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Test report

Report Nr.
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Commission:
Investigation of dehumidifying plaster **aero-durit® EP 2010** regarding the qualification

- as system for application on highly imbued masonry with salt contamination, or
- as measure to permanently dehumidify and dry up masonry

tested unter „worst case scenario" conditions and in comparision with available commercial products.

This report contains 5 text pages, 8 addendums and 5 picture addendums.

AUSTRIAN COOPERATIVE RESEARCH
KOOPERATION MIT KOMPETENZ

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Preliminaries:
An immense number of buildings are in need of rehabilitation due to damages caused by moisture and salt contamination. Besides expertise of the professionals , the selection of the appropriate materials is necessary for a promising rehabilitation measure.
With regard to the large number of products and systems available on the market, the choice of the right building material plays a decisive role.

Austrian standard **ON B 3355** basically merely describes the dehumidifying process of imbued masonry.

aero-durit® GmbH claims that when using the **plaster system aero-durit® EP 2010** a number of prcedural steps listed in ON B 3355 do not have to be applied yet allowing for a lasting drain of imbued masonry and a resulting dry, salt-free surface.

Basically the following characteristics of the product are specified by aero-durit® GmbH:

1. Good bonding and flawless drying even on soaked substrate with a level of moisture of more than 20% and up to 100%.
2. By special micro-pores and 4 binding-factors in the structure of the pores moisture is transported from the masonry and dispersed in the plaster and finally evaporated faster than the flow of moisture in the masonry.
3. Due to the high bonding strength of the plaster and relocation of salt during re-humidification the plastering system remains stable against crystallization pressure of salts in masonry therefore being resistant against salt and freeze-thaw-changes.

Consequently the following procedures may be omitted during the dehumidification of imbued masonry according to information of aero-durit® GmbH:

- analysis of salts
- treatment and lamination of masonry with salt contamination
- technical dehumidification measures
- horizontal and (partially) vertical sealing of masonry

A series of tests was designed to check this specifications. Some of the tests significantly differ from standard procedures in order to assess destructive mechanisms in as short a time as possible.

In the field of imbued and salt contaminated masonry mostly 3 main criteria decide on success or failure of the rehabilitation measure:

1. the application on the substrate
2. the conditions for the transport of moisture
3. the resistance against chemical attack (salts)

These 3 main features have been examined by various “worst – case” scenarios. The tests included various materials, partially newly developed, partially available on the market today.

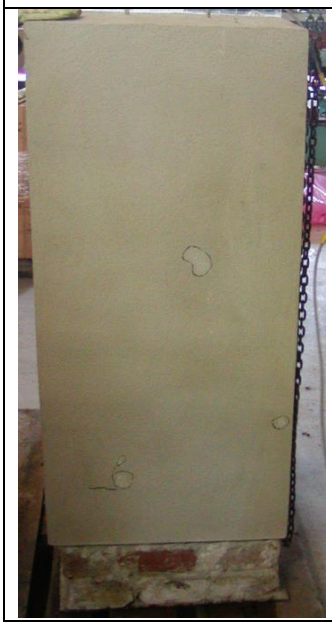
Tests and results

The application of plaster makes certain demands on the substrate (clean, dry, pre-wetting in hot atmospheric conditions and on sucking substrate). Consequently a humid or wet substrate with high moisture is hardly appropriate to provide permanent and functional composite of masonry and plaster.

For this test, 4 columns (sized 450 mm x 290 mm x 1180 mm - length x width x heigth) have been prepard and stored under water for 70 hours. The tiles for the columns came from the demolition of a 100-year-old farmhouse where they had been part of the ceiling construction of a stable, thus showing a considerable salt contamination.
Immediately after the storage under water, the columns have been rendered with 4 different plaster systems.

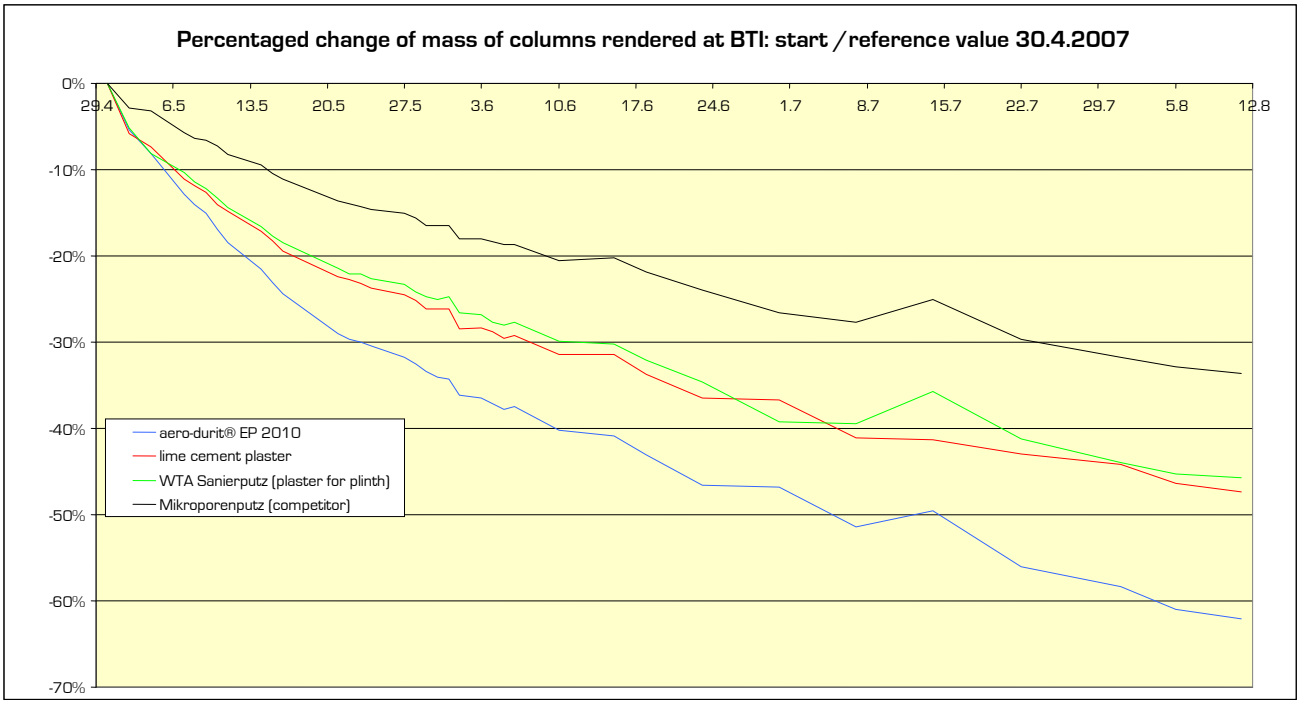
Column 1: aero-durit® EP 2010 dehumidifying plaster
Column 2: hand-applied lime cement plaster
Column 3: WTA Sanierputz (plaster for plinth)
Column 4: Mikroporenputz (competitor)

Flaws and cracks that appeared during the period of drying have been recorded by means of photographs.

aero-durit® EP 2010	lime-cement-plaster	WTA Sanierputz (plaster for plinth)	Mikroporenputz (competitor)
			

Column 1 with aero-durit® EP 2010 appeared to remain almost without cracks, whereas the other products clearly displayed cracks.

Subsequently the columns have been dried in laboratory climate. The change of mass during time has been recorded.



As a result it was noticed that colum 1 dried significantly faster than the other 3 specimen.

Resistance of a plaster against chemical attack is the third main criteria for the qualification of a plaster as rehabilitation measure.
Austrian standard ON B 3345 describes a test for the intrusion of salt into plaster for rehabilitation measures using a defined solution of sodium chloride, sodium sulphate and sodium nitrate. The test assesses whether the solution penetrates the defined specimen within 10 days.

For the "worst-case" scenario the concentration of the solution was increased by 50 %.
Furthermore the specimen have been stored for approx. 3 days in 2,5 cm of the solution and then transferred to the climate box. Total 28 freeze/thaw-cycles have been applied. After each cycle the amount of absorbed liquid was determined and after every 7th cycle the weathering was determined as well as a visual inspection of each specimen was done.
7 different plasters have been investigated, 2 of them explicitly declared as dehumidifying plasters (yellow marking). Resistance against chemical attack was verified for these dehumidifying pasters.

WTA Sanierputz (Rapid)	lime cement plaster (light)	WTA Sanierputz (plaster for plinth)	hand-applied plaster (undercoat)	Mikroporenputz (competitor)	aero-durit® EP 2010	lime cement plaster
						

Summary

When applied on masonry with high moisture, aero-durit® EP 2010 was the only product with finally no cracks and flaws.
Moreover a greater amount of water is delivered faster from the surface to the environment. This was observed at the columns as well as on the samples for freeze/thaw testing, even after applying salt contamination and doing the freeze/thaw cycles.
Verification of resistance against chemical attack (especially salts typical for masonry) was made for aero-durit® EP 2010. After exposure to salt and additional freeze/thaw tests only minor weathering on the surface was observed.
In summary aero-durit® EP 2010 dehumidifying plaster has fulfilled the requested criteria; the abandonment of supplementary horizontal or vertical sealing should be verified by an expert as the case arises.

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Der Zeichnungsberechtigte

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Specimen:

9 columns were built (size 450 mm x 290 mm x 1180 mm (length x width x heigth)) from 100 year old standard sized bricks.
Column 1 to 8 have been built with standard off-the-shelf masonry mortar on 31.03.2007, column 9 was built with aero-durit® EP 2010 dehumidifying plaster als mortar on 05.04.2007.

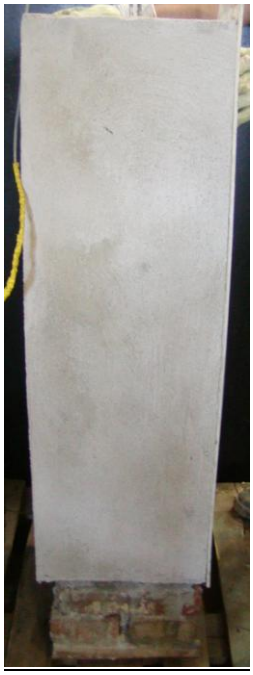
Columns 1 to 3 have been rendered on 05.04.2007 with 3 different plasters:
Column 1: aero-durit® EP 2010 dehumidifying plaster
Column 2: hand-applied lime cement plaster
Column 3: WTA Sanierputz (plaster for plinth)

Columns 4 to 9 have been stored under water for 70 hours. Columns 4 to 7 have been rendered on 18.04.2007 bay workers of Fa. rawatecc at the BTI site using 4 different plasters, columns 8 and 9 remained without plaster.
Pfeiler 4: aero-durit® EP 2010 dehumidifying plaster
Pfeiler 5: hand-applied lime cement plaster
Pfeiler 6: WTA Sanierputz (plaster for plinth)
Pfeiler 7: Mikroporenputz (competitor)

1. Characteristics of the platers on waterlogged masonry

During the monitoring of the drying behaviour of the columns, the cracks in the plaster have been observed. The drying took place in laboratory climate. Changes in the mass of the columns and the development of cracks were recorded regularly.

aero-durit® EP 2010 dehumidifying plaster



Aerodurit 2010 EP remained almost without cracks.
As a result of the salt contamination tests, only small local areas showed salt efflorescence. No other significant differences between the 2 columns rendered with aero-durit® EP 2010.
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Hand-applied lime cement plaster



Relatively large cracks after dehydration showed on two surfaces.
Other than the columns with aero-durit® EP 2010, the lower parts of the columns had extensive and uniform areas of salt efflorescence after the salt contamination tests.

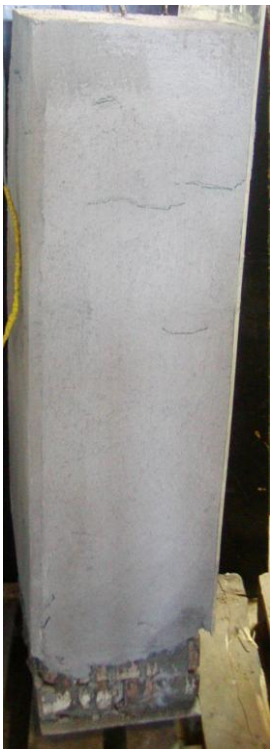
WTA Sanierputz (plaster for plinth)



This plaster showed distinct cracks, especially on the reverse side and on the left side..
Other than the columns with aero-durit® EP 2010, the lower parts of the columns had extensive and uniform areas of salt efflorescence after the salt contamination tests.

Mikroporenputz (competitor)





This plaster also showed a rather distinct trend to build cracks, but the almost circumferential crack in the upper part (pictures left and in the middle) also might be a result of an application of higher force to the upper part of this column.
(No column rendered with this system was exposed to salt contamination!)

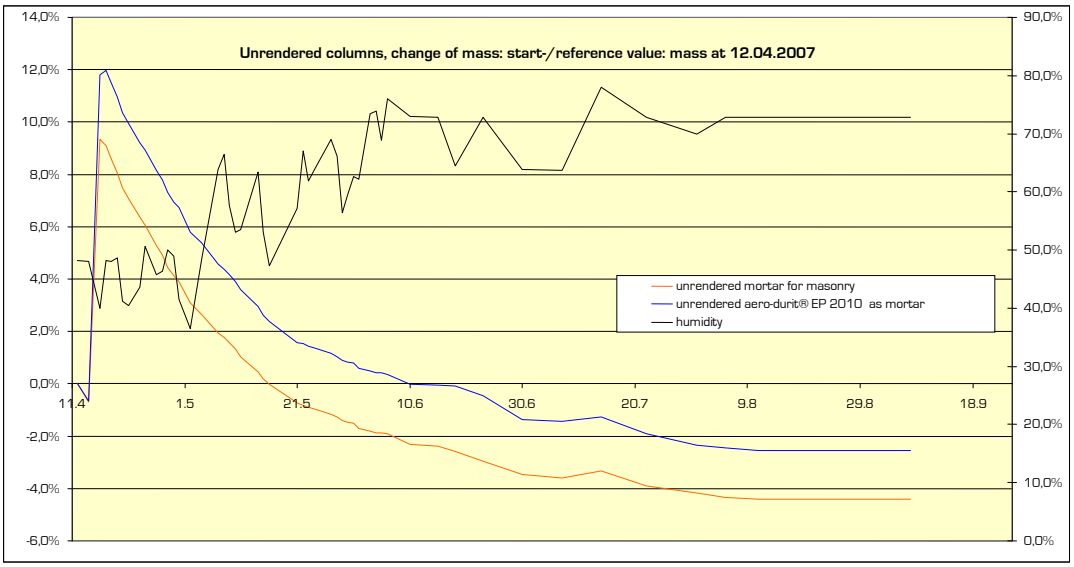
In this configuration, plastering on waterlogged masonry, aero-durit® EP 2010 clearly shows to be the best plastering system, since it remains almost without cracks. The other plastering systems show more or less distinct cracks.
Thus only aero-durit® EP 2010 without restriction qualifies as appropriate to application on masonry with high moisture, drying up without cracks.

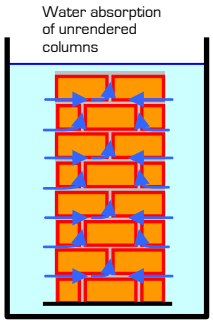
2. Results of the dehumidification tests:

The columns, built by Firma rawatecc and delivered to BTI, heve been dehumidified at laboratory climate for about 7 weeks. The loss of mass was recorded several times a week.

Unrendered columns (Nr. 8 & 9)

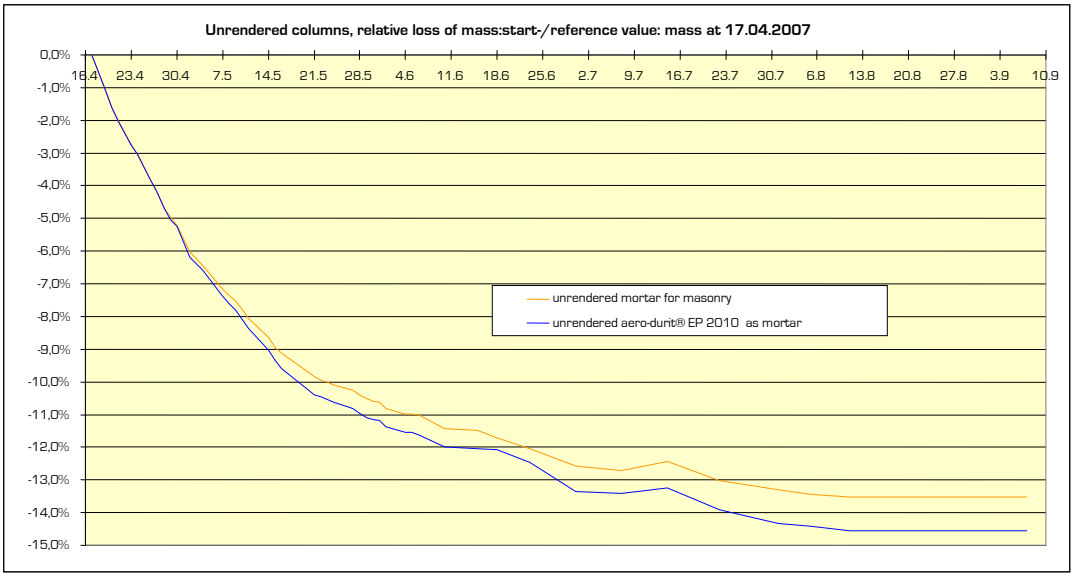
The water absorption of column 9, rendered with aero-durit® EP 2010 as mortar, is about 3 % higher than the water absorption of column 8, rendered with standard mortar.

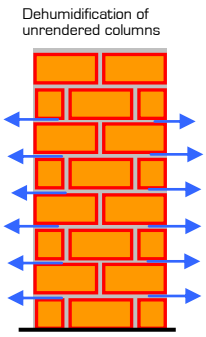




The pore structure of this mortar has an influence on the water absorption.

The dehumidification behaviour of both variants does not show significant differences.





The relatively very large share of brick surfaces masks the effect of the advanced pore structure.

After a certain time of dehumidification test, the option with aero-durit® EP 2010 as mortar seems to be advantegous.

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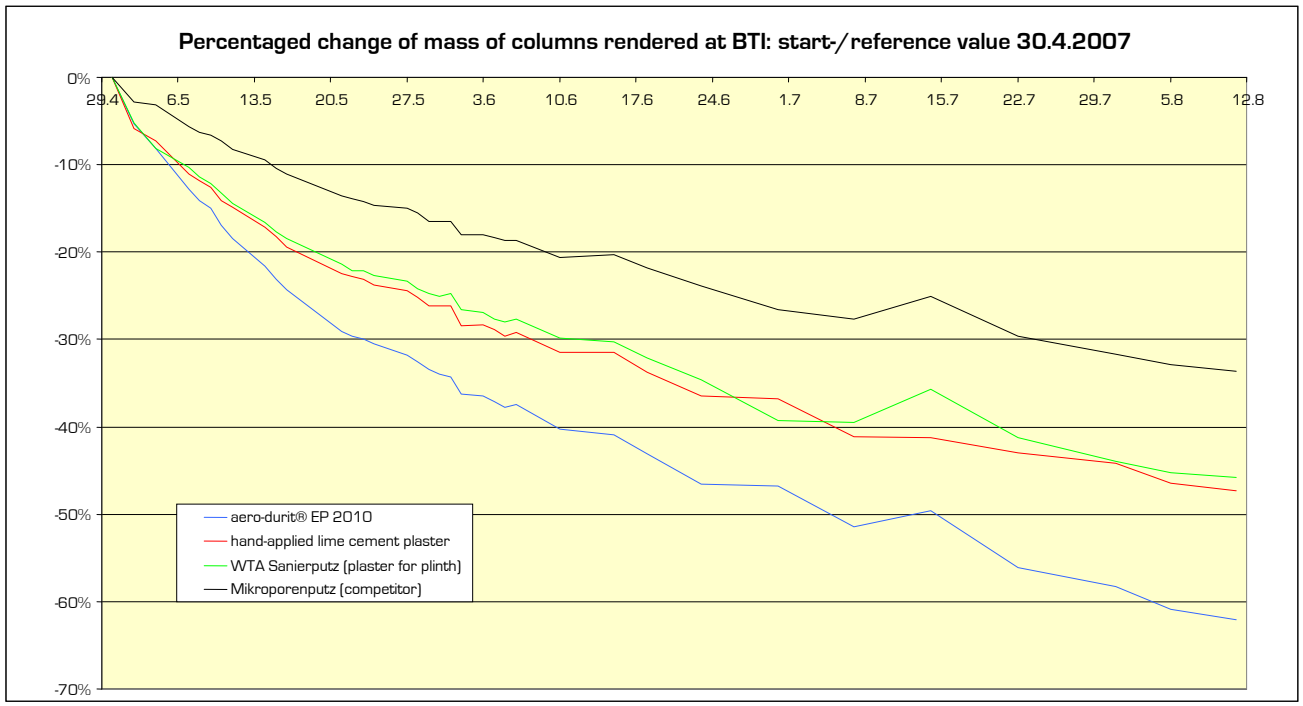
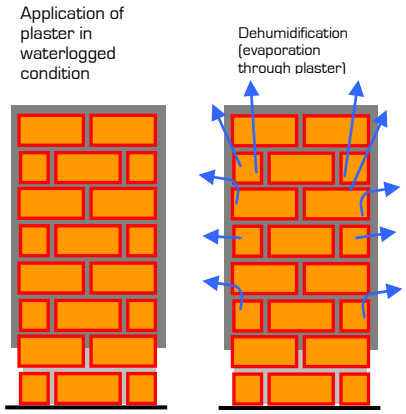
Columns rendered in waterlogged condition at BTI (Nr. 4 – 7)

The below diagram shows the loss of mass during dehumidification of each column in relation to the mass of the mortar applied. The reference for the analysis (about 2 weeks after rendering the columns) was selected to achieve consolidation of boundary conditions that have been slightly different due to the rendering.





The advantegeous pore structure of aero-durit® EP 2010 causes a significantly faster transport of moisture from the waterlogged bricks of the columns to the surface.

The loss of mass of the column rendered with aero-durit® EP 2010 (about 60 %) is significantly higher then with the other plaster systems tested. The column rendered with aero-durit® EP 2010 was drying up fastest.

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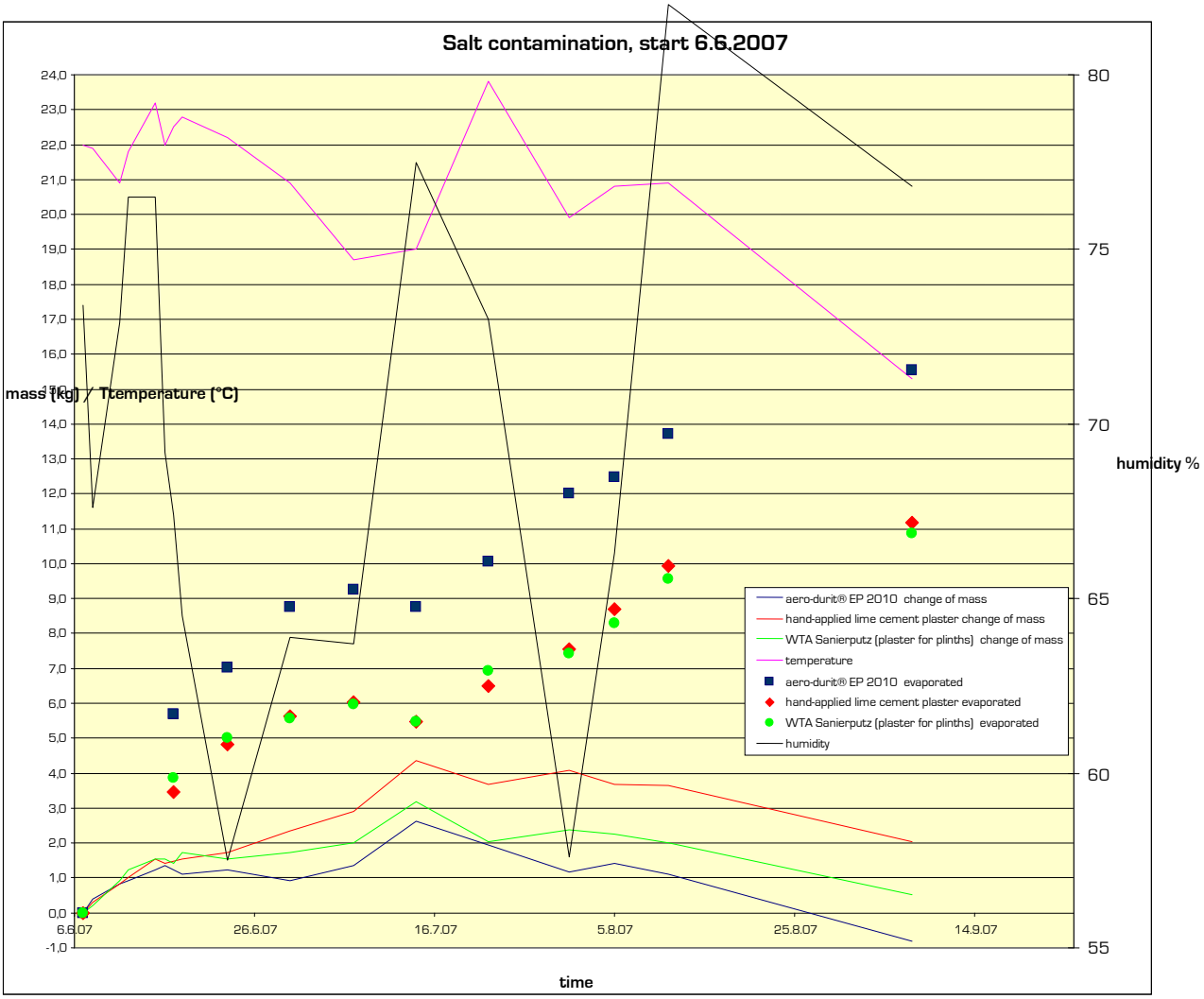
Rendered columns, not waterlogged (Nr. 1 – 3)

Test preparation, start of test

Each of the columns in this test was placed in a pan and exposed to 10% sodium chloride solution. Several times a week the mass of the columns and of the remaining solution in the pans was determined. To ensure the evaporation only through the rendered surface of the columns, the lower part and pan were covered with a skirt from plastic film.
The test started on 06.06.2007 and ended on 11.08.2007.
Subsequently the columns have been stored in the laboratory outside the pans.



The solid lines in the lower part of the diagram show the change of mass of the columns exposed to the salt solution. The column rendered with aero-durit® EP 2010 clearly shows the smallest change of mass.
The dotted lines show the amount of water evaporated through the rendered surface.The column rendered with aero-durit® EP 2010 has evaporated the largest amount of water.

With regard to this characteristics, the column rendered with aero-durit® EP 2010 has the highest evaporation rate.
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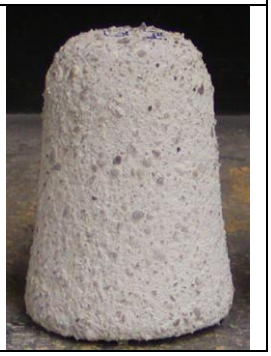
3. Resistance against salt

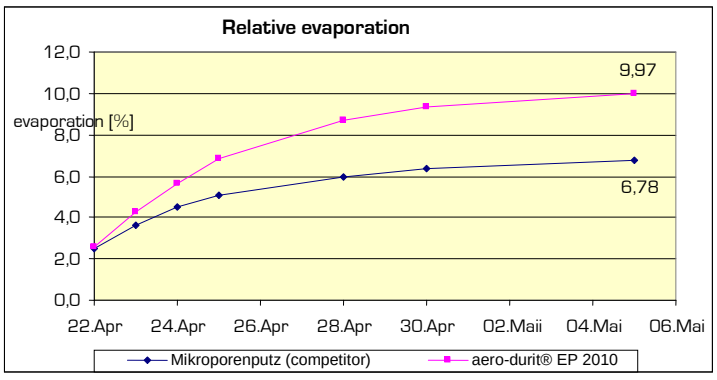
The considerations about a quick determination of salt resistance defined a test where specimen of various plaster materials were exposed to a concentrated salt solution and subsequently to freeze/thaw cycles.
The test consisted of 4 steps, each starting with 3 days treatment in the salt solution followed by 7 days of freeze/thaw cycles. Each freeze/thaw cycle lasted for one day, the temperature range was from + 24 °C to – 22 °C.
After each of the 4 steps, the specimen were inspected visually.

plaster	step 1	step 2	step 3	step 4
WTA Sanierputz (Rapid)				
hand-applied lime cement plaster (light)				
WTA Sanierputz (plaster for plinth)				
hand applied plaster (undercoat)				

Mikroporen-putz (competitor)				
aero-durit® EP 2010				
hand-applied lime cement plaster				

The pictures clearly show that only aero-durit® EP 2010 and Mikroporenputz have successfully passed this test with minimum weathering on the surface of the specimen. In contrast, the other specimen show significant damages and a relatively large amount of weathering.

After the salt resistance tests were finished, aero-durit® EP 2010 as well as Mikroporenputz have been exposed to another eveporation test in order to determine the influence of the incorporated salt on the evaporation rate.

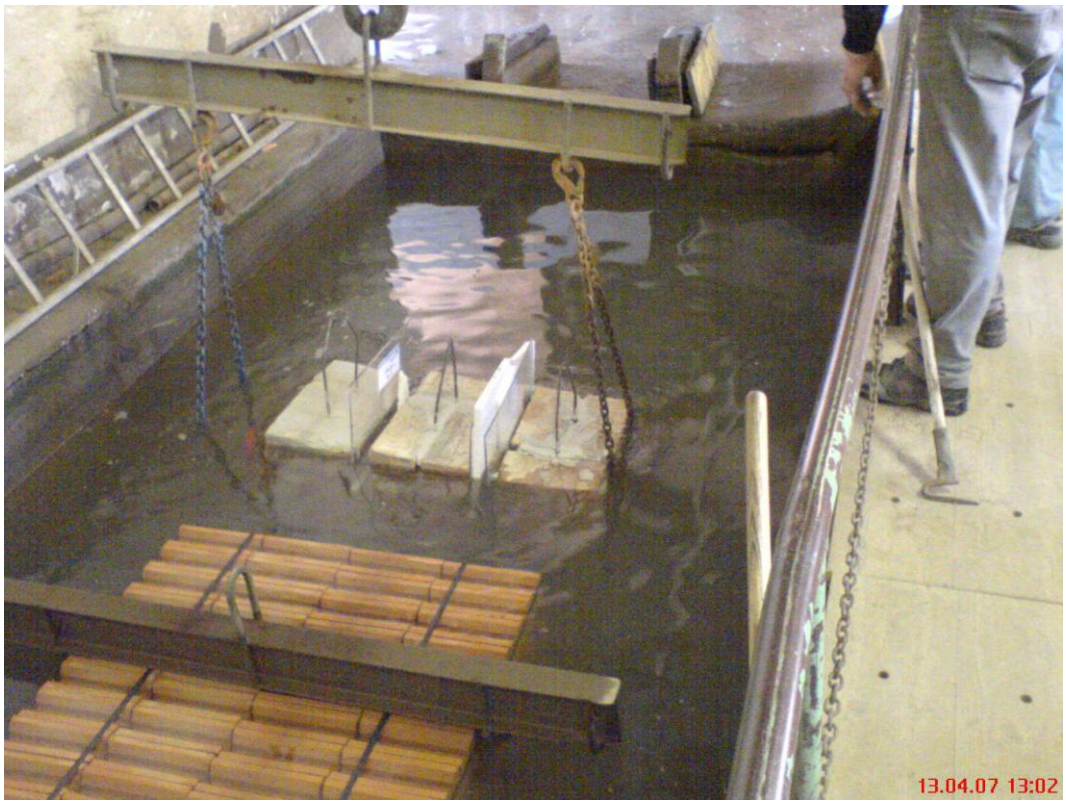


Even after the salt resistance tests, aero-durit® EP 2010 evaporates significantly more water than Mikroporenputz.

The bricks used for the columns came from a stable of an 100 year old farmhouse and thus have a significant salt contamination.

The columns have been built by workers of Firma **rawatecc – Bau und Betontechnologie GmbH**.

Storing the columns under water preparing „Rendering waterlogged masonry“ to investigate the ability of the mortars to dry up without cracks when applied to masonry with high moisture.



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Picture addendum - 4 -

Rendering the columns by workers of Firma rawatecc – Bau und Betontechnologie GmbH.

Storing the colums in the BTI laboratory

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Picture addendum - 5 -

Columns stored in 10 % sodium chloride solution for salt resistance test.