large displacements and deformations are common, and particularly for historic buildings, material properties, and boundary conditions are unknown or unknowable. Since billions of people are living in this type of structures, the problem is not only about preservation, but also human lives.

Even if in recent years the study and conservation of URM structures have attained high technological and scientific standards, in daily work, practitioners have the need to face and tackle this problem in rapid or appropriate ways, particularly with constraints on time or budget. In this perspective, there is still a lack of appropriate methods and tools. For these reasons, from 2018 the Block Research Group is working on a project funded by Swiss National Science Foundation (SNSF): "Practical Stability Assessment Strategies for Vaulted Unreinforced Masonry Structures". The goal of this research is to create better tools that can be used in engineering practice and to develop appropriate analysis strategies for diverse contexts and circumstances related to the availability of time and money. With this in mind, a new computational, open-source, Python-based framework for the assessment of URM structures, namely COMPAS masonry, is being developed.

The general idea is to frame the computational assessment of URM structures within the Heyman theory [1] but, at the same time, without forgetting the need to take into account other phenomena such as sliding, the role of stereotomy, large displacements and then to extend the computational applicability domain by using Discrete Element Models (DEM). The main methods adopted and implemented inside COMPAS masonry are Thrust Network Analysis (TNA) [2], Rigid Block Equilibrium (RBE) [3], Piece-wise Rigid Displacement (PRD) [4] and Discrete Element Modelling (DEM) [5]. Each of these methods is linked to a stand-alone COMPAS sub-package framed within the main COMPAS masonry package allowing in this way straightforward interoperability.

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