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# Using of Textile Reinforced Concrete Wrapping for Strengthening of Masonry Columns with Modified Cross-section Shape

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**Abstract**

This contribution deals with the issue of strengthening of brick masonry columns by thin layer of textile reinforced micro-concrete. The original columns of dimensions 290 × 290 × 1040 mm used for the performed experimental program consisted of sixteen layers of ceramic bricks jointed in lime-cement mortar. Used masonry achieved calculated characteristic compressive strength 5.3 MPa that presents commonly used grades of masonry. Textile reinforcement made of alkali resistance glass by Saint-Gobain Company was applied in two layers. The lower layer covered the whole surface of columns the second was added in the form of strips 300 mm wide on the bottom, top and the middle part of the columns. Present solution brought the only slight increasing of the load capacity due to significant concentration of tensile stresses in the corners of column. Additional set of masonry columns was prepared with the modified shape of the cross-section by cutting off approximately 30 mm of the corners. Newly formed polygonal cross-section shape of the columns brought more effective utilization of the reinforcing layers and significant increasing of the structure load capacity.


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*Keywords:* Strengthening; load capacity; textile reinforced concrete; masonry; burnt bricks; lime-cement mortar.

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## 1. Introduction

Strengthening of load-bearing structural elements plays very important role in the field of civil engineering and is realized due to several reasons – increasing of load, change of static scheme, degradation of material, change of building´s purpose, etc. Type of material and the way of load transfer (bending, shear, compression, tension and their combination) determine strengthening material, method and the global approach to strengthening process. Used materials and computation approach utilized for strengthening of existing load-bearing structural elements reflect the current level of knowledge. Reinforced concrete is the most widespread material in civil engineering and construction, but we can find brick or stone masonry structures in large number of existing structures (sometimes historical monument). Application of appropriate strengthening and stabilization method can prolong the life together with new utilization of existing building. In the point of view of life-cycle analysis the strengthening and renovation safe energy and material and means more effective solution than demolition and creation of new building. Similar results were achieved by using the demolition waste for second application in building industry [1].

Using of steel angles and strips means traditional and very widespread method for stabilization and strengthening of masonry columns [2], especially due to easy feasibility, price and proven procedure. The problem lies in the necessity of additional fire protection [3]. Bandage made from reinforced concrete or cement mortar means the second traditional method. Using of wrapping by fiber-reinforced polymer materials (carbon, glass, basalt, …) has been investigated last two decades and resulted into successful implementation of this method into practical application [4,5]. Due to the increasing development of textile reinforced concrete (TRC) the new possible fields of its application are found. The original research focused on the experimental investigation of earthquake resistance of masonry wall strengthened by slim layer of polymer textile reinforced mortar [6]. Strengthened specimens showed maximum load capacity up to 139% and the wall collapsed after the textile roving´s rupture. The type of loading determines optimal type of strengthening precaution [7]. Tetta et al in [8] investigated the shear capacity of reinforced concrete beams strengthened by textile reinforced mortar (TRM) and fibre-reinforced polymer jacket. The effectiveness of TRM rises with the increasing number of layers. TRC seems to be interesting alternative to FRP for strengthening and stabilization of compressed masonry columns, which is frequent requirement. The pilot experimental testing of this application showed several challenges to be solved [9]. Cohesion between original masonry and additionally applied FRP strips was ensured usually by epoxy resin. Properties of this contact zone had to be deeply analysed. The cohesion between brick and newly applied layer of micro-concrete is ensured by strength of contact zone – hydration products grow into inequalities and pores of bricks.

## 2. Description of Experimental Program

The main goal of performed experimental program was to quantify the benefit of an additionally applied slim layer of TRC on brick masonry columns with dimension 290 × 290 × 1040 mm. Additional set of masonry columns was prepared with the modified shape of the cross-section by cutting off approximately 30 mm of the corners (see Fig. 1). The modified columns have cross-section area about 2% lower, which has caused decrease of maximal force, in the case of non-strengthened column. This solution was chosen to eliminate the stress which is concentrated in the contact zone between textile reinforcement and brick. Higher utilization of maximal mechanical properties of strengthening fiber-reinforced polymers was achieved by modification of corner radius of brick masonry columns [10]. This was also expected in the case of strengthening by textile reinforced concrete.

### *2.1. Properties of used materials*

Bricks 290 × 140 × 90 mm with average compressive strength 35.4 MPa (±1.8 MPa) were joined by lime-cement mortar (1:3:5 volume ratio of cement, lime and sand 0/4 mm) with average compressive strength 5.9 MPa (±0.2 MPa) and flexural strength 1.3 MPa (±0.2 MPa). Used masonry achieved final characteristic compressive strength 5.3 MPa, calculated in accordance to CSN EN 1996-1-1. Relatively weak mortar was used to simulate original properties of old existing masonry structures.

The strengthening layer consisted of high strength micro-concrete and textile reinforcement, that together create the textile reinforced concrete (TRC). The properties of used concrete were investigated in various studies, eg. in