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WORKING EFFICIENCY OF „SACRIFICIAL" PLASTERS – PRACTICAL EXPERIENCE IN LATVIA

SANĒJOŠO APMETUMU DARBĪBAS EFEKTIVITĀTE – IEGŪTĀ PIEREDZE LATVIJĀ

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Introduction

Salt crystallization in porous materials constitutes one of the most frequent causes of decay of buildings, in a wide range of environment [1]. Among salts commonly found in masonry; sodium chloride (NaCl) is one of the most abundant. In spite of the several theories developed to explain salt crystallization damage, no unanimous opinion exists yet on the mechanisms causing the damage.

There are many factors contributing to the kinetics of crystal growth, including composition of salt mixtures and the degree of disparity between the ambient conditions and equilibrium condition, air movement and the characteristics of the porous matrix.

The salts can be delivered from many sources, including sea-spray, soil, and water, cleaning materials, de-icing materials and building materials themselves [2].

Salt can be transported in a porous material only if dissolved in water. During drying of a wall salt is transported to the evaporation front, where it crystallizes and accumulates. Generally the evaporation front is located near the surface of the wall, with as a consequence that the wall finish, i.e. the plaster runs the highest risk of decay. Even thought the plaster applied in restoration is usually considered as a sacrificial layer, a long service life of the plaster is pursued [3].

In the last decades, apart from traditional plasters, commercial multi layer desalination renders or so called "sacrificial" plasters are available on the market. These plasters are especially made rehabilitation systems consisting basically from porous soil and specific additives, and are especially developed for salt loaded masonries.

"Sacrificial" plasters have been used in several objects in Latvia, more significant of them are Riga Castle and Riga Cathedral. There also has been performed some practical experiments regarding "sacrificial" plasters when pilot areas were applied and tested after stated period.

"Sacrificial" plaster – as a method of desalination

There are different desalination methods described in literature [4] and application of "sacrificial" plasters is one of them. "Sacrificial" plasters have been used where the source of soluble salts were rising damp, sea or estuarine sand in mortar, past flooding, storage of culinary salt, gunpowder, chemicals, human and animal urine, cleaning and biocidal treatment. The application techniques are mainly suitable for large, plain areas of masonry or simple architectonical details. It is complicated to use them on delicate, damaged surfaces of carvings or sculptures. Where "sacrificial" plasters are considered to be appropriate it may be necessary to include their planning into a long- term maintenance programme, perhaps every five or ten years, particularly if there is a persistent replenishment of soluble salts [2].

There are different types of "sacrificial" or restoration plasters (Fig.1). "Salt transporting" plasters operate by transporting salts to the surface, where they should crystallize in the form of harmless efflorescence (quick (1) and slow (2) transporting). "Salt accumulating" plasters (3) work either by accumulating the salts in the inner layer, where enough space should be provided for their crystallization. Such kind of plasters usually contains water repellent in the outer layer. "Salt blocking" plasters (4) completely block salts or water and water vapour ("moisture sealing" – 5) from penetration in the plaster layer. These are less common and usually not recommended in restoration [4].

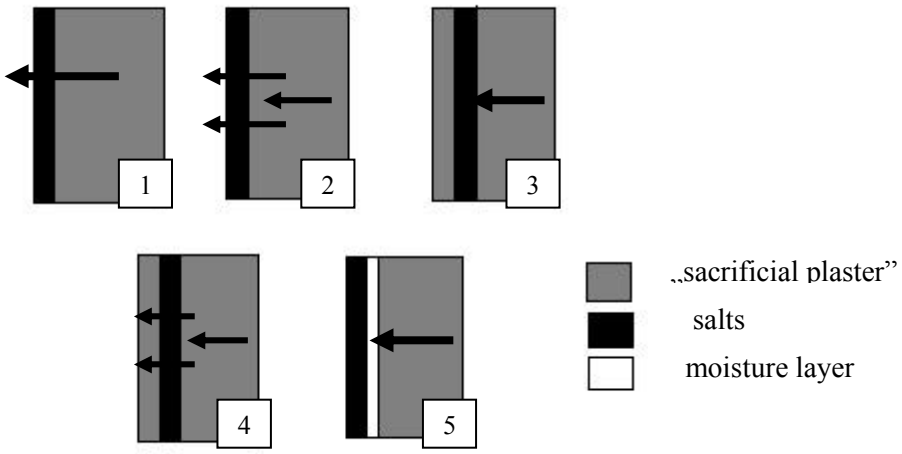

Fig.1: *Types of "sacrificial" plasters*

The behaviour of restoration plasters *in situ* is not always satisfactory.

Investigation

In order to evaluate the desalination effectiveness using "sacrificial" or so-called sanitary mortars the research project was carried out at Riga Dome Cathedral in collaboration with German colleagues from DZHD (Deutsches Zentrum für Handwerk und Denkmalpflege). Within the framework of this project lime-cement (1,5(lime):1(sand):5(cement)) mortar (No1), lime mortar (1:2) with 10% additive of cement (No2) and three different "sacrificial" plasters (No3–No5) were used on sampling sites (experimental squares). The salt content in sampling sites was repeatedly analyzed.

The obtained results (Fig.2-7) showed that lime-cement mortar being too dense was not able to absorb salts so effectively as lime mortar with 10 % additive of cement. From three sacrificial plasters one demonstrated better results than two others. One of those plasters admitted salts very slowly and the bulk of them deposits near the surface of masonry but not in the plaster. Two others also demonstrated a slow enrolment of salt mainly because of differences between pour sizes of "sacrificial" plaster and treated

The obtained results (Fig.2-11) showed that lime-cement mortar being too dense was not able to absorb salts so effectively as lime mortar with 10 % additive of cement. From 3 types of "sacrificial" plasters No3 and No4 admitted salts very slowly and the bulk amount deposits near the surface of masonry but not in the plaster. No5 demonstrated a slow enrolment of salts. Even if desalination process in the cases of traditional lime mortar occur very admissible as the disadvantage of this method could be considered the formation of efflorescence on the surface of mortar which could make it visually non acceptable [3].

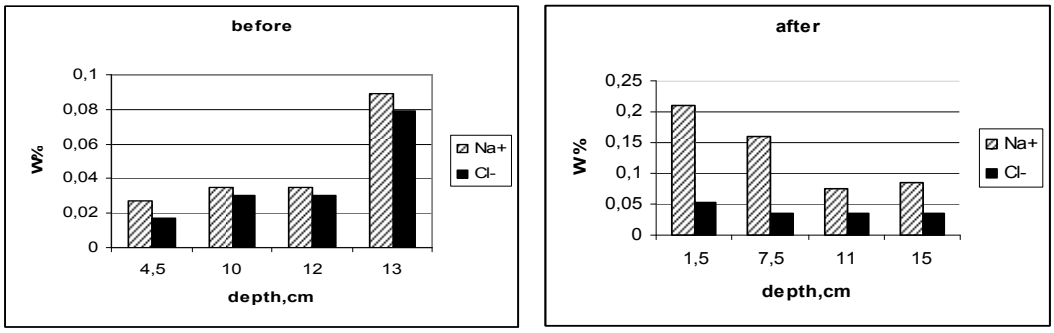

Fig.2 and 3: *Content of soluble salts before and after application – No1*

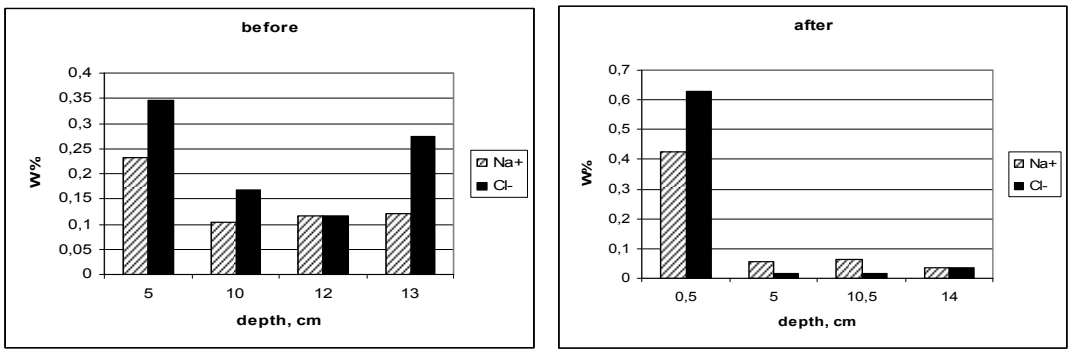

Fig.4 and 5: *Content of soluble salts before and after application – No2*

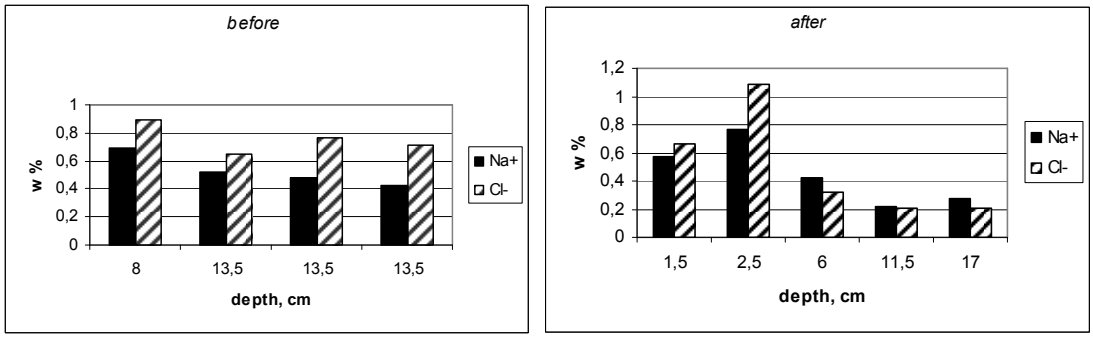

Fig.5 and 7: *Content of soluble salts before and after application – No3*

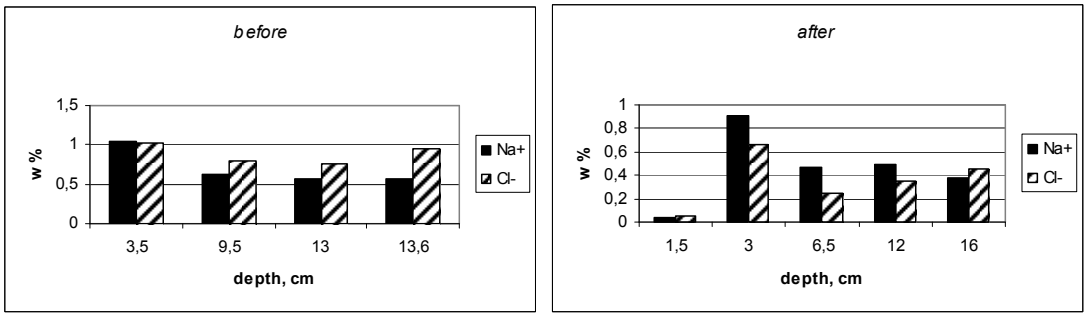

Fig.8 and 9: *Content of soluble salts before and after application – No4*

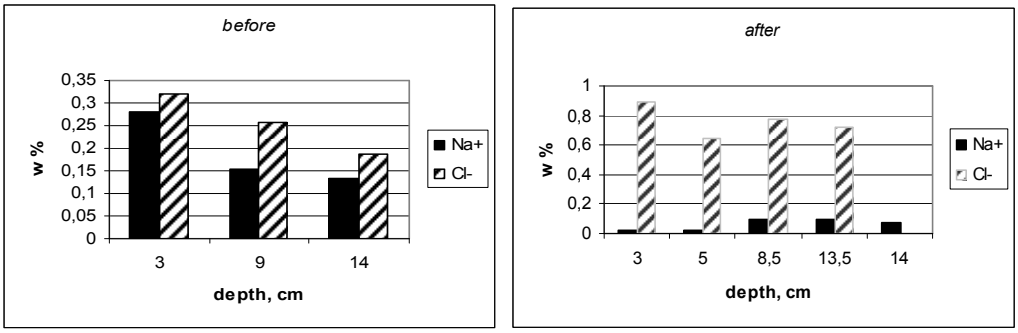

Fig.10 and 11: *Content of soluble salts before and after application – No5*

Parallel above mentioned another experimental sampling site was examined in the Capithulum hall of Riga Cathedral. "Sacrificial" plaster No6 was applied on the surface of the 13th century brick wall (Fig.12) in 1995. Two boreholes were made in experimental sampling site in Capithulum hall in 2006. Anion and cation chemical analysis of borehole samples presented low concentration of salts in the depth until 8 cm of brick walls. The layer of "sacrificial" plaster was 0.6 cm thick. Gained results (Fig.9) presented that sample of "sacrificial" plaster (Fig.10) has low concentration of salts. That means that together with aforesaid this "sacrificial" plaster does not work. Salts accumulate right behind "sacrificial" plaster, but not in its pores as required.

Fig. 12: *Square of "sacrificial" plaster in Capithulum hall*

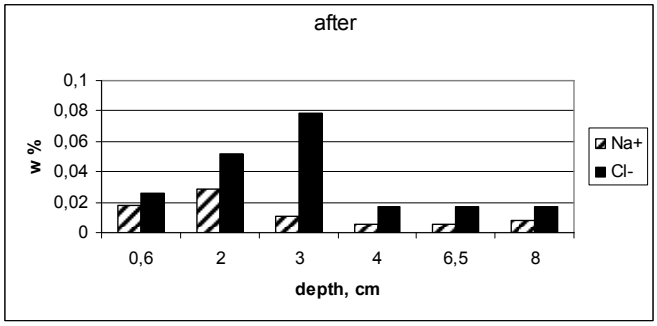

Fig.13: *Content of soluble salts after application of "sacrificial" plaster No 6*

Fig.14: *Sample of "sacrificial" plaster (0.6 cm thick)*

Conclusions

It could be concluded that "sacrificial" plasters do not work enough effectively. Results demonstrate that, if the evaporation is enhanced and the plaster is thick enough, the salts do not reach the surface and no visible damages are observed. In this case the plaster behaves according to "salt accumulating" working principle (Fig.1). When the evaporation is slower or/and the plaster layer thin, the salt accumulates near the surface where it crystallizes not only in the form of harmless efflorescence, as expected, but also inside the pores of the material, causing damage.

Optimal thickness of the plaster layer is therefore necessary in order to avoid surface damage.

In a "salt transporting" plaster, hygroscopic salts tend to accumulate near the surface and are therefore very sensitive to the changes of RH (Relative Humidity) in the air.

The properties of sacrificial plasters as well as historical masonry of Riga Dome Cathedral (composition, physical properties and moisture transport behaviour, etc.) should be further examined in order to evaluate working efficiency and suitability of desalination methods and materials.

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J.Svare, I. Vītiņa, L.Krāģe, R.Lūsis „Sanējošo apmetumu" darbības efektivitāte – praktiskā pieredze Latvijā. *Pēdējos gados blakus tradicionālajiem apmetumiem tirdzniecībā ir pieejami tā saucamie „sanējošie apmetumi". Šie apmetumi ir speciāli veidotas sanācijas sistēmas, kas sastāv no porainas grunts un speciālām piedevām. Tirdzniecībā ir pieejami dažāda veida „sanējošie apmetumi". Viena veida apmetumu darbības pamatā ir sāļu transportēšana uz apmetuma virsmu, kur sāļi kristalizējas nekaitīgas efflorescences veidā. Pavisam cits darbības princips ir pamatā apmetumiem, kuri sāļus uzkrāj apmetuma iekšējā slānī, kur tie kristalizējas, neradot kaitējumu. Blakus jau minētajiem ir tādi apmetuma veidi, kuri pilnībā bloķē sāļu un ūdens iekļuvi apmetumā un ir ar hidrofobu virsmu. „Sanējošie apmetumi" izmantoti gan Rīgas pils, gan Rīgas Doma u.c. atjaunošanas darbos, kā arī, izveidojot un pēc noteikta laika pārbaudot speciālus no šī apmetuma izveidotus eksperimentālos laukumus, ir izvērtēta šo apmetumu efektivitāte. Tomēr „sanējošā apmetuma" darbība objektos, kuros tas lietots, ne vienmēr ir apmierinoša.*

J.Svare, I.Vitina, L.Krage, R.Lusis Workinf efficiency of "sacrificial" plasters – practical experience in Latvia. *In recent years, apart from traditional plasters so called "sacrificial" plasters are available on the market. These plasters are specially designed rehabilitation system consisting from porous soil and specific additives. There are different types of them. There are different types of "sacrificial" or restoration plasters. "Salt transporting" plasters operate by transporting salts to the surface, where they should crystallize in the form of harmless efflorescence). "Salt accumulating" plasters work either by accumulating the salts in the inner layer, where enough space should be provided for their crystallization. "Salt blocking" plasters completely block salts or water and water vapour from penetration in the plaster layer. These are less common and usually not recommended in restoration. Such plasters have been used in several objects in Latvia (Riga Castle, Riga Cathedral etc.). There also has been performed some practical experiments regarding "sacrificial" plasters when pilot areas of them were applied and tested. Nevertheless, behaviour of restoration plasters in situ is not always satisfactory.*

Я.Сваре, И.Витиня, Л.Краге, Р.Лусис Эффективность воздействия «восстанавливающей штукатурки» - практический опыт в Латвии. *В последнее время в продаже среди традиционных отделочных материалов стали доступны различные «восстанавливающие штукатурки». Эти штукатурки это особенные санационные системы, состоящие из пористого грунта и специальных добавок. В продаже доступны различные виды «восстанавливающих штукатурок». В первом случае работы штукатурки происходит перемещение солей на ее поверхность, где соли кристализуются в виде безвредной эффлоресценции. В другом случае, соли накапливаются во внутреннем слое штукатурки и при кристализации не происходит разрушение штукатурки. Кроме выше перечисленных, существуют штукатурки с гидрофобной поверхностью, которые полностью блокируют проникновение солей и воды в штукатурку. Они применялись в реставрационных работах Рижского замка, Рижской думы и др. объектов. Эти штукатурки так же были специально использованы для отделки экспериментальных площадок, эффективность воздействия была исследована и оценена. Влияние «восстанавливающей штукатурки» на некоторые опробованные объекты не всегда достаточно высокая.*