Modern Solutions for Strengthening of Structural Elements

Sorin DAN
Lecturer, Dr.
"Politehnica" University
Timisoara, Romania
sorin.dan@ct.upt.ro

Corneliu BOB
Professor
"Politehnica" University
Timisoara, Romania
cbob@mail.dnttm.ro

Cosmin ENUICA
Civil Eng., PhD student
"Politehnica" University
Timisoara, Romania

Liana BOB
Researcher, Dr.
ICECON Research
Institute, Timisoara,
Romania

Catalin BADEA
Lecturer, Dr.
"Politehnica" University
Timisoara, Romania
catabadea@gmail.com

Aurelian GRUIN
Researcher, Civil Eng.
Building Research Institute
Timisoara, Romania
agruin@incerctm.ro

Summary

The paper deals with the results and recommendations based on experimental programmes.

The first experimental programme presents the strengthening effect of RC column by jacketing with new RC and some methods of increasing bond between old and new concrete.

The second experimental programme refers to a new procedure for strengthening of masonry walls. In the first stage the models are tested at vertical and horizontal actions. Finally, the models are strengthened with different bars as near-surface-mounted-reinforcement and CFRP and retested.

Keywords: strengthening; RC columns; RC jacketing; chemical bonding agent; connectors; masonry walls; near-surface-mounted-reinforcement; carbon fibre reinforcement polymer.

1. Experimental programme

1.1 RC columns

The experimental programme focuses on quantifying the influence of different techniques for connecting between the two concrete layers: old concrete substrate and the added new concrete. The test selected for the study was the pull-off test.

The connection between the substrate (RC prism) and the added concrete (RC jacketing) were: concrete-to-concrete bond; bonding agent as epoxy resin; chemically (Fig. 1) or mechanically anchored steel connectors.

The results obtained on the specimens without special techniques for connection, concrete-to-concrete bond, as well on the specimens with improved bond by using special techniques, are presented in Table 1.

Fig. 1: RC columns strengthened by RC jacketing

Table 1: Pull-off test results

No.	Concrete-to-concrete bond	Improved Bond		Efficiency $(\tau_{af} - \tau_{ai}) / \tau_{ai}$ x 100
	Bond strength τ_{ai} [N/mm^2]	Bonding solution	Bond strength τ_{af} [N/mm^2]	[%]
1.	1.30	epoxy resin bonding agent	1.38	6 %
2.	1.38	chemical anchored connectors	1.70	23 %
3.	1.42	mechanical anchored connectors	2.18	54 %

https://doi.org/10.2749/222137908796291840

1.2 Masonry walls

Masonry brick walls using mortar M25 and having a window opening were designed and manufactured as shown in Fig. 2 (scale 1:2).

Vertical and horizontal loads were applied on the top RC strap. The horizontal load simulated a seismic action. The first tests were done on the un-strengthened masonry wall until cracking and then strengthened (Fig. 3) and rested.

During the tests the vertical load had a constant magnitude, while the horizontal load S was increased up to the failure. The failure and the crack pattern at failure for the un-strengthened masonry wall are presented in Fig. 2.

Fig. 2: Un-strengthened masonry wall failure and crack pattern

The un-strengthened masonry wall failure was characterized by cracking in different ways: horizontal cracks at wall base – due to tension from eccentric compression; horizontal cracks at wall top – due to friction; inclined cracks starting at the window corner – due to main tension stresses.

The strengthening proposals (Fig. 3) were selected function of the cracking pattern. Subsequently, were applied: vertical CFRP wraps placed on the masonry wall exterior edge; vertical Romanian High Adherence Steel Bar PC52 as near-surface-mounted-reinforcement; horizontal high adherence steel bars Brutt Helical System BHS as near-surface-mounted-reinforcement in the mortar layer.

The initial masonry walls once cracked were strengthened by the previous different modern and efficient techniques and rested in order to find out the bearing capacity of the rehabilitated walls. The experimental failure horizontal loads S as well as horizontal displacements at different heights were measured. The results regarding horizontal top-displacements are presented in Fig. 4 both for un-strengthened and strengthened masonry wall.

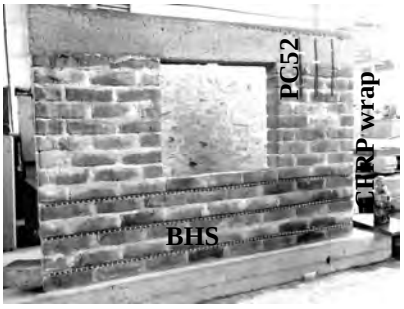

Fig. 3: Masonry wall strengthening

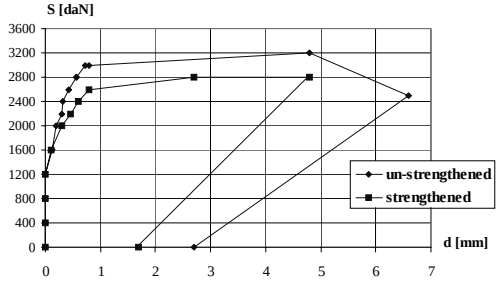

Fig. 4: Horizontal displacements of masonry wall

2. Conclusions

Concerning the rehabilitation of RC concrete columns by RC jacketing the bond strength obtained on specimens without special techniques for connection – concrete-to-concrete bond – seems to be similar to the specimens with roughening technique: partially chipped and pre-wetted, partially chipped. The specimens with a bonding agent, with steel connectors and special connectors "conexpand" show an improved adherence of the RC jacket.

Concerning the use of efficient techniques for strengthening of old existing buildings in seismic zones the following conclusion may be drawn: by using the proposed modern strengthening techniques, the horizontal bearing capacity of the initial wall (fractured by testing) was recovered at 87.5 %, which shows the technical efficiency of the proposed rehabilitation solutions.