Investigating the mechanics of masonry structures with the help of virtual experiments

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Abstract

The main focus of the efforts of our team is on discovering how the different types of masonry arches and vaults carry their loads, and how they respond to their typical external quasi-static mechanical effects. Masonry structures are, by their deepest nature, discrete systems that consist of separate solid bodies, and this discrete nature fundamentally determines their behaviour. This is why continuum methods (like membrane theory or FEM) can only be rough approximations in many situations. In addition, as Heyman often stated, small perturbations of the structural geometry (e.g. slight support displacements) can significantly modify the system of internal forces, hence a range of slightly differing geometrical positions of the structure should be considered and compared before drawing conclusions.

To validate such conclusions, physical experiments are indispensable; however, physical experiments are expensive, troublesome, and not always feasible. In order to partially replace them, our team uses "virtual reality", i.e. numerical models that are calibrated according to the results of a low number of physical experiments. Our main tool for this is the Discrete Element Method (DEM). The presentation will shortly summarize what is DEM, and then give an overview how our team suggests to calibrate the material parameters of a discrete element model according to a real physical experiment so that the model could then be applied for simulating several similar tests based on the same physical experiment. Then, the presentation will show recent results of our team that were reached using virtual experiments.

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