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Structural Analysis of Historical Masonry Structures: Concepts and Possibilities

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Abstract

Masonry is usually described as a composite material formed by units and joint, with or without mortar, and different bond arrangements. It is certain that the problems associated with modeling ancient and modern masonry structures are very different. Physical evidence shows us that ancient masonry is a very complex material with three-dimensional internal arrangement, usually unreinforced, but which can include some form of traditional reinforcement. Moreover, these materials are associated with complex structural systems, where the separation between architectural features and structural elements is not always clear.

Structural analysis of these structural systems is a much relevant part of the safety assessment, even if other information has to be added so that a reasonable estimate of safety can be made. As masonry is very weak in tension, linear elastic calculations are not applicable and limit analysis or non-linear analysis must be used. In the presentation, the concept of safety will be addressed in detail, illustrating the levels considered for material and structural representation, and providing recommendations. This is to be followed by a discussion on the possibilities of structural analysis for static applications, with a comparison of different modeling strategies. Finally, the issue of earthquake analysis is to be addressed for structures with and without rigid diaphragms. Different methods are discussed and a comparison is made between pushover methods and non-linear dynamic analysis with time integration. It will be shown that traditional, adaptive or modal pushover analyses are not in agreement with non-linear dynamic analysis or experimental observations.