Seismic vulnerability analysis of a large monumental complex

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ABSTRACT

Historical masonry structures are characterised by a high level of seismic vulnerability, as demonstrated by the earthquake events occurred in the last decades [1]. Monumental- historical buildings represent a particularly challenging topic: their morphological evolution, characterised by transformations, aggregations and modifications developed over centuries, gave rise to very complex structures that should be considered as "structural aggregates" rather than as "unique building"[2]. To achieve reliable results from the structural assessment, deep and accurate investigations are needed, on the base of precise and detailed knowledge of the construction itself [3-5]. This, obviously, does not mean that the whole aggregate shall be subjected to a blind in-depth high accuracy investigations and mechanical tests for the characterization of the material, but that a good knowledge shall be achieved basing on a well-organized historical analysis able to reconstruct the actual morphology accounting for the transformations undergone during centuries [6]. Besides, the intrinsic nature of the aggregate requires the need to recognize the structural units characterizing the monumental constructions, subdividing the complex in elementary cells which interact among each other [7, 8].

The present paper concerns the achievements reached by assessing the structural performance and seismic vulnerability of the *Certosa di Calci* historical complex, a monumental building located in Tuscany, Italy, by applying an in-depth multi-level and multi-disciplinary approach. The methodology presented, although used for a specific building, can be extended to other constructions provided by similar – even not identical masonry complex.

Basing on a preliminary and in-depth multidisciplinary knowledge analysis [9, 10] able to reconstruct the structural evolution of the aggregate, criteria to divide complex structural aggregates into structural units were studied and validated, accounting for the realization period, the different morphology of elements and components (such as storeys and roofs, interstorey height, material quality and typology, main resistant directions, etc.) [11-13]. Relevant structural units were then modelled using FEM approach: the numerical model represents a useful "tool" to assess the reliability of the adopted subdivision criteria and to analyse the influence of parameters that mostly affect the seismic vulnerability of the complex[14, 15]. Being the structural unit a component of the whole aggregate, the modelling phase need to be critically reviewed accounting for interaction phenomena among units, defined in relation to the structural characteristics of the aggregate and of the units themselves and allowing to introduce simple parameters opportunely calibrated basing on a critical review of the building features and of its structural complexity.

The results of numerical analyses can be used to weight the influence, in terms of structural behaviour, of each ones of the selected parameters, defining a general and accurate procedure for the structural assessment of monumental buildings.

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