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COST-BENEFIT ANALYSIS APPROACH FOR STRUCTURAL REINFORCEMENT OF "PILOTIS" BUILDING STRUCTURES

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ABSTRACT

In the present paper, some strategies for the rehabilitation of reinforced concrete buildings supported on "pilotis" are presented and it is proposed the development of a CBA for the same structure with and without the different selected interventions. Through the estimation of the costs associated with interventions for each solution used, and the assessment of the benefits that each solution added to the structure, it is intended that the application of a cost-benefit analysis model (CBAM) would support the stakeholders decision of the in a rehabilitation process for certain buildings.

Keywords: reinforced concrete structures, pilotis, structural rehabilitation, cost-benefit analysis, decision support.

INTRODUCTION

The last high intensity earthquakes occurred in Europe revealed that many cities or regions may suffer significant human and economic losses, because of the vulnerability of some reinforced concrete buildings without earthquake-resistant design. Most of these buildings, built until the end of the 1970s, have poor seismic resisting capacity. This fact results from the structural regulation at the time did not include any specific criteria for seismic design (Falcão Silva et. al.; 2014).

In the actual situation the country experiences, economic and efficient rehabilitation interventions in existing buildings should be assumed as priorities. The selection of techniques to be implemented should include a cost estimate, encompassing the respective work and disturbances, as well as an estimate of the benefits of the intervention (Mishan; 1998) (EVALSED; 2013).

The present paper presents three seismic strengthening solutions applied to a reinforced concrete building built during the 1950s, being analyzed the cost of each solution, in order to contribute to the implementation of cost-benefit analysis for the rehabilitation solutions choosing.

RESULTS AND CONCLUSIONS

For a case-study it was selected a reinforced concrete building located in Lisbon, representing one of the most vulnerable typologies in case of an occurrence of a seismic event. The selected building belongs to a set of housing units, representative of the reinforced concrete building without earthquake-resistant design, characteristic of the 1960s. The buildings units under study correspond to an example of the Modern Architecture in Portugal (Tavares da Silva et. al; 2016a).

The case-study building has constructive characteristics that allow the introduction of several reinforcement solutions, such as: i) metallic bracing; ii) reinforced concrete bearing walls; iii) reinforced concrete jacketing of columns. The efficiency of the proposed solutions may be assessed taking into account: i) the improvement of the seismic performance of the building; ii) the costs of each strengthening strategy; iii) the relationship between costs and benefits which may include, in addition to the direct reinforcement cost, the interventions costs in building repair for any damage resulting from seismic actions, the damage repair costs in the "filling" and, even, the "costs" of human losses (Tavares da Silva et. al; 2016b).

Non-linear static analysis, i.e. adaptive pushovers, was performed for that building. Data from adaptive pushover analysis allowed tracing the capacity curves, displacement profiles and drifts. The resulting capacity curves indicate that the metal bracing was the technique which provided a higher increase for the initial stiffness.

The use of methodologies based on cost-benefit analysis (CBA) may contribute in a very positive way to the decision process concerning building rehabilitation investment projects (Falcão Silva et. al.; 2014). The software M-MACBETH (M-MACBETH; 2016), used in the scope of the work developed, provides a methodology to support decision process by evaluating the different options of a project, taking into account a multiple criteria analysis, which is one of the parts of CBA methodology.

Based on the assumptions considered, the M-MACBETH software calculated the overall weighting of each of the solutions considered, and it was observed that the intervention option with the highest benefit corresponds to the metal bracing, with a score of 89.25. It appears that the option corresponding to the lowest value of the ratio cost / benefit (C / B) represents the most favorable option because it represents a major benefit for the same cost. The most attractive technique corresponds to the use of metallic bracing with a C / B of 687.65 against C / B 895.69 and 1278.12 for structural rehabilitation using reinforced concrete jacketing and reinforced concrete bearing walls addition, respectively (Tavares da Silva et. al; 2016b).

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