SĀĻU DESTRUKTĪVĀ DARBĪBA AKMENSMATERIĀLOS UN TĀS NOVĒRŠANA
DEGRADATION OF STONE MATERIALS CAUSED BY SALTS AND ITS PREVENTION

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Salts are widely recognised as a major contributor to the loss of the world's architectural heritage(1). Modern materials like cement and concrete of bridge desks, railway sleepers and runways are equally at risk. The damage is attributable to the growth of salt crystals within the porous structure of materials. Crystal growth can take place as a result of crystallisation from supersaturated solutions, of changes in hydration state or of chemical reactions.

The disintegration of stone materials due to the influence of soluble salts derived from polluted environment (soil water, sea-spray, cleaning and de-icing materials and building materials themselves) in Latvia is one of the greatest dangerous to the historical monuments (2,3).

Chemical and physical analyses of the disintegrated stone materials of Riga Brethren's Cemetery, Riga Castle, Monument to Freedom, of the Riga Dome Cathedral etc. show that $CaSO_4 \bullet 2H_2O$, $MgSO_4 \bullet 7H_2O$, K_2SO_4, KNO_3, $KNaSO_4$ as well as NaCl are the main products of corrosion. Water migration favours the solubility, hydrolyses and crystallization of the corrosion products and degradation of the stone materials.

As more practical and effective methods for stone cleaning and desalination developed by Latvia restorers are following: water-wool-cotton, clay and lime poultices, sacritifical renders, sanitary mortars and dry removal.

Good results have been achieved by clay poultice used for desalination of green cupper stains on the surface of travertine of Monument to Freedom (in Riga). In this case the solution of NH_4OH and EDTA was added to clay and poultice was applied in traditional way, after that wool-cotton-water poultices were used. Advantages of clay poultice are that it is possible to desalinate comparatively large areas, avoiding introduction of large amount of water, as well as low expenses of method.

Different methods have been applied for desalination of freshwater limestone i.e. clay and water poultices as well as dry removal. Chemical and XRD analyses of corrosion products freshwater limestone of Riga Brethren's Cemetery show that they contain sodium, potassium and calcium sulphates and dust. Though the method of water poultice is labor-consuming, it is effective: during the period of 10-13 days the black surface of the stone turns into white and the amount of sulphur trioxide drops to safe level (from 20-30% to 5-10%,).

For desalination with lime poultice, lime paste is prepared of freshly burned limestone, slaked and applied to the stone surface in 2—2,5 cm thick layer of paste, subsequently covered with wet cloth and polyethylene. The poultice should be moistened daily with water and left on the stone surface for 2—3 weeks and after carefully removed. The half of corrosive salts is removed in this conservation process and disintegrating, mechanically fragile stone surface returned to a monolith.

Desalination with sacrifical layers could be achieved by use of traditional lime: sand render with selective screening of aggregate from 600 μm and below in order to produce a micro-porous mix, which will more readily absorb moisture and salt from the wall.

In order to evaluate the desalination effectivity using lime and sanitary mortars the research project was carried out at Riga Dome Cathedral in collaboration with German restorers.

Dry removal of salts and its isolation from object can be used not as direct desalination method but as one of the measures of regular maintenance.

Dabas piesārņojums, ko rada automašīnu izplūdes gāzes, skābais lietus, sāls tehnoloģijas lietošana apledojuma likvidēšanai un ūdens migrācija, izraisa ķīmiskās un fizikālās korozijas procesus ne tikai kultūrvēsturiskajos objektos,bet arī betona un dzelzbetona konstrukcijās (4).

Visgraujošāko akmensmateriālu sairšanu veicina ūdenī šķīstošo sāļu uzkrāšanās un kristalizācija akmens porās ūdens iztvaikošanas rezultātā. Bez NaCl, ko plaši lieto ledus likvidēšanai uz ielām, senatnes mūros no gaisa piesārņojuma un tā ķīmiskās iedarbības ar akmensmateriāliem ir izveidojušies kālija, nātrija, magnija, kalcija sulfāti, nitrāti un hlorīdi. Atkarībā no žūšanas apstākļiem (vides temperatūra, gaisa relatīvais mitrums, gaisa masas kustība) ir iespējama:

1. sāļu kristalizācija uz akmens virsmas jeb eflorescence, kas notiek lēnas žūšanas rezultātā, uz akmens virsmas veidojās sāļu kristāli;
2. notiekot straujai žūšanai mitrums, migrējot no dziļākiem slāņiem, iztvaiko jau porās ārējās virsmas tuvumā, sāļu kristalizācija notiek porās un šādu procesu sauc par kriptoflorescenci.

Ūdenī šķīstošo sāļu kristalizācija notiek lielajās porās, kur sāļu šķīdums ieplūst no mazajām porām. Lielajās porās kristāls aug tik ilgi, līdz turpinās sāls šķīduma padeve no mazajām porām un kapilāriem. Kad kristāla izmēri sasnieguši kritisko izmēru - pora tiek sagrauta. Ja netiek pārtraukta sāls šķīduma pieplūde, process turpinās arī mazajās porās un kapilāros. Parasti vislielākie kristalizācijas spiedieni veidojās akmensmateriālos ar lielu mazo poru daudzumu.

Kriptoflorescences pazīme ir sauss sairstošs akmensmateriāls (ķieģelis, mūrjava, apmetums, akmens). Šāda veida sairstošo akmensmateriālu sabrukšanas apturēšanai vēsturiskajos objektos ir nepieciešama sāļu identificēšana, pamatu hidroizolācija ūdens pieplūdes pārtraukšanai un piemērotu atsāļošanas metožu izvēle.

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