INTERVENTION MEASURES ON BUILDINGS AFFECTING BY HUMIDITY

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***Abstract**: At present, a number of historical buildings and monuments are affected by a common phenomenon, namely the capillary rise of water through foundations and walls, resulting in the appearance of dampness. At first glance this phenomenon does not receive the proper attention, which is why in a very short time it makes its presence felt by: efflorescence, molds, the appearance of molds and lichens, the fall of plasters, degradation of bricks, horizontal and vertical cracks, sediments. In addition to the fact that this "cancer" of construction called dirt creates an unsightly appearance, unpleasant, pungent odor can lead to the reduction of building stability and hence the thermal transfer is higher by a wet wall compared to a dry one. Thus, this paper aims at presenting the ways of intervention on a building affected by humidity, by making the study of a building located in Sibiu, consisting of a dwelling house, fencing and land.*

***Keywords:** buildings, humidity, intervention measures, degradation, consolidation*

1. Introduction

One of the most important problems faced by old buildings or historical monuments is the upward humidity. This phenomenon occurs because the water migrates in the walls, the resulting humidity resulting in significant changes in the properties of the building materials.

Water as well as water vapors that are present at some point in different building blocks of a building cause the phenomenon of „Dampening the masonry". The causes that determine the humidity of some building elements can be classified into three categories:

- accidental causes due to the cracking or breakage of sanitary pipelines, roofs, terrain or waterproofing, floods, etc .;
- functional causes due to condensation due to defective ventilation, heat or thermal insulation of the building, or open water vapor generation;
- relational causes that are due to the interaction between the humidity of the site and foundation or construction.

The first two cases of invasion of moisture building elements can be resolved relatively easily by removing the causes that cause the wetting effect. With regard to the third situation, the cause of the wetting can only be eliminated by applying special measures and methods of control.

2. Materials and Methods

The present study refers in particular to the issue of the building from the point of view of the causes of excessive humidity in the underground area, the effects produced and the necessary measures, the analyzed building being a dwelling house, built in 1940, having a height regime S + GF + E (basement, ground floor, floor).

Following the on-site visit, the following issues were identified:

- on the right side facade there is a degradation of the concrete socket for the area where the garage that was attached to the building was demolished;
- it is also possible to observe the existence of a horizontal waterproofing at the upper level of the exterior walls of the basement (Figure 1);
- on the corner of the building, on the rear facade, respectively the left side façade, there can be noticed cracks as well as the inclination of the stair house towards the exterior of the building. (Figures 2, 3);
- there is no pavement on the entire perimeter of the building, except for the main façade where it exists but is degraded (Figure 4);
- the windows in the basement area have light courtyards that may have areas where water is infiltrated (Figure 5);
- drainage of rainwater from the roof is done by means of the tubs which have been changed up to about one meter from the height of the landscaped terrain;
- from those observed on-site, pluvial water take-backs in the ground were not changed (Figure 6);
- the exudation phenomenon is present, which is represented by lime deposits occurring in certain cases in joint mortars and brick masonry (Figure 7);
- on one of the exterior walls on the main façade an inefficient intervention was carried out over time with the application of a molten bitumen layer (Figure 8).

Fig.1 Slope Deterioration - Right Side Facade

Fig.2 Cracks in Rear Facade

Fig.3 Cracks in the left side facade

Fig.4 The front side pavement

Fig.5 Position the windows in the basement

Fig.6 reception facilities rainwater into the ground

Fig.7 Lime deposits on mortar

Fig.8 Ineffective intervention by application of a molten bitumen layer

At the same time measurements were made with the humidity meter Testo 606 and it was found that the humidity of the basement walls is 10-12% below the value of 5-7% considered normal humidity. Exceptions to the above mentioned are the basement walls, including the walls of the stairwell, in the sewage area where the measurements indicated a very high humidity with a value of over 30% (Figure 9).

Fig. 9 Moisture-affected area - route area of the sewage system

During the inspection, a number of elements have been identified that have led to high humidity in certain areas of construction, namely:

- in the basement of the building there is an absorbent well provided with a pump that maintains the level of the ground water bed at a constant level (figure 10);

- in the basement of the building were identified horizontal drainage made of ceramic drain elements located at approximately -0.30m, -0.35m compared to the floor basement floor;
- as a result of the on-site surveys, it can be seen that the groundwater level is very high (Figure 11), the property being located near the Trinckbach brook.


Fig. 10 Absorbent hose with pump


Fig. 11 Identification of groundwater level

3. Results and Discussion

From the discussions with the beneficiary it was found that there are situations in which the basement floods with water, which is not always related to outdoor atmospheric precipitation. At the same time, it was found that the pumping well or the pump no longer deal with water capture or discharge, which leads to flooding of the basement. Also the underfloor chimney ventilation ducts are obstructed.

The occurrence of the phenomenon of overburdening and degradation of the walls

The causes of the phenomenon of overflowing and degradation of the walls from the basement are determined by:

- the high level of groundwater due to the proximity to the nearby brook, which leads to capillary ascent through the basement walls without horizontal waterproofing at the lower level of the basement walls;
- in occasional situations where precipitation of high intensity is upstream, the level of the brook increases, which leads to the elevation of the groundwater level, this being the horizontal drainage and the absorbing well, whose existence probably dates back to the beginning of the execution of the building;
- the horizontal migration of water from the foundation ground to the basement wall, since there is no vertical waterproofing;
- lack of pavement on the perimeter of the building that could have been a protective role;
- infiltration of water through the area of light courtyards that have degraded over time;
- installations for taking up stormwater buried in the ground which have not been changed since the beginning of the building and which may cause degradation leading to loss of water in the ground.

Based on the field observations, the hypothesis of the existence of a water spring in the area was taken into account, but this can only be ascertained when the rehabilitation interventions will be carried out.

Effects of excessive humidity

The effects of excessive humidity have led to:

- degradation of the concrete socket due to excessive humidity (probably using a lower concrete class and possible chemical aggression of groundwater) (Figure 1);
- compressing / inclining towards the exterior of the staircase building at the secondary entrance (figures 2 and 3);
- the appearance of cracks in the corner of the building, the rear facade and the left side facade due to the compaction of the respective corner area (figures 2 and 3), the water infiltration due to water;
- the basement walls are not overly humid because the plaster and floor have been demolished in several rooms and the windows have been permanently opened, which has resulted in the natural ventilation of the walls;
- humidity measurement by humidity meter requires a radius of about 2 cm, resulting in greater humidity in the middle section of the wall section;
- the degradation of the plaster and the presence of visible signs of humidity in the area of the basement bathrooms where the absorbent well is located, including the walls of the staircase (Figure 9), in this area neither the plaster nor the floor was demolished, which led to a minimum natural ventilation as there is no window;
- the occurrence of the exudation phenomenon (Figure 7) which does not pose a danger to the building because there is no double circulation of moisture from the outside to the inside and vice versa on the same face, the only problem identified being aesthetic if the masonry would not be plastered.

Intervention measures

The recovery of the existing basement is important both for the functionality of the construction (the use of the underground spaces) and for the stability of the structure, considering the resistance of the external wall masonry.

On the basis of the elements on the ground, the adoption of a set of measures that greatly improved the state of the basement was called:

- to maintain the groundwater level below the floor, it is proposed to remove the existing flooring in all rooms, including the existing drainage and the execution of a drainage system (transversal and longitudinal) on the floor, with discharge into the absorbing well (widened and arranged). In this sense, drainage tubes embedded in drainage channels (gravel) and covered with geotextiles will be used. It is very important to purchase a floating pump with a higher capacity, which automatically starts to increase the water level in the absorber well. The solution also contributes to maintaining the groundwater level at a lower floor level;
- floor restoration will be accomplished by the execution of a excavation on a depth of 30-35 cm. After the excavation is carried out, the floor covering layer is approximately 30 cm and it is washed from gravel (figure 12). Depending on the situation at the time of the intervention, if the groundwater level is found to be very high, it is possible to increase the thickness of the clump to exceed the groundwater level, but at the same time we must have a minimum height required in the basement. Above the washed gravel, which has the very large aggregate particle diameter, is placed the geotextile membrane that is the sand that has to be dried and free of loesoid powders. Above the sand is mounted brick on the broad.

The ventilation channels are located perimetrically and are made of a washed type having a diameter of Φ 4-8;

- a vertical wall drain (membrane with crampons) to protect the walls from the transverse moisture from the ground on the one hand, and on the other hand, thanks to the projections, a free space can be created around the outer walls be naturally ventilated, evacuating the water vapor to the outside. At the same time, a perimeter drain (perforated top tube PVC 110) is placed at the base of the foundation, along the entire perimeter of the building, as shown in Figure 12, which can be lowered 20 cm below the base of the basement wall, depending on the situation in the moment of intervention. The drainage tube will discharge the collected water to the outside sewer. Above the drain shall be placed the type of the diameter of Φ 8-16, the geotextile membrane, the sand, the concrete slabs and the edges. The sort has the role of cutting the capillarity and the pavement system provided has the role of protecting the building with a 5% slope to the outside;
- remove all existing plaster from the basement walls and the joints will degenerate approximately 2-3 cm;
- restore the plaster with a lime mortar prepared with paste and use only lime-based breathing paints;
- clean the bitumen on the exterior wall of the main facade before applying the plaster;
- the chimney flue ducts that are obstructed will be put into operation as they constitute a natural way of ventilating the basement;
- the courtyards of light will be completely demolished and others will be made in their place;
- all water and sewerage systems will be replaced.

The following intervention measures are based on economic considerations regarding the approximate cost of building protection, so for degraded basin rehabilitation interventions it is proposed to create a shingle which has a SPB Φ 5#100X100mm welded mesh attached to the socket by means of anchors made of PC52 Φ 12 (9pieces/m^2) and having the dimensions 15x35. The anchors will be embedded in the socket by means of an epoxy resin adhesive, and then the C20/25 concrete will be cemented and cast in a thickness of 10 cm (Figure 1).

Rehabilitation interventions on the corner of the building - the rear facade and the left side facade (figure 2, figure 3) will be made from the outside of the building and the consolidation of the foundation will be done by reinforcing with C16/20 reinforced concrete. Subsoiling will be done on sections of up to 80cm length with a pitch of about 2.0m to a depth of 2.8m.

The following operations will be performed for the sub-divisions:

- the working trenches from 1.0m to 2.8m will be drilled perimeter to the outside of the foundations;
- remove the ground from the foundation and clean the surface of the concrete by spraying and washing with water jet;
- a reinforced concrete belt 8 Φ14 will be made beneath the base of the foundation with Φ8/15 stirrups, and the reinforcement carcasses will be executed according to the length of the sections, the reinforcement being done by overlapping welded or looped longitudinal bars;
- install the reinforcement to anchor the Φ10/20 PC52 socket;
- will pour the concrete to the ground.

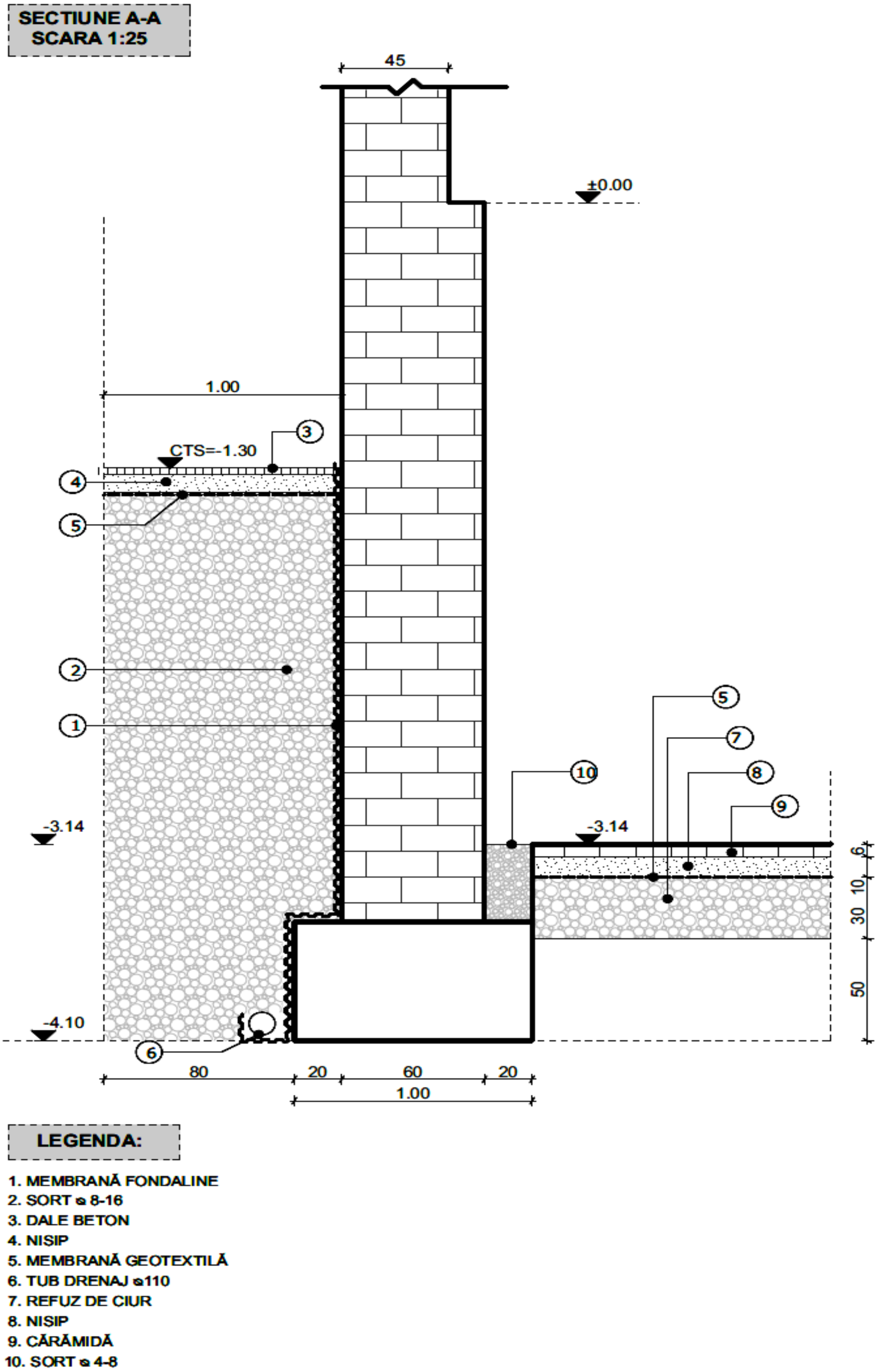

Fig.12 Applying intervention measures

As for the consolidation of the socket, it will be done after the soles consolidation has been completed.

Surface preparation will be done by splicing the superficial layer and, as appropriate, removal of non-adherent areas as follows:

- drill holes with a diameter of Φ10-12mm and a depth of approx. 200mm well cleaned with compressed air;
- will be execute at least 9 holes per square meter;
- the epoxy resin based adhesive and then the anchors made of PC52 Φ 12 will be inserted into the holes;
- once the adhesive has been hardened, a SPB Φ 5#100X100 mm welded mesh will be installed;
- concrete spraying with C16/20 concrete will be carried out in a thickness of approx. 3-5cm.

4. Conclusions

The proposed measures are indicative, but from the point of view of those who elaborated this study is the most effective way to intervene for the recovery and stability of the building.

Depending on the findings made during the work on the groundwater level, two absorbent wells may be made in the outside of the building, approximately 4-6m away from the building.

In the area of the bathrooms, where the plaster has not been demolished and there are obvious signs of humidity, and during the execution of the works it is found that the humidity in the walls is very high, a premixed mortar can be used.

The success of these works is determined by the strict observance of the implementation technologies, the choice of materials and the observance of those mentioned in the present study.

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