PRELIMINARY ASSESSMENT OF THE SEISMIC VULNERABILITY OF LOAD-BEARING MASONRY BUILDINGS IN MALTA THROUGH NUMERICAL MODELLING.

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Introduction

The seismic risk is Malta is perceived to be low, and no significant events have been recorded in recent years. In 1693, a major earthquake struck about 170 kilometres from Malta, devastating south-eastern Sicily, and causing serious damage in buildings in Malta with historical records of significant damage in Mdina but also in Valletta, Rabat and elsewhere.Research suggests that a similar earthquake on the same fault could occur every few hundred years.

The present study is part of a wider research initiative in Malta focusing on the vulnerability of buildings to seismic activity including the vulnerability of unreinforced masonry buildings, their characteristics contributing to seismic vulnerability and their effect on the adjacent structures. The integrity of a building during an earthquake depends on various factors including the materials used, structural systems, building height and building layout, position in a block and building-soil interaction. The urban landscape of Malta is characterised by a large density, mainly consisting of load-bearing masonry structures. The local globigerina limestone resources have been exploited over the years in the construction of buildings and stone masonry buildings are characteristic not only of historic areas which evolved over many years, but also recent development. Load-bearing masonry structures rely on globigerina limestone blocks (franka) and hollow concrete blocks.

The present study focuses on a specific load-bearing masonry typology developed in Malta during the past 40 years. Therefore the structural systems analysed are typically characterized by the following features: 3 to 4 floors above ground level, masonry load-bearing structure with rigid reinforced concrete slabs and a basement level “soft story”. The study consisted in the assessment of the seismic vulnerability of the structural typology through structural numerical modelling and using a specific seismic analysis software tool: 3D Macro. The numerical modelling tool is based on a discrete element approach.

The following building characteristics have been assessed through the structural modelling: presence of long corridor adjacent to party wall / central corridor, with/without lateral walls, with/without the soft storey. Both single blocks and an aggregate of adjacent blocks have been considered in the assessment. Building configurations assessed included shared and independent party walls between properties, staggered floors in adjacent buildings and varying number of floors. The behaviour of the aggregate wasanalyzed with respect to various combinations of adjacent building types.

Analysis of Results and Discussion

In the preliminary analysis of this building typology using numerical modelling through 3D Macro, structural units, located in a specific urban area, namely Xemxija in Malta, have been analyzed (Fig.1). In a first phase of research, the influence of the soft storey has been assessed. In particular, the structural units have been modelled, using the specific software, 3D Macro, with and without the soft storey. The safety factor was obtained through the analysis and the results are reported in Table 1.Results obtained in this first phase of research show that the presence of the soft storey is a very influential indicator on the assessment of damage of the buildings, with the safety factor being reduced significantly.

Figure 1. Structural Units 1 and 2 (Xemxjia – Malta).

Table 1. The safety factors assessed for models analysed using 3D Macro

	with the soft storey	without the soft storey
Structural unit 1	71%	155%
Structural unit 2	83%	188%

Conclusion

In the subsequent phases, other indicators of vulnerability were assessed, namely: the presence of a long corridor adjacent to party wall / central corridor, with/without lateral walls. Both single blocks and an aggregate of adjacent blocks have been considered in the assessment. Building configurations assessed included shared and independent party walls, staggered floors in adjacent buildings and varying number of floors. The behaviour of the aggregate was analyzed with respect to various combinations of adjacent building types. The various combinations assessed in a structured manner, provide significant insights into the contribution of the individual indicators to the overall structural vulnerability of the block and the aggregate.

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