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WATERPROOF EXPERTISE OF AN OBJECTIVE WITH BRICK WALLS AFFECTED BY CAPILLARY MOISTURE

F. TĂMAŞ[1] I. TUNS[1]

Abstract: *Removing moisture from the capillary walls affected by rising dampness is a priority for the historical sites in question. Appropriate measures and method of intervention varies from one situation to another, especially when the financial factor is decisive. For Romanian Orthodox Diocese in Hungary, St. Nicholas Cathedral from Gyula, some of the methods with high efficiency rate over time are suggested. It is about Drykit, Dryzone respectively, and Comer. They come as a result of the on-site technical expertise. Specific intervention works from the outside and inside will be complemented with other related, aimed at removing the floor effect, foundations ventilation, remediation of fallen plaster and damaged paintings.*

Key words: *moisture capillarity, waterproofing materials, rising damp, foundation ventilation.*

1. Issues Highlighted by Technical Expertise

According to church history, because of the occurrence of moisture in the walls of the Episcopal Cathedral, over the years there have been various interventions for drying up. However, the smell of mould and indoor humidity persist, being also one of the causes for destruction of furniture and paintings inside.

Last interventions were made from 1998-2000, but soon humidity reappeared.

The technical expertise made in October 2008 revealed [3].

a) On the inside

- Measurements carried out in specific points show that the humidity increases vertically, from 12% to 35%.
- Blooms can be observed on some parts from plaster face. Migration of salts from walls also led to the appearance of efflorescence (Figure 1 and Figure 2).
- Stone floor has a high humidity level, ranging to around 22-28%.

Fig. 1. *Blooms and coloured spots on the plaster*

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

Fig. 2. *Coloured spots on the coating, caused by migration of salt from walls*

• The interior perimeter of the church presents a channel about 25 cm deep and 20 cm wide filled with crushed stone (sort by 30 mm) mixed with fines at the bottom (Figure 3):

Fig. 3. *Structure of the perimeter channel from the inside*

b) On the outside

• From the analysis of relative humidity in terms of vertical variation, at the plaster level (the latest repairing was made in previous years with Baumit W mortar) can be said that the humidity rises in capillary walls (of thickness between 1.6 m and 2.6 m) until above the rate at which aerated plaster ends, at about 2.5 m (Figure 4).

This is shown in particular, on church facades.

It can be said therefore that the effect of mortar from the plaster is reduced because of high moisture contained in the walls.

Fig. 4. *Variation of capillary moisture in wall height*

Without adopting a radical action to break capillarity, the plaster effect will decrease even more over time due to clogging pores with salt, emphasizing the phenomenon of dampness.

• A ditch is made on the outside perimeter of the church with about 30 cm deep and 30 cm wide, and changes a drain covered with granular crushed stone grade (25-30) mm.

Unfortunately, poor execution and lack of maintenance have led, in time, led to loss its initial role. This can be observed on Figure 5.

Fig. 5. *Ditch structure*

• Figure 6 presents the church plan with the points (marked red and numbered) where humidity readings was made.

• According to that plan, the percentages of humidity levels at wall coating are given in Table 1.

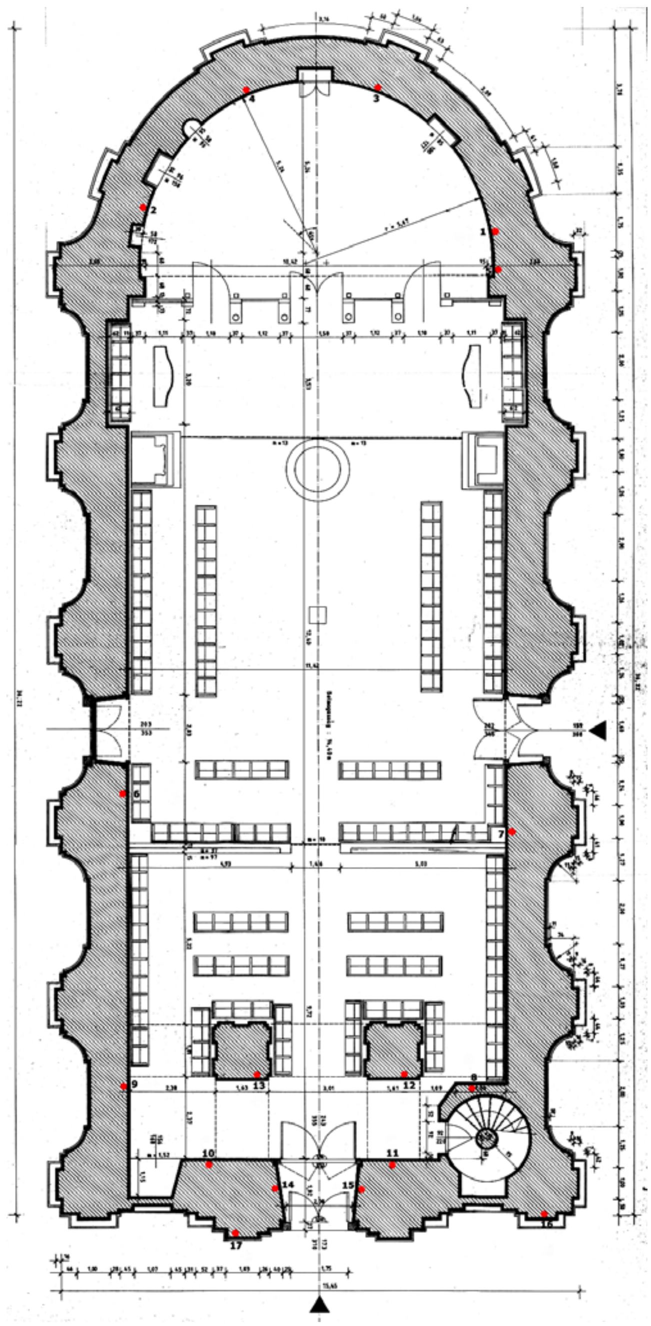

Fig. 6. *Church humidity points plan*

Humidity level table Table 1

Considered area		Measurement elevation from the floor, [cm]			Observations
		20	50	100	
Inside	1	35	33	24	Under the floor – water saturated aggregates
	2	< 35	0	0	-
	3	28	< 35	< 35	-
	4	0	< 35	28	-
	5	22	22	28	-
	6	20	24	22	-
	7	< 35	< 35	0	-
	8	< 35	< 35	< 35	-
	9	22	26	< 35	-
	10	22	< 35	< 35	-
	11	< 35	< 35	< 35	-
	12	< 35	0	0	-
	13	22	0	0	-
	14	< 35	< 35	0	-
	15	< 35	< 35	0	-
Outside	16	22	16	26	< 35% up to 2,5m
	17	12	18	14	< 35% up to 2,5m

• The moisture level at the coating face, measured from the bottom up, increase from about 12% to about 35%; is also high at the boundary between the previously executed plaster and the original one, with flaking and colour change of the painting.

• Rainwater collection pipes are led to a distance of (4-5) m from the building, but are not connected to the sewage system.

2. Intervention Measures Suggested

Considering those presented in the previous paragraph, the proposed measures to be adopted are:

a) To break the capillarity

• The execution of a barrier at floor level at the entire section of wall with effect in breaking the rising moisture (for example DryKit method) which stops completely capillary rise [5]. Using this method, any rise of water is prevented by changing the wetting angle, which means reversal of concave meniscus to convex, respecting the law of Jurrin (Figures 7 and 8) [1]:

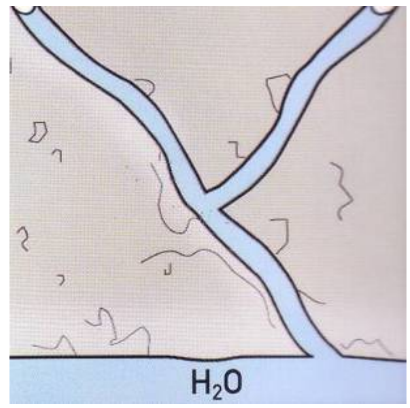

Fig. 7. *Untreated wall*

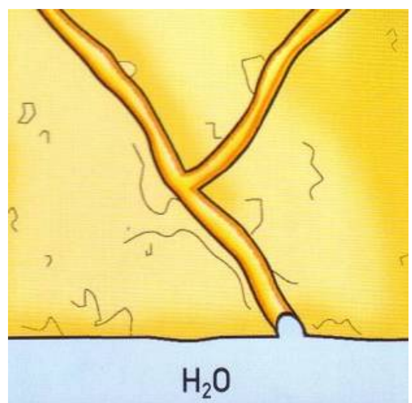

Fig. 8. *Treated wall*

• The execution of a barrier at floor level at the entire section of wall (Dryzone method can be used for its efficiency of over 10 years, according to Technical Approval).

The treatment is based on principle of injection different solution which 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, around 24-48 h (Figure 9), [2].

• Comer method - interrupt the capillary phenomenon.

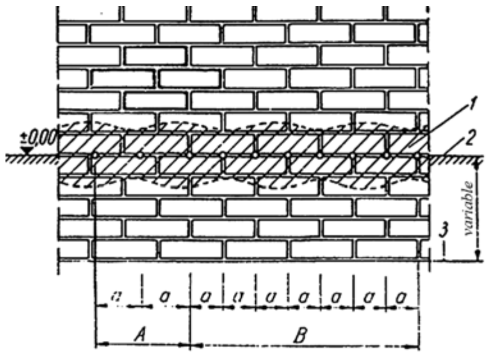

Fig. 9. *Treatment with synthetic resins: A, B - incorrect and correct positions of pipe fittings; a - distance between pipe fittings; 1 - impregnated zone, 2 - ground elevation, 3 - foundation elevation*

The Isolcomer building improvement system, as part of Comer technology for rising dump treatment can be used for buildings with a maximum of 2-3 floors with walls made of homogeneous materials (of the same shape and type), bricks, tuff blocks etc. [2].

In essence there are five stages to follow, in this order:

- Cut: consists of cutting the wall with special machines that use diamond chains. The cutting is done on the load-bearing walls (perimeter and internal) that sit directly on the foundations, as these are the ones where the humidity rises due to the capillary effect.

When finished the wall is ready for the second phase of the work.

- Insert insulation sheets: this is the most important phase of the procedure, and consists of inserting the waterproofing sheet in the cut made in the wall.

This sheet prevents humidity rising and creates a water-resistant barrier against rising damp.

Correct mode of intervention is illustrated in Figure 10.

Insulating sheet can be sandblasted on one side or both sides (the latter being mainly used in areas with significant seismic applications, which have provided better grip in the cut).

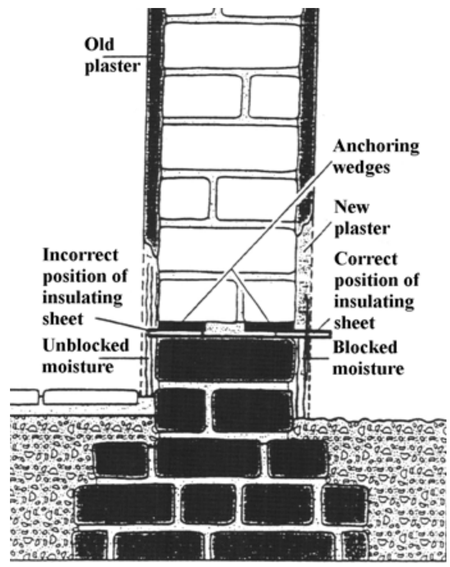

Fig. 10. *Correct mode to use insulating sheets*

The sheet comes in rolls and can be cut to desired size either manually or mechanically using a cutting bench.

- Insert anchoring wedges: In this point plastic anchoring wedges will be inserted in the cut under pressure.

These wedges have holes with channels for inserting the mortar and therefore have the threefold function of compressing it, blocking the insulating sheet in place in the cut and providing momentary stability to the walls while the mortar dries [4].

b) Other specific measures

- Ventilation works on the exterior foundation, till the base of it or up to 1.8 m depth (where the foundation base is at an elevation higher than –2.5 m), (Figure 11).
- Few technological rules must be accomplished as follows: waterproofing foil is positioned with the neps towards the foundation; rainwater collection pipes will be connected to sewage; the surface where

insulating foil will be placed must be cleaned from dust and fallen cement plaster; any existing caves will be filled up with cement mortar and rough stone.

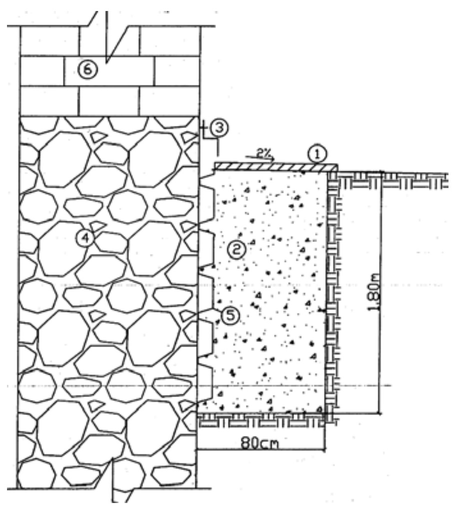

Fig. 11. *Ventilation exterior foundations side: 1 - Concrete Sidewalk; 2 - single layer gravel, sort (15-30) mm; 3 - "Z" profile from plastic or aluminium, 5 cm wing; 4 - Cathedral Foundation; 5 - Neps foil (Tefond, Fondaline type); 6 - Cathedral Wall*

• Ventilation works on the interior side of floor and foundation, with implementation to a minimum depth of 80 cm and capillary break over the whole perimeter of the church, by creating a drainage layer of 25 cm thickness and under floor insulation (it is prohibited to use sand or ballast instead of single layer gravel), (Figure 12).

3. Conclusion

Analysis of the degradation of the existing building in terms of matters related to rising humidity, has been done with professionalism and suggested methods for correcting problems found benefit from knowledge and experience in the field. Each of the three suggested methods has advantages and disadvantages, but the choice of either must meet beneficiary specific criteria.

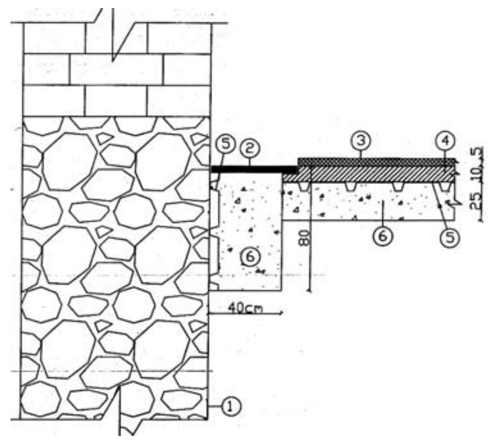

Fig. 12. *Ventilation interior side of foundations: 1 - Cathedral Foundation; 2 - zinked grate (15-20) cm; 3 - finished floor; 4 - 10 cm thick floor, C12/15 concrete reinforced with welded mesh and square mesh 6 mm diameter at 20 cm distance; 5 - neps foil (Tefond, Fondaline type); 6 - drainage layer, 25 cm thick single layer gravel, sort (7-16) mm or (16-31) mm*

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