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Stone masonry in historical buildings — Ways to increase their resistance and durability

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Abstract

The paper is devoted to stone masonry structures in view of possible improvement of their dynamic-seismic resistance and durability. Many existing structures and large models were investigated by the authors in the framework of national and international research projects. The investigation of a large stone masonry model, tested on the shaking table, had as main purpose the evaluation of the behaviour of new and rehabilitated masonry structures reinforced with polymer grids produced in the European Union. The test plan consisted of the following parts: tests of individual material properties; seismic tests of a masonry model reinforced with polymer grids inserted horizontally in prescribed bed joints; seismic tests of a masonry model reinforced on parts of a wall surface by vertical polymer grids bonded with fibre-reinforced plaster. The paper presents the selected representative results and synthesis of obtained data. The polymer grids and fibre mortars enhance the seismic resistance of stone masonry structures. They contribute also to the durability of historical and other stone masonry structures, especially in cases of vertical polymer grids combined with fibre lime–cement plaster.

Keywords: Seismic vulnerability; Retrofitting; Upgrading; Fibre mortars; Polymer grids; Stone masonry; Seismic tests; Seismic resistance

1. Introduction

Historical buildings and monuments create a part of cultural heritage and therefore, countries, unions, national and international bodies should pay attention to their maintenance and preservation to protect them for future generations. A limit state method, as a general worldwide method for the design of new structures and the assessment and rehabilitation of existing ones, has not been developed for failures due to the material deterioration to the extent that it has for failures due to actions as earthquakes, settlements, wind, snow, etc., combined with gravity loads. Both for new and old structures it is important to identify an action-effect process starting from the structure's environment. Then, the mechanisms are active to transfer the environment into environmental actions on structural materials. The action effects need to be taken into account in developing methods for the prediction of working life, and developing tools for its prolongation [1–8].

New international/European standards define shorter design working life in comparison with those ones in national standards. The indicative design working life in EN 1990: 2002 [9] presents lower figures in comparison with national standards, e.g. STN 73 0031: 1989 [26], as shown in Table 1. The structure shall be designed such that deterioration over its design working life does not impair the performance of the structure below that intended. Environmental effects and anticipated level of maintenance should be taken into account. Although the indicative values of Table 1 will record the wide use, the customer, national authority or the designer can decide for higher design working life, including necessary changes in respective safety factors and other parameters dependent on the design working life.

The indicative design working life in Table 1 does not correspond to actual demands on historical buildings, where the recommended life should be as long as possible. Thus, the

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