MINIMUM THICKNESS OF MASONRY DOMES AND VAULTS SUBJECTED TO VERTICAL LOADS: A PARAMETRIC STUDY BY THRUST SURFACE ANALYSIS

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Following the fundamental work of Jacques Heyman [1], one of the main research lines active nowadays for evaluating the safety level of historic masonry constructions makes use of the tools and techniques of the limit analysis of structures. Within this context, masonry is generally considered unable to transmit tensile stresses, its compressive strength is assumed unbonded, and no sliding failure is allowed between units. The two last hypotheses find even greater justification in the case of historical monumental buildings, where compression is generally low compared to the strength of the material, and where traditional construction techniques usually enable avoiding failure by sliding.

Within the framework of limit analysis, the Thrust Surface Analysis (TSA) is a well-established technique for effectively determining statically admissible stress fields in masonry vaults and domes. Although original formulation of the TSA introduces the thrust surface concept by referring to a discontinuity surface for the stress within the 3d body [2], we consider a masonry dome as a system of rigid blocks. Imposing the constraint that all the forces acting on each block meet at one point, in the limit case of an infinite number of blocks the set of all the centres of pressure becomes a surface, which is named the “thrust surface”.

The present contribution addresses the determination of optimal thrust surfaces in masonry domes and vaults subjected to vertical loads. The optimality criterion consists in minimising the dome thickness needed to make equilibrium to a given set of external loads. The set of differential equilibrium equations is solved numerically by expressly developed procedures. The study cases comprise spherical and ogival domes and vaults; in each study case the constrained minimization problem is solved by searching within a suitable given class of admissible thrust surfaces.

REFERENCES

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