DEGRADATION OF STRUCTURAL ELEMENTS IN THE CASE OF OLD MASONRY BUILDINGS

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ABSTRACT:
Conservation of existing masonry buildings has been developed in countries with tradition in this field (France, Italy, Greece) and it is now becoming a growing and constant concern for engineers and restorers in our country. The cause of the degradation of the materials is a complex one which cannot yet be fully explained. For buildings made of masonry it is difficult to determine the causes that led to the degradation because most of the time these cases are the result of several simultaneous factors. Determining the current state of a building is based on an assessment of damages resulting from structural safety level. Finding the appropriate solutions to increase the safety of the structure, preferably using traditional materials are current concerns for the rescue of existing buildings.

1. INTRODUCTION
Decisions to intervene on the rehabilitation of a building are specific to each building separately. Different solutions depending on the severity of degradation are observed. To bring the building to the desired performance requirements, necessary current repairs are sometimes justified and sometimes necessary to intervene on the structural strength or the strength of the foundations. If taking into account the historic buildings, the intervention decision must consider the preservation of the architecture and material.

2. MATERIALS AND METHODS
2.1. Factors that cause degradation
Any building is subjected to the following factors during its existence:

a. Degradation: a feature of constructions due to climatic factors, operational processes or exceptional actions:

- The climatic factors acting on buildings and causing damage over time are: wind, snow, heavy rain, temperature variations, etc.
- A proper maintenance, the choice of materials specific to geographical areas, a structural system designed and built properly, and the achievement of current repairs all lead to maintaining the building characteristics and to its long life.
- Outstanding actions are the most important factor of destruction. Floods, landslides, earthquakes can cause both material and human damages.

b. Obsolescence: represents the changes in time that any construction suffers during its functioning. These changes may affect the building more or less, depending on the structural characteristics, the quality of the material and its destination. The building, both the structural system and the finishing, may also be affected because it is subjected to changes over time (P100/3 - 2008).

2.2. Methods of intervention
For historic buildings, preserving the monument should be the basic criterion in choosing the intervention
solution. Preserving the building is maximized when rehabilitation interventions are minimal. To better preserve the authenticity of the building it is advisable to carry out repairs of the damaged items rather than to replace them and also bringing the building to its normal functioning status must be achieved by keeping the initial static scheme. Methods of intervention can be classified as follows:

a. Conservation. Conservation is a process by which it is preferred that the damaged elements are repaired by using traditional techniques, rather than replaced.

b. Improvement. This implies returning to the initial capacity of resistance for some structural resistance elements without greatly affecting the behaviour of the structural system. One can enumerate the following as works of improvement: consolidation of the affected elements; replacing the portions of damaged items; reducing the payload; replacing some items with others (preferably of the same material); demolishing and rebuilding some portions of the construction.

c. Adjustment. The building will be able to take over the site seismic forces. Depending on the severity of degradation, one can demolish some portions of the building and restore it on a new structural system (Crişan, 2003; Niculţă, 2007).

2.3. Studied building site conditions

- seismic site: \( a_g = 0.10 \) g, \( T_c = 0.7 \) s (according to PN100/1-2013);
- wind site: \( q_{red} = 0.5 \) kPa;
- execution of construction: between the years 1800-1803;
- structural system: walls are made of masonry, respectively of masonry and stone;
- importance class: II;
- importance category: \( B_c \) (Raport Tehnic, 2014);
- the current state of the church: observations made on-site revealed the existence of multiple cracks and crannies. These degradations are present in the window openings, in the gun area, on the altar and the iconostasis;
- interactions with neighbouring buildings: there is a building situated in the neighbourhood, near the outer wall of the shrine.

The church has the following dimensions: 21.01 m length; the width is variable in the plan, the total amount being 13.12 m (containing the outbuildings); the height of the aisle cornice is 7.19 m, the tower cornice is 16.22 m and the total height at the top of the cross is 27.64 m (heights measured at the quota ± 0.00).

a. The actual degradation state of the building was determined by visual observations and measurements.

Thus, the following were established:
- one has analyzed the composition and structure of the whole building resistance;
- findings have been made regarding the conservation status of the materials (brick, stone, mortar);
- the position of the cracks, their shape and dimensions were found;
- one has found the existence of some areas affected by moisture or loose plaster;

![Figure 1. Current level plan](image)

2.4. Damages observed at the resistance structure made of masonry, found on the exterior walls of the building

- on the outside of the buildings situated on either side of the tower you can see a point made throughout the body height, at the link between it and the church building;
- vertical cracks appear in walls, especially above the window openings;
- vertical cracks can be seen in the wall (in a door area) that are going all the way to foundation;
- deterioration of the mortar between the bricks, shattered;
- one can see the separation of material (due to water ingress from rain) in cornices, frames and casings.
2.5. Damages occurred in the building structure

- one can see cracks in the lintels located above the holes; the lintels are made of masonry and have the form of an arch;
- vertical cracks appear in the walls above the window openings;
- the peeling of the plaster can be seen in some areas;
- the occurrence of horizontal cracks in floors and vaulted arches on the transverse direction, made of brick (across the narthex), (Raport Tehnic, 2014);
- cracks in the altar area and canopy, extending to the wall;
- cracks in the horizontal plane, in the bearing area of the vault, situated between the aisle and the altar;
- in the key soffit at the arches, which rests on the pillars, cracks are located on the arches situated in the longitudinal direction and the transverse direction.
2.5. Deterioration of wood in the roof and the tower roof structure

a. Roof framing
- some of the elements that compose the wooden roof structure (rafters, battens) were affected by humidity;
- some elements of the roof structure show signs of decay and sometimes attacks of microorganisms;
- the roof framing from the altar area presents some incorrect achievements of details (Raport Tehnic, 2014);
- propping is done directly on the brick wall and the wooden roof structure elements;
- combining the continuity of wood elements in some places has been made poorly;
- you can see the occurrence of longitudinal cracks in certain elements of the roof structure.

b. At the tower one can observe the following:
- the subsequent construction of the church door openings based on the tower walls has reduced the resilience of the tower, (Raport Tehnic, 2014);
- over the openings in the south wall, one can see cracks at bottom and dislocations of the material on the vertical and less inclined direction;
- the staircase to the choir and the church bridge are made of wood and show age-related degradation;
- wooden items inside the tower lean against the brick wall directly and sometimes show signs of deterioration due to rot or attacks microorganisms.
3. CONCLUSIONS

Selecting the rehabilitation method and its achievement in terms of technology depends on the state of degradation, structural conformation, the possibility of achieving the work, the importance of building. For historic buildings, such a work must take into account the conservation of the monument, both in terms of exterior and interior, as well as the restoration of the structural system. Maintaining the building at a certain level of desired performance is achieved through routine maintenance and repairs, whenever a problem occurs and throughout its life.

4. ACKNOWLEDGMENTS

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5. REFERENCES


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