CONTINUUM AND DISCRETE APPROACHES TO THE STATICS OF MASONRY VAULTS

Abstract

This dissertation presents continuum and discrete approaches to the statics of masonry vaults.

The thrust surface concept is introduced within Heyman's safe theorem and extends the funicular curve to the 3D case. A variational formulation of the truss network of masonry vaults is presented and allows to search a 'safe' thrust surface within a design domain. Such a model is based on a scalar potential φ of the stress carried by the thrust surface S (Airy's stress function) and polyhedral approximations to φ, by a predictor-corrector strategy based on the convex hull technique (no-tension model).

In the same way, a static load multiplier for curved structures is iteratively obtained and validated, by increasing the live loads over several steps and verifying, for each interaction, the existence of a corresponding statically admissible state of equilibrium via lumped stress method. Using this approach, we can observe potential cracks, where the stress state is unidirectional.

A tensegrity model of reinforced vaults is also proposed and allows to perform a design minimal mass reinforcements of masonry vaults under static and seismic loads.

Several case studies of unreinforced and reinforced masonry vaults are presented and discussed.