CONSIDERATIONS ON NON- DESTRUCTIVE MONITORING METHODS USED IN MASONRY STRUCTURE CONSTRUCTIONS' EXPERTISE OF THE EXISTING BUILDING STOCK

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Abstract*: In the context of building construction works from existing building stock, the paper presents considerations regarding the monitoring methods used in heritage buildings in Romania and constructive implications necessary for structural consolidation.*

Keywords: *technical expertise, physical non-destructive methods, masonry damages,*

1. Introduction

Preservation of existing buildings in the built environment including heritage buildings with masonry bearing structure requires extensive activities involving multidisciplinary collaboration (restorer architect, engineer-expert certified ISC and appropriate, engineer surveyor) at the stage of technical expertise. Technical expertise is made under the law [3], [4], [5] .

In case of construction at which the subsidence uneven, with the general trend of loss of overall stability or local, decision and solution -building have regard to the outcome monitoring their consumption methods (geometric - methods Geodetic high precision) while identifying the causes that generating [1].

The phenomenon of subsidence lead to changes in local or general state of stress and strain (rotations and displacements) in structural situation in which cracks and dislocations affecting specific structural strength . If there aren't local subsidence, structural monitoring is limited to visual analysis and instrumental methods of other structural degradation.

• *Physical methods* involve installation of appliances and devices for measuring the structural elements of the building eventually moving with the construction; can assess the relative values of specific linear and angular deformations.

Tracking process of cracking (crack changing parameters: opening, length, depth) was performed using direct reading methods (mechanical or optical) or methods using electric and electronic measuring translating: resistive / inductive / potentiometric / capacitive / rope vibrant / oscillating circuit / optic fibre).

Analysis of fracturing process can provide information relating to: technical qualities of the studied material's element, the trajectory of stresses main tension or compression, deformations.

Geometrical methods shall report landmark set on structural elements of the building to a system of fixed points outside the building, located on stable land, non-deformable and outside the area of influence and allow evaluation of absolute amounts of deformations and displacements construction (method geometric levelling of high precision).

The main damages of masonry construction at seismic faults, specific action on Romanian territory, are mentioned:

- Horizontal cracks along the joint floor with structural walls;
- Inclined cracks due to principal tensile efforts;
- Local crushing of masonry under the action of concentrated loads (eg. Under floor beams) due to the quality thereof;
- Vertical or inclined cracks at the intersection of walls, with or without dislocation of masonry due to tensile stresses or weaving poor (or non- being) intersecting walls;
- Inclined cracks in the bearings of lintels, or permeated throughout unsearchable structural wall thickness;
- Inclined cracks above the voids in walls, highlighting the discharge into the masonry vault;
- Sometimes cracks can pass through concrete lintels;
- Cracks inclined on pillars’ masonry of exterior walls of windows;
- Horizontal cracks in masonry pillars due to bending moments from seismic action [4], [5].

2. Investigation Steps for old masonry structures

In works’ investigation of existing buildings that have masonry bearing walls structures, authorized expert should use criteria for assessing the actual characteristics that would provide viable and effective solutions for rehabilitation of the objective.

The main requirements to the investigation of masonry structures are:

1. Qualitative assessment of the overall condition of the objective subject of investigation consisting of: visual inspection, surveying and architectural degradation and damage, historical analysis, identifying the main types of masonry (characteristic shapes and sizes) and execution technologies used;
2. Analysis of the degradation of masonry structures investigated and assess the main causes of degradation is to inventory :
- Main types of degradation and deterioration identified ;
- Nature of degradation (mechanical, chemical, biological) .
3. Evaluation of the resistance of masonry structures based on calculation methods and data obtained on the physic-mechanical tests carried out in situ and in laboratories. It is recommended that laboratory tests to be grouped into specialities (mechanical, physical, chemical, biological or otherwise). The expert may request in materials and masonry features : brand, apparent density, apparent porosity, report of aggregate binder (mortar), the nature of the binder, the structure of the aggregate in mortar. Masonry assembly features requested in accordance with specific regulations and standards.

On the state of degradation of the structure, the expert may require analysis of the causes chemical or biological attack, setting nature to combat these causes and solutions in this field. The program for specific tests in situ and laboratory requires a prior selection of investigative methods after accurate evaluation parameters by the expert.

Laboratory investigation methods for old masonry are classified into two categories namely, destructive methods (determination of mechanical strength , chemical and physic - chemical methods) and non-destructive methods, each containing various analytical procedures, work being carried out on the basis of technical specifications and procedures own laboratories profile [5], [6], [7] .

3. Case Studies

A. Jassy, Railway Station

Short history

Construction of passengers' railway station of Jassy (historic monument) consists of three sections: the first, main building, realized in the period from 1868 to 1970, building A and building B completed in 1928 built subsequently completed in 1948. The main building is the first large train station built in Romanian principalities track is located at the end of Lemberg - Cernauti - Jassy railway. The architectural model was Doge's Palace. Building plan indicates a length of 133.8 m, 113 rooms and a height of P + 2E; central body was conducted during 1868-1870 under the rules of the concession, for the construction and operation of railway lines, under management of Victor Ofenheim (Fig. 1).

Fig 1. The main building of Jassy Rail Station

Seismic activity, earthquakes that occurred since 1977 and raising the ground water up to the level of the foundation situated on upper terrace Bahlui river that contains silt loam characterized by pronounced sensitivity to water were the main causes of structural damage resistance and finishes.

Technical expertise used a simplified method of calculation in order to assess the ability of resistance. Since the beginnings, structure presents a low level of earthquake protection being initially calculated only on vertical loads resulting need for intervention.

The rehabilitation project of strengthening the resolve of the main building, replacing all interior installations, replacement of interior and exterior carpentry, repair of roof framing and implementation of modern finishes.

Uneven subsidence measurements were highlighted by geometric precision geodetic surveying on the whole area occupied by the building and up to the line directly on the share 0.00 m from the original plan. Thus, was performed a support network of 3 terminals levelling. The measurement was done on the lengthwise and crosswise, each opening and contour. They have chosen 20 points station coordinates determined through intersections before and 600 side - shots. Coordinates on the same direction indicates variations in rates of

3 ... 4 mm in the transverse direction and 4 ... 6 mm in the longitudinal direction, indicating that the points located on central direction transverse ranges odds up to 4 .. .6 mm.

Uneven subsidence of nearly the same size on the two main directions indicate extensive damage and relatively uniform cushion loess that were made foundations . Raising the level of groundwater is reflected and proper functioning of the sewerage network in building A previous consolidated main body. [2].

Expected consolidation measures before de1990 and non finalized before 2005 did not how to provide for groundwater raising blade until the quota share -0.50 natural land throughout the area of the station. Simultaneously with uneven subsidence rate of 0.00 m in the original plan were observed in the structure seepage concrete floor on the ground and in some areas even in recent plaster structure from unconsolidated elements.

Consolidation solutions were to increase the foundations underpinning section using natural stone blocks, structural walls were strengthened at junctions and branches with masonry pillars; lintels and masonry structural walls were clad. Additionally, cross diaphragms were introduced monolithic reinforced concrete for reinforcement of structural elements. (Fig. 2).

a.Underpinning foundations

b. Reinforcing concrete diaphragm

c. Reinforced concrete pillars at the intersection of load-bearing walls

Fig. 2

B.Hebrew Temple, Radauti, Suceava

Description of building:

Hebrew Temple (synagogue) in Radauţi, Suceava was built after the agreement between Heritage site sacred Hebrew Communities Federation of Romania (FCER). The start year of construction was 1879, and since completion of construction in 1880; the temple has a confined masonry structure made by old concrete elements, class II of importance for seismic application.

Foundation type is not specified and the land is swampy foundation being drained prior to the period of completion of construction.

The main causes of degradations generated on Hebrew temple in Radauti are the lack of specific activities to ensure maintenance (maintenance and repair) and abandoning rehabilitation works carried out during 1980-1985. Thus, by examining carefully the position of the building and shows the following:

- Road, poorly maintained building, with parallel role to bypass heavy traffic transiting important city generates vibrations which are transmitted to the building site and generating separation of mortars substrate (fig. 3) and cracking joints (fig. 4);

- Sudden temperature changes day - night, low temperatures a number of days annual rainfall which works with sheet metal damage, favors additional intake of moisture to the outer walls (fig. 5);

- Abandoning rehabilitation and implicit lack plinth masonry structure exposed directly to water and freezing- thaw phenomena (Fig. 6-7) ;

- Reduced distance to one of the neighbouring buildings (left side) led to increased damage while mentioned , due to the influence of the technologies used in construction, demolition and reconstruction (fig. 3-4) ;

- Must be mentioned other reasons: there may be infiltration of ground water , surface water table is close to the city of Radauti, the foundation soil compaction effects of the earthquake in March 4, 1977 .

Fig 3

Fig. 4

Fig. 5

Fig. 6

Fig. 7

In this case, the rehabilitation works are: restoration of plasters and sealing cracks, replacing all installations and wood joinery.

4. Conclusions

Current activities and special performance monitoring structures throughout the life of the buildings is covered by the obligations deriving from the administrators and the package of laws concerning construction quality .

Investigation methods (physical and geometric) for old masonry structures are decided by certified technical experts as appropriate cooperation involving skilled builders and surveyors.

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