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THE STRUCTURAL REHABILITATION OF A MASONRY BUILDING

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Abstract. The paper presents a structural rehabilitation system for the basement of a strongly damaged building having the walls, columns, arches and cylindrical vaults of brick masonry. As a consequence of deterioration due to humidity presence in the basement, the columns sections were diminished substantially to about 25%...30% of their initial section, the building being in this way very sensitive to collapse. The intervention solution was chosen on financial criteria, and the final purposes it was to rebuild the bearing capacity at least to the initial one. The technology also was chosen in order to avoid vibrations and to provide safety conditions for the workers during the intervention. To provide safety for the workers a scaffolding was provided all along the basement floor. The columns were consolidated by coating with reinforced concrete and metal profiles, to provide for the taking over of the loads in vaults and arches, while foundations were rebuilt by coating with reinforced concrete. The foundation coating was performed in four steps to avoid the setting of the ground under the columns.

Key words: rehabilitation; masonry; damage; humidity; strengthening.

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1. Introduction

The structural damage found in many old buildings with a brick masonry structure, endangers the construction safety and stability and raises more and more problems to their beneficiaries.

The incapacity of the buildings to meet the requirements for structural performance imposed to be applied structural intervention measures to bring the structure back to at least its initial state or to higher performance levels.

Existing studies and research in this field give only a principle solution to the issue of structural rehabilitation of such constructions (Niculiţă & Groll, 2007; Popa & Ilieş, 2009; Nistor *et al*., 1991; Budescu *et al*., 2001). That is why every individual construction represents a case study that can bring into analysis new study elements and solutions for structural intervention (Niculiţă & Groll, 2007).

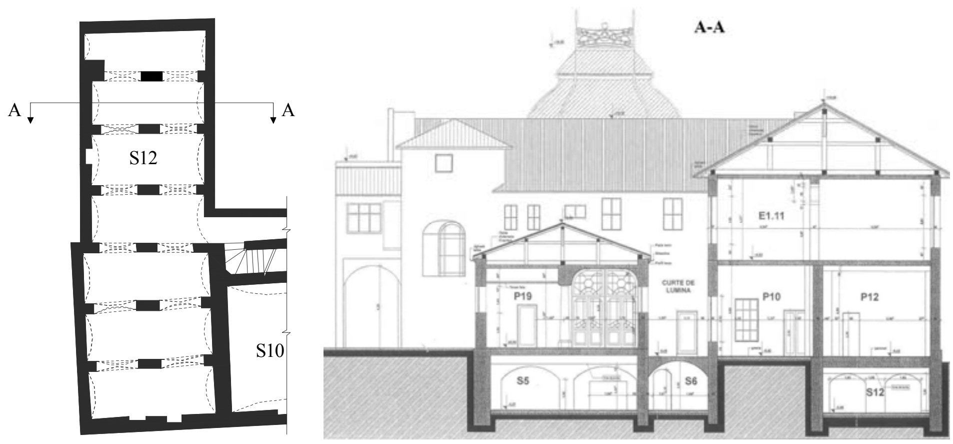
The causes leading to the incapacity of the construction to meet the performance requirements are multiple and various, but the majority of the degradation phenomena have at their origin the presence of water.

In the case of masonry using brick and lime mortar as the basic material, moisture is an extremely harmful factor as brick is porous and water-sensitive and humidity generates and amplifies the damaging processes.

In this context, it has been analysed and established the intervention measures required to rehabilitate the basement of a masonry buildings.

2. Description of the Construction

The building subjected to the investigation is a masonry one, which has a height regime basement + ground floor+ first floor (S+P+1E) and is situated



a *b*

Fig. 1 – Basement floor plan (*a*) and cross section (*b*).

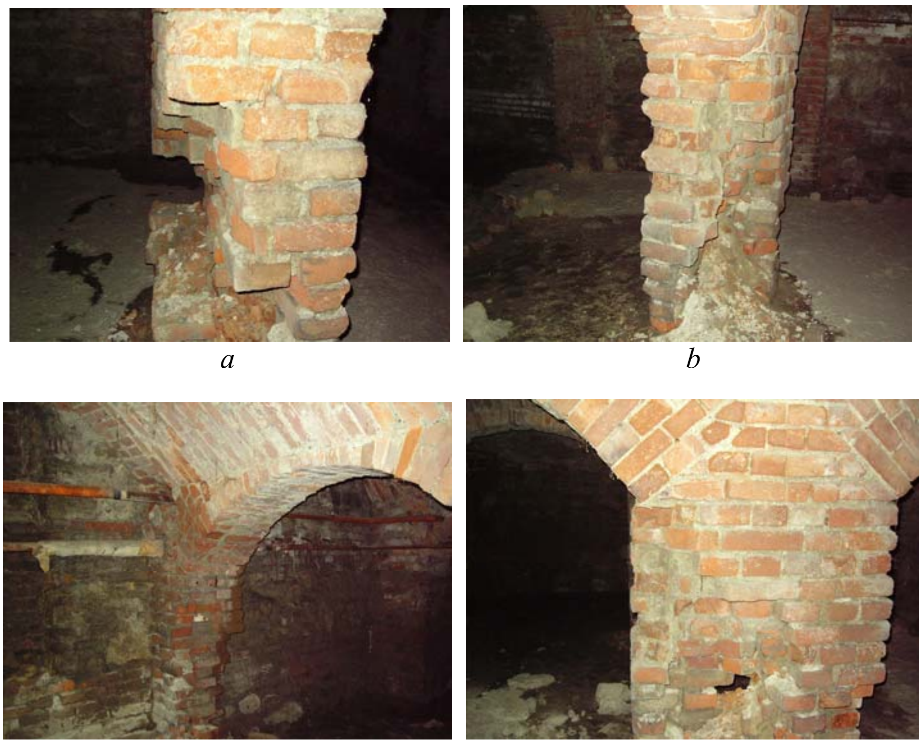
in the city of Turda. It was built at the beginning of the 20th century on a basement that used to exist from a former building of the 19th century.

The area of the building under investigation in this paper regards the basement plan and the cross section presented in Fig. 1.

The structural system is made of brick and stone foundations, structural walls and columns made of brick and lime mortar. The over the basement floor is made with cylindrical vaults intersected with brick masonry arches, while over the ground floor and the first floor are made of wood.

3. Structural Damage and its Causes

Structural damage stops at the level of the basement and is mainly caused by the action of the water originating from rainwater and from the damaged pipes as water can be permanently found in the basement of the building.



a *b*

c *d*

Fig. 2 – Structural damages to columns.

No degradations due to earthquakes, foundation settlements or other causes were found.

The deterioration of the brick predominantly in the columns led to the reduction of their section to about 25...30% of the initial section, making the balance be weak and poor (Fig. 2).

4. Intervention Measures

Considering the advanced state of column damage and the actual danger of floor collapse over the basement, the bulding was evacuated (Pop,).

Two intervention variants were considered: the demolition of the building and the strenghtening of it.

For the strengthening of it, the following aspects seen as principles were put into analysis:

a) removing causes producing degradations (elimination of humidity coming from water infiltrations);

b) assuring the bearing capacity or the increase it to the initial state;

c) implementing a suitable technology to avoid vibrations in the building and to provide safety conditions for the workers, during the entire period of intervention.

The studies and analyses performed led to the conclusion that consolidation represented a less expensive and a faster variant. Rehabilitation solution was chosen according to P100-92 valid at that moment.

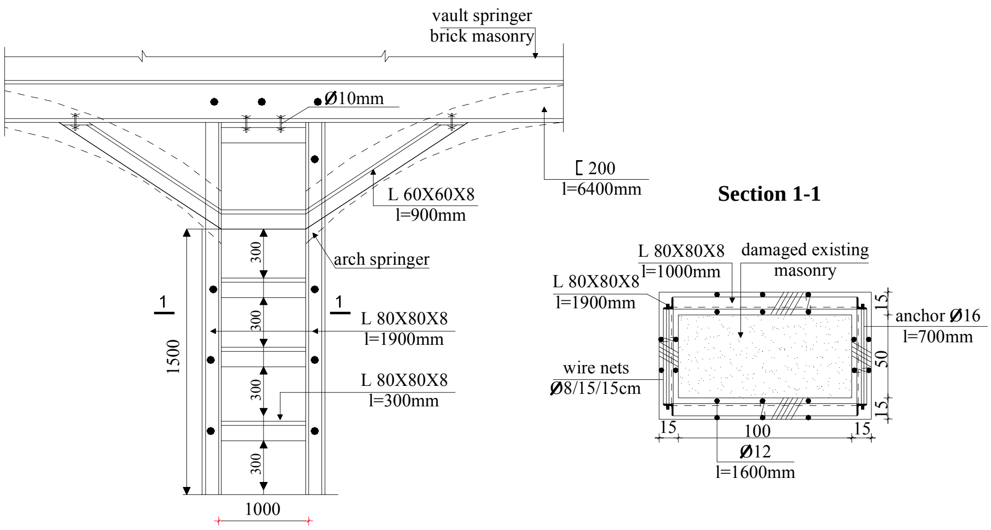


Fig. 3 – Strenghtening of central column.

In the first step, to provide working conditions, water in the basement was removed and kept it under the height of the basement floor. To protect workers during the operations a scaffolding was erected as well.

In the first stage, the columns were consolidated by coating then with reinforced concrete to which stiff reinforcements were added. The work and details are given in Fig. 3 for central column and in Fig. 4 for the the marginal columns.

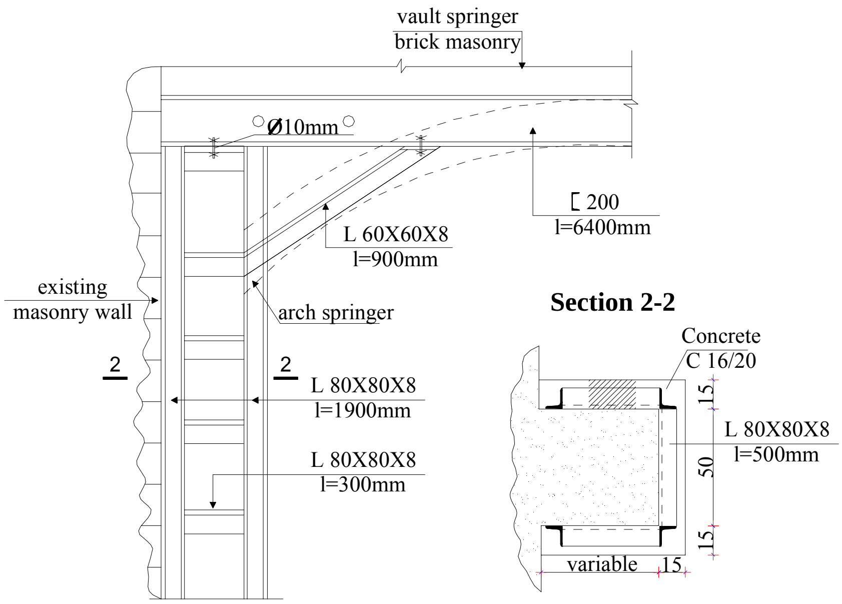


Fig. 4 – Strenghtening of marginal column.

To make additional supports for the vaults, steel columns were provided along them. The final situation after their interventions is shown in Fig. 5.

Fig. 5 – Strenghtening solution.

After the columns were strengthened, the scaffolding was dismantled and the foundation consolidation was started. Every independent foundation was strengthened with reinforced concrete, poured in four steps, presented in Fig.6 (section 1, 2, 3 , 4).

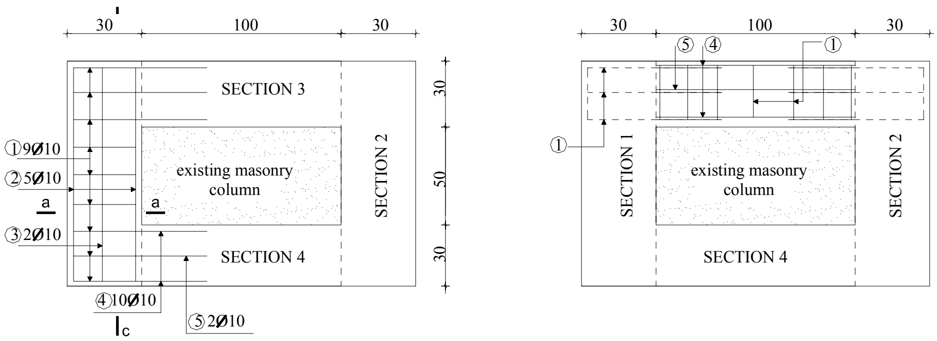


Fig. 6 – Foundation reinforcement.

Figs. 6 and 7 shows the reinforcing method, and Fig. 8 presents aspects during the execution stage.

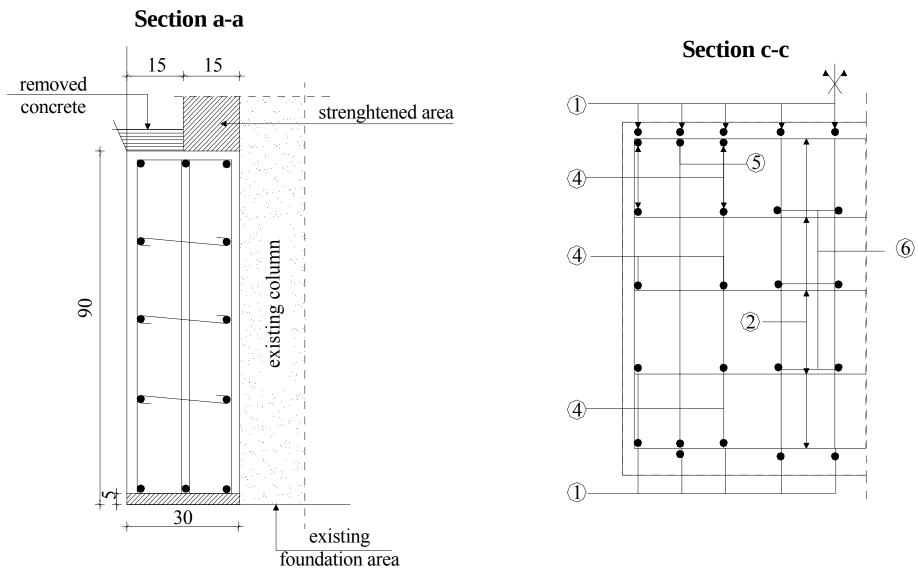


Fig. 7 – Constructive details of foundation reinforcement.

Fig. 8 – Foundation reinforcement during execution.

Finally, measures to remove water and other causes leading to damage were taken.

5. Conclusions

These interventions date back to year 2008, and the building continues to be watched in time for its behaviour. The survey showed that the taken measures were good as in five years since consolidation, not even the smallest improper building behaviour can be reported.

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REABILITAREA STRUCTURALĂ A UNEI CLĂDIRI CU STRUCTURA DE REZISTENŢĂ DIN ZIDĂRIE

(Rezumat)

Se prezintă un sistem de reabilitare structurală pentru subsolul unei clădiri din zidărie, grav avariate. Subsolul este realizat cu pereţi, stâlpi, arce şi bolţi cilindrice din

zidărie de cărămidă. În urma degradărilor cauzate de prezenţa umidităţii în subsol, secţiunile stâlpilor s-au redus substanţial la aproximativ 25%...30 % din secţiunea iniţială, clădirea fiind astfel în pericol de prăbuşire. Soluţia de intervenţie a fost aleasă pe criterii economice de refacere a capacităţii portante cel puţin la nivelul avut de structură iniţial. Tehnologia aleasă a ţinut seama de evitarea vibraţiilor din timpul execuţiei pentru a asigura astfel condiţii de siguranţă muncitorilor pe timpul intervenţiei. Astfel, s-a realizat un eşafodaj prin înaintare pentru întreg planşeul de subsol. Consolidarea stâlpilor s-a realizat printr-o soluţie de cămăşuire cu beton armat şi profile metalice asigurând preluarea încărcărilor din arce şi bolţi, iar cea a fundaţiilor prin cămăşuire cu beton armat. Cămăşuirea fundaţiilor s-a făcut în patru tronsoane pentru a evita refularea terenului de sub stâlpi.