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Long-action of additional horizontal prestressing on masonry

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Abstract

This article is focused on verifying behaviour of a brick masonry which was horizontally post-tensioned. An experimental model of three walls has been built for the measurement. The model is in scale 1:1 and represents a part of a real structure. Longitudinal strain of brick walls has been measured by wire strain gauges in important places. Surrounding temperature and temperature inside the walls were also recorded. Results of the experiment have been continuously evaluated and compared with the simplified numerical models. Right now we have a better picture of actual behaviour of the brick masonry wall which was horizontally prestressed and we are able to design appropriate restoration works for historical buildings.

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*Keywords:*masonry; addition prestressing; strain; brick walls; experimental measurement

1. Introduction

The existing historic buildings are strengthened by different methods. One of those methods is strengthening with additional prestressing. This way of restoration was used on different construction types – family homes, castles, towers, churches, but also in civil engineering (for ex. masonry arch bridges) [1], [2], [3]. The restoration works done so far convincingly show that strengthening with prestressing is effective and above all, gentle. There are minimal alterations made to existing structures – mounting ropes, anchor plates, steel deviators and boring or milling

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spare cable channels. The biggest advantage is that after finishing work, the alterations made to the load-bearing structure are not visible. The preservation of the original architectural appearance after the strengthening is especially wanted with protected heritage objects.

When strengthening with additional prestressing, there is a need for good proposal, which will adhere to the process and technology of prestressing. There are several things that must be determined; size of prestressing and the appropriate order and arrangement of prestressing cables. While creating the proposal, it is also important to determine the material characteristics of the existing object, which can be hard with masonry objects. Structural behaviour is determined by the composite material (bricks and mortar) in interaction with the foundation and subsoil. It's especially difficult to determine the solidness of the masonry, which is being strained by prestressing parallel to bed joint.

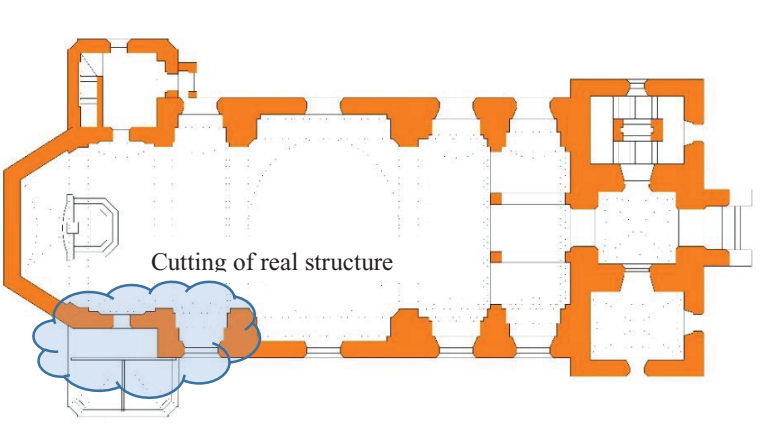
This article is focused on the experimental examination of long-term behaviour of the structure part, which was additionally strengthened by horizontal prestressing. The intention of this measurement isn't only the observation of unit deformation at designated places, but also future comparison of the evaluated results with more complicated numerical models – detailed micro models.

2. Experimental model description

An experimental model of three brick walls was built in the university area, for measurement. It represents a part of the real horizontally post-tensioned structure, in 1:1 scale. It's the segment of the St. Michael Archangel church in Švábenice (Fig. 1), which was built in baroque style during 1716-1718. The church is built on a slope and already had some issues with the stability of gable and tower during the 18th century. Definitive stabilisation has been achieved thanks to a huge reconstruction in 1997, when the church was braced lengthwise with prestressing.

A new reinforced concrete strip was built on the perimeter of the church at a depth of 1,2 m under terrain, which was encircling the chancel and nave of the church. The strip was prestressed with monostrands. A concrete-steel threshold was built in front of the tower foundation and at the same level like the above mentioned strip. The threshold was also prestressed with monostrands, so the circle of prestressed foundations was closed up. Subsequently, the monostrands placed in the grooves created peripheral (spatial) enlacement of the object close above and under the church windows. The obvious cracks in the structure have been injected beforehand, so that there was no unwanted closing of existing cracks during the prestressing, which could do even more damage to the structure.

a) b)



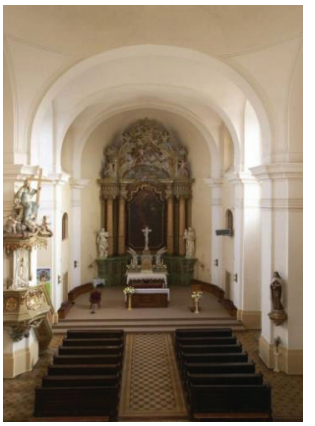


Fig. 1. (a) Ground plan of church; (b) View of reconstructed church