THE DEVELOPMENT OF A RAPID EMPIRICAL SEISMIC VULNERABILITY ASSESSMENT METHODOLOGY FOR CONTEMPORARY LOAD-BEARING MASONRY BUILDINGS IN THE MALTESEISLANDS

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According to historical records, the last major earthquake reported to have caused extensive damage in the MalteseIslands dates back to 1693. It is not possible to assess the vulnerability of masonry structures to seismic action through post-earthquake damage assessments. Considering a return period of 475 years, the probability of occurrence of a major seismic event is quite high. This study is an attempt at addressing the issue of the seismic response of the building stock in Malta. It focuses on the typical contemporary load-bearing masonry building typology. This typology mainly consists of blocks of apartments including a semi-basement with no internal walls and, in most cases, roofed over by hollow core precast prestressed planks, and with around 4 overlying residential floors in addition to a penthouse level.

The methodology developed draws on other methodologies employed within other countries and on the experiences of regions with a high incidence of earthquakes, where such methodologies have been well-calibrated. In particular, reference is made to a number of first and second level pre- and post-earthquake assessmentmanuals and their corresponding forms, which have been developed in Italy over the past 40 years, not only with respect to the actual parameters listed but also with respect to the background principles affecting the seismic vulnerability of buildings as outlined in the manuals to these forms. These include the 'Analisi della Condizione Limite per l'Emergenza (CLE) dell' insediamento urbano', the

'Agibilita' e Danno nell' Emergenza Sismica (AeDES)' and 'Edifici in muratura in zona sismica. Rilevamento delle carenze strutturali – Manuale per la compilazione della scheda delle carenze'. A number of GNDT manuals also provide an important background to this study. These include the 'Scheda per la valutazione qualitativa dei possibili effetti locali nei siti di ubicazione di edifici strategici e monumentali', and the manuals and corresponding forms of the GNDT first and second level vulnerability assessment methods. Following the verification of the applicability of these assessment methods to the local contemporary load-bearing building typologies present in Malta and Gozoit is clear that the methods employed in other countries cannot be directly transposed to the local building stock due to inherent variations in local construction methods and materials and the presence of particular building characteristics. In addition the soft storey effect, could have a negative effect upon the seismic vulnerability of the building typology being considered and is, therefore, considered in more detail in the proposed method. The need for the development of a new seismic vulnerability assessment method for the seismic vulnerability assessment of individual buildings in the MalteseIslands is, therefore, evident. The newly-developed Form is based on the existing seismic vulnerability assessment forms, but is further adapted to cater for the specific construction methods and materials and building characteristics present in the contemporary load-bearing masonry building typology present in Malta and Gozo.

The method was used in a Pilot study in Msida (Malta) and this allowed for the refinement of the Form prior to its use in the Test Sites, namely Xemxija (Malta) and Nadur (Gozo), where the seismic vulnerability assessment of a total of 183 individual buildings was carried out. The extensive field surveys of the buildings present in the Test Sites and in the Pilot Study, together with the extraction of parameters related to the internal layouts of buildings from the Malta Environment and Planning Authority (MEPA) Development Permit Drawings, allowed for the completion of an exhaustive and detailed database.

The method is based upon ten main areas and therefore the Form is likewise divided into ten sections including: general building identification, general characteristics, vertical and horizontal structural systems (general and seismic vulnerability characteristics), the pre- and post-earthquake condition of the building, ground characteristics, building information and use, accuracy of assessment, post-earthquake assessment outcome, and a final section with the degree of seismic vulnerability.

The last section of the Form summarizes the seismic vulnerability rating resulting from the relevant sections of the new assessment form, in order to establish a final rating following a qualitative assessment of the ratings concluded for these previous sections of the form which is based on the characteristics of the individual building under evaluation. By reference to FEMA 154, the study identifies 4 main parameters of the vertical structural system which are considered to have a greater bearing on the seismic vulnerability rating, thereby allowing for the formulation of a more refined rating for this section of the Form.

The study includes a FEMA 154 assessment and a GNDT Level II seismic vulnerability evaluation for all the 183 buildings assessed in the Test Sites. A refinement of the GNDT Level II ranges corresponding to the Low, Medium-Low, Medium and Medium-High seismic vulnerability ratings was carried out, in order to make it more applicable to the scenario of the MalteseIslands. A comparison of the results obtained using the different methods, was carried out. This was intended to assess the differences between the methods when these are applied to the typology analysed and also to assess the merits of the proposed new method developed for the MalteseIslands.

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