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REMOVING CAPILLARY MOISTURE FROM BRICK WALLS USING A DRYING METHOD AND CASE STUDY

F. TĂMAŞ[1] **I. TUNS[1]**

Abstract: *this paper presents one of the methods used to remove moisture from the capillary walls of buildings, problem which appears due to the lack of the horizontal insulation layer in these buildings or poor ventilation of interior spaces. Each project that is proposed to rehabilitate a building in terms to eliminate capillary moisture from its walls has specific issues. For the objective presented in this article, the church "Adormirea Maicii Domnului" from Smeura village, Argeş County, DryZone technology was used. The system DryZone consists in placing a gel in the wall which is distributed by capillarity effect creating a chemical barrier. The system is used on any type of stone masonry, brick or mixed and any thickness. One of its main advantage is that requires no special equipment.*

Key words: *moisture capillarity, waterproofing materials, gel, chemical barrier, injection.*

1. Methods Used To Combat Moisture in Buildings

The main forms in which moisture may appear in buildings are follows:

- Capillary lift, which occurs in most cases, due to the lack of horizontal insulation in the old buildings or as a result of poor ventilation of the rooms with cold walls and steam evaporated as a result of an industrial technological process or breathing of a lot of people;
- Capillary suction due to catastrophic circumstances (flooding) or defective material used in the construction site and their microstructure by allowing accumulation of moisture in the pores;
- Systematically condensation because of a defective envelope (walls, roof);
- Failure of the constructive elements of construction and architectural details, in terms of their original design (cornice, balcony, loggia, terraces, leakage, location, selection of foundation solution, the solution of roof depending on climate and architectural design based on the same parameter);
- Degradation of any accidental leakage of water or facilities;
- Sidewalks around buildings can sometimes be the source of local impervious to moisture removal in the crowded and which tend to eliminate the atmosphere in the hot season. The methods used to combat humidity in building are:
- Methods based on interventions at the

[1] Civil Engineering Dept., *Transilvania* University of Braşov.

infrastructure of buildings (underpinning);

- Methods based on stimulating the ventilation of masonry invaded by moisture;
- Methods based on stimulation of moisture removal by electrochemical phenomena;
- Methods based on injection of water-proofing substances [2].

2. Masonry Waterproofing by Injection

One of the methods to combat moisture from buildings is sealing masonry with different waterproofing solutions, which may be introduced into the porous or by injection (by pressure) or by electric means of transportation (electrochemical method).

Key factors are:

- The nature of the material treated;
- The degree of porosity and water saturation of the material to be treated;
- The cohesion of stabilizer materials; moistening (false humid) when they are - Thickness of masonry;
- Hydrostatic pressure in that layer to be treated (height compared to damp injection);
- Ambient temperature and temperature of impregnated solution;
- Diameter, depth and fixation distance of injected pipe fitting;
- The pressure that must be injected.

Pressure necessary for injections are fractions atmosphere (0.10-0.20 daN/cm^2).

3. Principle of Injection Treatments

In the practice of injecting operations it is necessary to work either with water solutions of various waterproofing substances or polymers emulsion in water. The main problem is related to the presence of water removed from the pores of materials, to which injected liquid should be immiscible or not to generate precipitation of resin injected as a result of contact with existing moisture [1].

Principles of synthetic resins emulsified in water are:

- Emulsification in water is strictly necessary because the contact of the im-pregnated solution with a wet environment which dilute some extent the injected solution; also emulsification in water is necessary in order to prevent precipitation of other substances in contact with water;
- The injected solution must waterproof an entire area on a width of 2-3 rows of brick, sealing occurring by clogging the pores with the solution that polymerize inside them after some time (not too long), around 24-48 h (Figure 1);

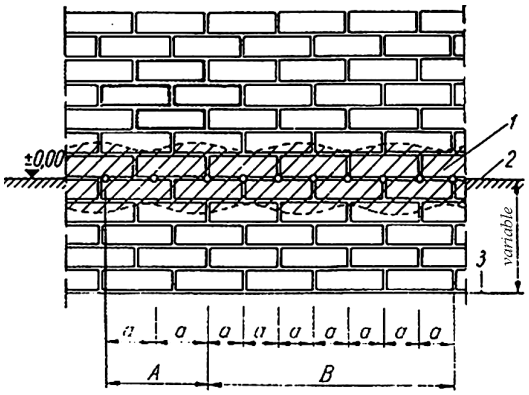

Fig. 1. *Treatment with synthetic resins:*
A, B - incorrect and correct positions of pipe fittings; a - distance between pipe fittings;
1 - *impregnated zone,* 2 - *ground elevation,* 3 - *foundation elevation*

- The solution must be injected and binding properties when it is used to play the cohesion of a friable layer (mortar, concrete, stone or brick);
- At the beginning of the injection operation an extra pressure is required, in order to overcome the pressure of superficial moisture from material microcellular structure which precludes solution migration in the impregnation of the treated location. In general low pressure is used, but manual and mechanical pumps should be fitted with a pressure gauge control.

Injections can be done either mechanical, with low pressure simple pumps, either by free fall. It is advisable to use injections by free fall, using a vessel preferably transparent or translucent in order to track variation in the level of injected liquid while its consumption.

In general a high capacity vessel which link to a tube and an elastic body with pipe fittings ramification that connect hoses and injection tubes itself are used.

Diameter of the injection tube is between 5-10 mm. They are fixed in the wall at a certain distance depending on every specific situation and which may vary between 5-50 cm. Fixing is made by waterproof mortar with rapid hardening based on resins or plaster.

It will usually fix that to make the joints as the wave front penetrates faster through the mortar. Height at which the tank with fluid to be injected is placed vary between 1.00 m - 1.50 m from the tubular pipes fixed in the wall.

It is recommended to couple to the same vessel up to 10-15 tubes simultaneously.

4. "Adormirea Maicii Domnului" Church Case Study

4.1. Choosing of DryZone

Dryzone is a special damp-proofing cream that is introduced along the mortar course at regular intervals by injecting it into pre-drilled holes. The Dryzone then diffuses before curing to form a continuous water-repellent barrier. This prevents the damp from rising up the wall. This method is fast, clean, simple, and due to its water based cream and completely non toxic, is safe and completely error proof to apply.

DryZone can be injected two to three times faster than ordinary liquid injection fluids [3].

4.2. Applying Solution on Site

According to the expertise and moisture measurements made at "Adormirea Maicii Domnului" church, Smeura village, Argeş County, was found the presence of capillary moisture in walls, with varying amounts depending on the studied area, but all exceeded 35%.

Fig. 2. *"Adormirea Maicii Domnului" church before moisture treatment*

Fig. 3. *Degraded wall, due to capillary moisture*

Fig. 4. *Degraded frescos, due to ascending humidity*

Inside the church, humidity can be seen at heights up to 1.4-1.6 m.

This led to degradation in some areas of wall painting, the persistence of a smell of mold and fungi harmful to the health hazard installation.

Capillary moisture stands and outside the Church. Attached photos are presented with the situation. Wall thickness is from 40 cm to 80 cm and made of full brick.

Technical solutions

In order to complete moisture removal from the capillary walls measures described bellow will be taken:

a) Capillarity breaking walls using DryZone technology - aimed to create a protective chemical barrier, following next steps:

- Runs spaced horizontal holes with 12 cm at brick joints, Ø12 mm diameter and depth $L = G - 5$ cm, where G is the wall thickness;
- DryZone gel is injected (not completely fill the perforation)s;
- Gaps are covered with plaster after approx. 45 days;

b) Airy exterior plaster (cell) DER POR will be made, using the following technology:

- cleaning horizontal and vertical joints of the exterior masonry to a depth of approximate 2 cm;
- Remove the plaster that came off or showing signs of moisture and clean the joints;
- Open masonry should not be plastered for at least 60 days;
- Exterior plaster such as DER POR will run according to its technology - or stone tiles, leaving a space between walls and plywood at least 3 cm;
- Prohibiting the use of washable paint products, semi-washable or addition of polyvinyl acetate;

c) Ventilation foundations in this way:

- Removing the concrete slabs above the concrete channel;
- Adjacent foundation for a minimum 30 cm wide distance, the bottom channel will be demolished (Figure 5) [4]:

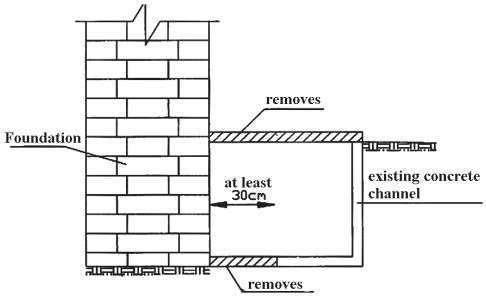

Fig. 5. *Removing the bottom channel for a minimum 30 cm wide distance*

- Where the bottom channel does not reach the foundation, the soil will be pull out, till foundation base, on a wide distance of minimum 30 cm (Figure 6):

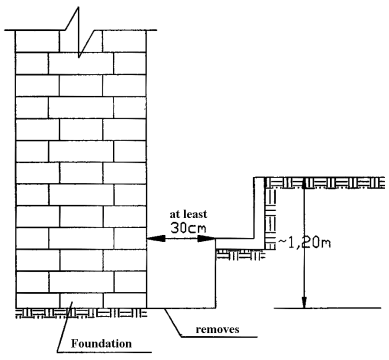

Fig. 6. *Removing the soil till foundation base, for a minimum 30 cm wide distance*

- A detail is presented bellow, with warning that waterproof foil need to be placed with the naps toward foundation, in order to create an air space between it and the foundation wall (Figure 7) and few explicit images from intervention of this church (Figures 8-12).

The numbers presented in Figure 7 are: 1 - precast concrete pavement, 5 cm; 2 - mono-granular gravel layer, sort (7-16) mm; 3 - plastic or aluminum with 5 cm wing "Z" profile, attached with plastic screws; 4 - brick and concrete foundation; 5 - naps foil (Tefond, Fondaline); 6 - brick wall; 7 - aerated plaster (cell), DER POR.

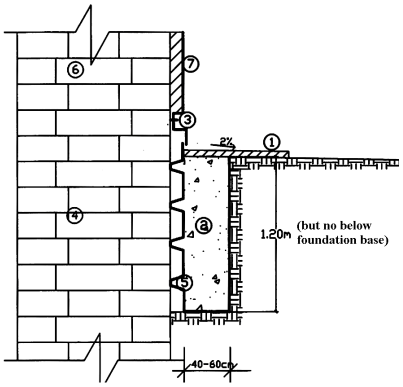

Fig. 7. *Detail for ventilating foundation at "Adormirea Maicii Domnului" church*

Fig. 8. *Setting the right elevation before making holes in brick wall*

Fig. 9. *DryZone gel inserted in holes made at the bottom of brick wall*

Fig. 10. *Continuous belt of holes at the bottom of brick wall*

Fig. 11. *Intervention at the exterior side of the wall*

Fig. 12. *Preparing foundation wall for the intervention from outside the church*

5. Conclusion

Using this method, DryZone, at "Adormirea Maicii Domnului" church, Smeura village, Argeş County, was a solution that leads to eliminating moisture from capillary wall.

Besides the provisions described in this article several conditions were met, to achieve project objectives.

These additional measures are:

- The church will necessarily be provided with gutters and rain pipes;
- The pipes will be connected with underground rainwater drainage of PVC, Ø110 mm, depth of 80cm. At each connection between the pipe and PVC pipe parts cleaning will be installed;
- Rainwater drainage will be directed to flush the opposite creek.

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