Preface

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Biographical notes: Elio Sacco is a Full Professor of Solid and Structural Mechanics at the University of Naples 'Federico II'. He is an Associate Editor of *Meccanica* and editorial board member of several international journals. His research field and activity concerns are mechanics of masonry materials and structures, material constitutive modelling, micromechanics and homogenisation techniques, multiscale analysis of heterogeneous structures, and analysis of plate and shells.

Michela Monaco is a Tenured Assistant Professor in Structural Mechanics and Experimental Mechanics at the University of Campania 'Luigi Vanvitelli' since December 2002. She is an author and reviewer of papers in the field of structural mechanics. She is also a member of evaluation units of both European and Italian funds and grants. Her research field and activity concerns are mechanics of masonry constructions, dynamics, experimental mechanics, and solid mechanics.

Masonry structures represent a large part of the constructions in the world. Old masonry buildings, historical towns and monumental constructions characterise the heritage of the countries. This important heritage deserves to be saved, maintained, preserved, protected and restored. Thus, the formulation of reliable and efficient procedures for evaluating the structural response of masonry constructions and, hence, their state of safety is a challenging research in civil engineering field.

This special issue of *International Journal of Masonry Research and Innovation*, entitled 'An Italian contribution to the analysis of masonry structures', aims to discuss some of the important and interesting subjects related to the analysis of masonry structures. It collects the papers presented during the Italian workshop 'Mechanics of masonry constructions', held in Cassino (Italy) on July 4, 2016 in memory of Antonio Ercolano, who spent large part of his scientific life at the University of Cassino and Southern Lazio developing researches on the mechanics of masonry. During the

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workshop, researchers involved in the study of masonry structures discussed the results of their recent studies.

The special issue contains 12 papers dedicated to different aspects of the mechanics of masonry, including experimental, theoretical, computational issues.

The analysis of masonry structures cannot disregard an accurate knowledge of the structure; the recent progresses of the laser scanner technique allow the acquisition of the external skin of the structure, i.e., its geometrical configuration. Actually, it is demonstrated that the laser scanner can be successfully employed even to collect information, like damage and loss of verticality, for the development of accurate structural analysis. Alessandri and Mallardo remark that the laser scanner technique may have interesting use in structural monitoring and non-destructive testing of masonry constructions.

The masonry material of old and monumental structures is characterised by a significant compressive strength accompanied by a very low tensile strength, which results to be random and decreasing with the time. Thus, one of the most adopted models to reproduce the collapse of masonry structures is the so called no-tension material model, based on the three Heyman's assumptions: masonry has no tensile strength, it is infinitely resistant in compression and does not slide along fracture lines. Angelillo presents the normal rigid no-tension (NRNT) material model, which assumes that the displacements are due only to the fracturing of the material, i.e., the elastic deformation is considered definitely equal to zero. Then, the energy formulations for NRNT material is discussed, as basis of numerical procedures for the solution of the boundary value problem. Numerical applications are developed, simulating the response of real case studies. Como proposes a limit analysis approach based on the no-tension material model for the evaluation of the thrust of masonry domes. In particular, the analysis of the St. Peter's Dome is presented. One of the most natural applications of the Heyman's no-tension material model is the analysis of masonry arches. Auciello proposes a numerical procedure based on a complementary energy approach to evaluate the collapse of the Saint-Martin Bridge arch when it is subjected to its weight and to a distribution of horizontal forces simulating the earthquake effect. A limit analysis approach, based on the static theorem, is adopted by Marmo et al. formulating the thrust network analysis (TNA), which is a methodology that allows to model internal forces within masonry arches and vaults by means of a network of thrusts. According the static theorem of the limit analysis if a network of thrusts able to equilibrate the external load can be found, the structure does not collapse under this loading condition. Several numerical examples are reported to analyse the loading capability of masonry arches and vaults. Rocchetta et al. propose a different formulation of TNA, presenting a lumped stresses network approach for the analysis of the masonry arches and vaults. The procedure is derived by a variational approximation of the continuous equilibrium problem; the proposed approach is validated studying a hemispherical dome, a groin vault, a cloister vault and a masonry beam.

In some cases, the tensile strength of the masonry is not completely negligible and, in the meantime, the compressive strength cannot be considered unlimited. Thus, material models based on damage mechanics and, eventually, plasticity can be adopted. In this framework, Addessi and Sacco propose a constitutive law for the mortar which account for the tensile and shear damage, the unilateral contact and the frictional effect; analogously, a damage model is adopted for the brick. Both the constitutive laws are framed in the non-local continuum theory and introduced in a two dimensional finite element which accounts for the transversal strain of a masonry wall. Numerical applications demonstrate the ability of the proposed model in reproducing experimental outcomes.

An original numerical procedure based on the coupling of finite elements and boundary elements is presented by Minutolo and Ruocco. The proposed technique can successfully be adopted for the description of complex structures by substructuring the construction and relaxing the continuity between elements introducing nonlinear interface elements. Numerical applications are developed to verify the accuracy and the reliability of the procedure.

The structural behaviour of spandrels in unreinforced masonry buildings can play a fundamental role in the overall response of the construction mainly when subjected to seismic actions, as they are the structural link of masonry piers. A wide experimental campaign on reduced scale spandrels made of different type of masonry are performed by Calderoni et al. The failure mechanisms are illustrated and numerical simulations of the experimental evidences are presented.

The development of accurate stress analyses is fundamental not only to verify the stability of existing masonry constructions, but also to properly design effective strengthening and repairing interventions. An evaluation of the behaviour of steel elements to be used for restoration interventions is discussed by Mascolo et al., developing a numerical procedure for thin-walled beams. A validation of the proposed procedure is performed by comparing the numerical results with experimental data.

The structural analysis of real monumental masonry constructions is not a simple task. Frunzio et al. approached the study of Palazzo Ducale in Parete (Caserta). The construction is complex in the geometry and subjected to many modifications during the centuries, so that it is quite impossible to imagine a model which could faithfully reflect the masonry history of over a thousand years. For this reason, simplified approaches based on limit analysis can be adopted to get reliable information on the capacity of the structure. Churches are important and complex masonry structures that, often, reveal to be very vulnerable to the seismic action. De Matteis et al. present a study concerning the seismic vulnerability assessment of churches based on a damage reconnaissance activity carried out after the 2009 L'Aquila earthquake on a population of 64 churches. The recurrent damage mechanisms and the main local structural fragilities are illustrated and a predictive model is applied for outlining fragility curves related to the seismic risk of churches.

The wide set of topics addressed in the papers of this volume is only a part of the larger chapter concerning the mechanics of masonry.