A user-friendly digital tool for the structural assessment of historic domes: the case study of Saint Peter in Rome.

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Abstract: This paper presents a digital tool for the rapid structural assessment of historic masonry dome which assume the behaviour of a pushing dome, portioned by long meridian cracks. The proposed procedure incorporates the existing mechanical model in the user-friendly visual programming environment offered by Rhinoceros3D + Grasshopper, allowing it to be used by students, researchers and practising structural engineers. The proposed method has been validated investigating the Saint Peter's dome. As known, the behaviour of Saint Peter's dome gradually shifted from that of a rigid shell, stiffened by hoop stresses, towards that of a pushing dome, partitioned by long meridian cracks. The proposed method consists in the parametric modelling of the failure mechanism which allows exploration of the domain of possible solutions using the theorems of the limit analysis. Hence, a heuristic search method is subsequently used to refine the geometry of the collapse mechanism and compute the value of the horizontal trust. Subsequently, the evaluation of the safety factor of the structure is evaluated by checking the structural integrity of the drum. Unlike other more time-consuming advanced methods of analysis, the proposed method allows the users to perform a structural assessment of historic masonry dome in a rapid and computationally-efficient manner. The digital tool developed will be freely available from a web archive of the University of Minho.

Keywords: Limit Analysis; Visual Programming; Historic Masonry Domes; Nelder-Mead Algorithm.