On nonlinear analysis of historical masonry monuments damaged by Emilia 2012 earthquake

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Abstract

The finite element analysis program DIANA has been used since 10 years at the Engineering Department of the University of Ferrara for evaluating the load-bearing capacity of masonry historical buildings. Some of these studies have been published in international technical journals [1-7] and conference proceedings. [9-11]

The purpose of this presentation is to illustrate some of the more recent studies concerning historical buildings damaged by the recent 2012 Emilia (Italy) earthquake. In particular, such studies addressed the structural analysis of two medieval towers.

The first one is the Fornasini tower, a XIII century watching tower located in Poggio Renatico, near Ferrara [9-11] which was severely damaged. Of particular interest are the nonlinear static analyses of the first floor vaults and a comparison between the push-over analysis of the whole structure, performed according to the Italian Building Code, and a full nonlinear dynamic analysis.

The second one is the tower of the fortress of San Felice sul Panaro [6], one of the most significant monument which was strongly damaged by 2012 seismic events. These studies, not yet published, involve the large cross vault of the "room of Julius II"; here a modal push-over analysis was performed instead of a regular push-over analysis, since the participation mass corresponding to the first vibration mode was found to be less then 60% of the total mass. This type of analysis was already been successfully applied to the masonry Chimney of the Faculty of Engineering of Ferrara [5].

Finally, the present contribution covers the studies done on the "Prospettiva di Corso della Giovecca" in Ferrara, where static, pushover and dynamic analyses were carried out in order to design an innovative seismic isolation system for the protection of heavy ancient marble pinnacle [7].

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