BIM-BASED METHODOLOGY FOR THE SEISMIC PERFORMANCE ASSESSMENT OF EXISTING BUILDINGS

METODOLOGIA PARA AVALIAÇÃO DO DESEMPENHO SÍSMICO DE EDIFÍCIOS EXISTENTES COM RECURSO A BIM

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ABSTRACT

This presents a BIM-based methodology for the seismic performance assessment of existing mixed URM-RC buildings that consists of four phases: (1) **Anamnesis**, dedicated to the survey and collection of facts about the existing building, the structure and its environs. It aims at a better understanding of the complexity of different layers, historic phases, interventions and additions; (2) **Diagnosis**, dedicated to the analysis and interpretation of the collected facts in order to obtain the necessary understanding of the current state of conservation, the building's behaviour and performance, and to discern about the eventual need for intervention; (3) **Therapy**, corresponding to the actual retrofitting design and can be performed using a fully developed information model (as in the case of new design), along with advanced BIM-based analysis and simulation methods to predict the expected improved performance and the related life cycle costs from the application of the proposed retrofitting measures and to evaluate different retrofitting proposals; and (4) **Control**, entailing a series of cyclical and regular monitoring actions and the implementation of strategies for a preventive conservation plan.

Keywords: BIM / Seismic Performance Assessment / Mixed Buildings / Laser Scanning / Rehabilitation

EXTENDED ABSTRACT

The recent advent of Building Information Modelling (BIM) has been changing the paradigm in the Architecture, Engineering and Construction (AEC) industry. Regarding the assessment of existing buildings, one of the applications of BIM with more significant potential concerns the so-called "reverse engineering" (i.e., the reverse process compared with the traditional design procedure), which consists in recreating the existing “as-built” structure into a BIM model. Thanks to the high level of interoperability of BIM-based data, it is possible to transform this model into an accurate 3D computational numerical model, exploiting all the information collected and organised during the survey phase.

This BIM environment will represent the backbone strategy for bridging the research gap associated with a particularly vulnerable structural typology when subjected to seismic loads: the mixed URM-RC buildings. In fact, unreinforced masonry (URM) structures represent the highest proportion of the building stock worldwide and in regions affected by destructive seismicity, and together with reinforced concrete (RC) buildings, they account for the largest proportion of casualties in earthquakes. However, one typology that has revealed to be extremely vulnerable to seismic loads concerns the derived mixed URM-RC buildings. These have risen from the later introduction of RC structural elements (slabs, columns, ring-beams, etc.) into existing URM buildings, making them structurally more complex and unpredictable. The implementation of such practices, mainly in retrofitting interventions of existing unreinforced masonry (URM) building stock, has been spread all over the world, especially due to numerous vague recommendations given in certain building codes. Only in recent years, researchers have started to turn their attention to the seismic vulnerability of these structures, by studying and observing their particular damage patterns, mechanisms, and interaction effects from coupling RC structural elements to URM loadbearing walls. Moreover, the beneficial nature of structural interventions with RC on URM buildings located in seismically prone regions is still a contentious issue for most of the research community.

In this context, the full version of the present work (Correia Lopes, Vicente, Ferreira *et al*., 2020) presents a BIM-based methodology for the seismic performance assessment of existing mixed URM-RC buildings that consists of four phases: (1) **Anamnesis**, dedicated to the survey and collection of facts about the existing building, the structure and its environs. It aims at a better understanding of the complexity of different layers, historic phases, interventions and additions; (2) **Diagnosis**, dedicated to the analysis and interpretation of the collected facts in order to obtain the necessary understanding of the current state of conservation, the building’s behaviour and performance, and to discern about the eventual need for intervention; (3) **Therapy**, corresponding to the actual retrofitting design and can be performed using a fully developed information model (as in the case of new design), along with advanced BIM-based analysis and simulation methods to predict the expected improved performance and the related life cycle costs from the application of the proposed retrofitting measures and to evaluate different retrofitting proposals; and (4) **Control**, entailing a series of cyclical and regular monitoring actions and the implementation of strategies for a preventive conservation plan.

A case study building is presented to demonstrate the advantages and applicability of this methodological approach during the different phases of a building's lifecycle. This building is an example of the URM-RC building typology and consists in a residential palace from the 18th century located in the city of Aveiro, Portugal. Once accurately known the geometrical information (based on a laser scanning survey), and estimated the structural loads, it was possible to predict the material properties based on the calibration of natural frequencies obtained numerically and experimentally from an *in situ* ambient vibration testing campaign. Then, non-linear static (pushover) analyses have been performed based on the macro-element approach, using the 3DMacro software, in order to assess the seismic performance of the analysed building before and after the intervention (without

and with RC, respectively). Finally, the geometrical survey process used during the anamnesis stage will aid in the control stage (structural monitoring), should damage occur in the future, since it can help to detect significative deformations due to construction defects or cumulative ageing effects over time.

REFERENCE

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