M. Sc. Franziska Braun[1)]
Prof. Dr.-Ing. Habil. Jeanette Orlowsky[1)*)]

Analysis on the efficiency of stone consolidation actions

Analiza skuteczności środków do wzmacniania kamienia

DOI: 10.15199/33.2016.11.07

(Doniesienie naukowe)

Abstract. In this study the effectiveness of stone consolidation actions was analysed on two German sandstones with different binders, the Baumberger (calcareous) and Sander (clayey). Due to varying treatment procedures the investigated sandstones showed different petrophysical and mechanical properties.

Keywords: sandstone, stone strengthener, silicic acid ethyl ester, consolidation.

Streszczenie. W artykule przedstawiono analizę skuteczności konsolidacji piaskowców na przykładzie dwóch niemieckich piaskowców zawierających różne materiały wiążące – piaskowce Baumberger (wapnisty) oraz Sander (marglisty). Zależnie od zastosowanej obróbki badane piaskowce wykazywały różne właściwości petrofizyczne oraz mechaniczne.

Słowa kluczowe: piaskowiec, wzmocnienie kamienia, ester kwasu krzemowego, konsolidacja.

Sandstones represent important historical as well as still used building materials. Due to time dependent weathering processes, the stone surface and the stone structure lose their strength and as a result, the stone disintegrates [1]. Using stone strengthener based on silicic acid ethyl ester (SAE), sandstones can be conserved [2]. The effectiveness of these conservation actions depends on several factors, e.g. the type of stone and binder, the penetration depth and gel deposition rate of the used SAE and the selected treatment procedure. The aim of this study is to show, how these factors affect the success of a conservation action.

Experimental study

Investigations were carried out on two German sandstone types (Sander Sandstone (SST), Baumberger Sandstone (BST)) consisting of two different binders (clayey, calcareous). They were treated with two different consolidating agents based on SAE (KSE 100, KSE 300) in three different procedures (vacuum impregnation; 1- and 5-time impregnation-by capillary suction over the lower part of the stone samples with a treatment time of 1 hour). The main difference of the selected KSE products is the amount of deposited silica gel (KSE 100: 10%, KSE 300: 30%). Investigations (Figure 1) were performed to analyse differences in strength between treated and untreated material and to show influences of different treatment procedures. The stone samples had a prismatic geometry with the dimensions 50 x 50 x 100 mm. Below, only selected results of BST and SST are presented.

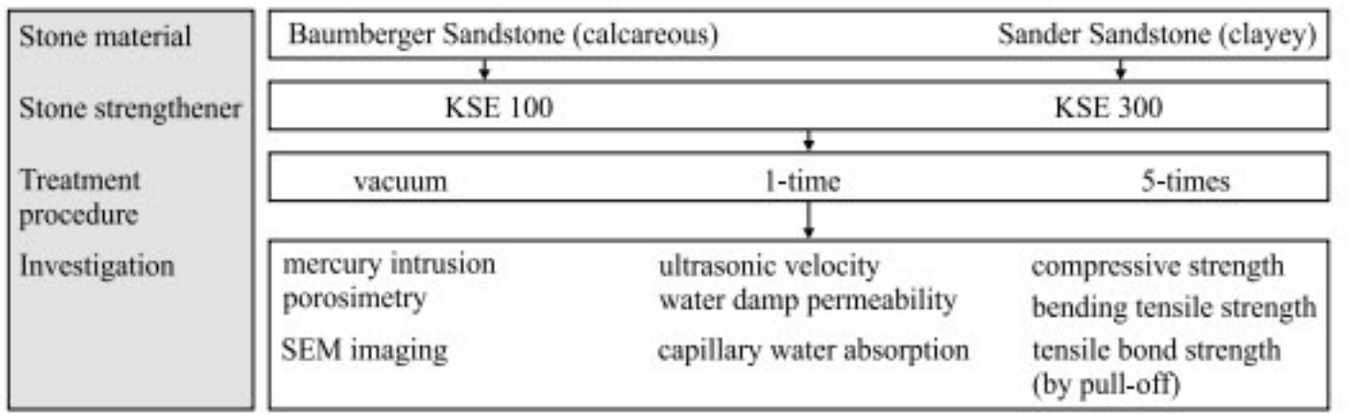

Fig. 1. Stone material, stone strengthener, specific treatment procedures and performed investigations

Rys. 1. Użyty kamień i środek do wzmacniania kamienia, stosowana obróbka oraz przeprowadzone badania

Results

To evaluate the efficiency of a stone consolidation action, the penetration depth and the behaviour of the absorbed stone strengthener in the stone matrix have to be analysed. The capillary water absorption (CWA) as well as ultrasonic velocity and porosity measurements give information about the pore system and its connectivity, so that the absorbed stone strengthener can be detected. Figure 2 presents the area related mass increase respectively the CWA (kg/m²) over time ($h^{0.5}$) for untreated and treated BST samples. The CWA of untreated and 1-time im-

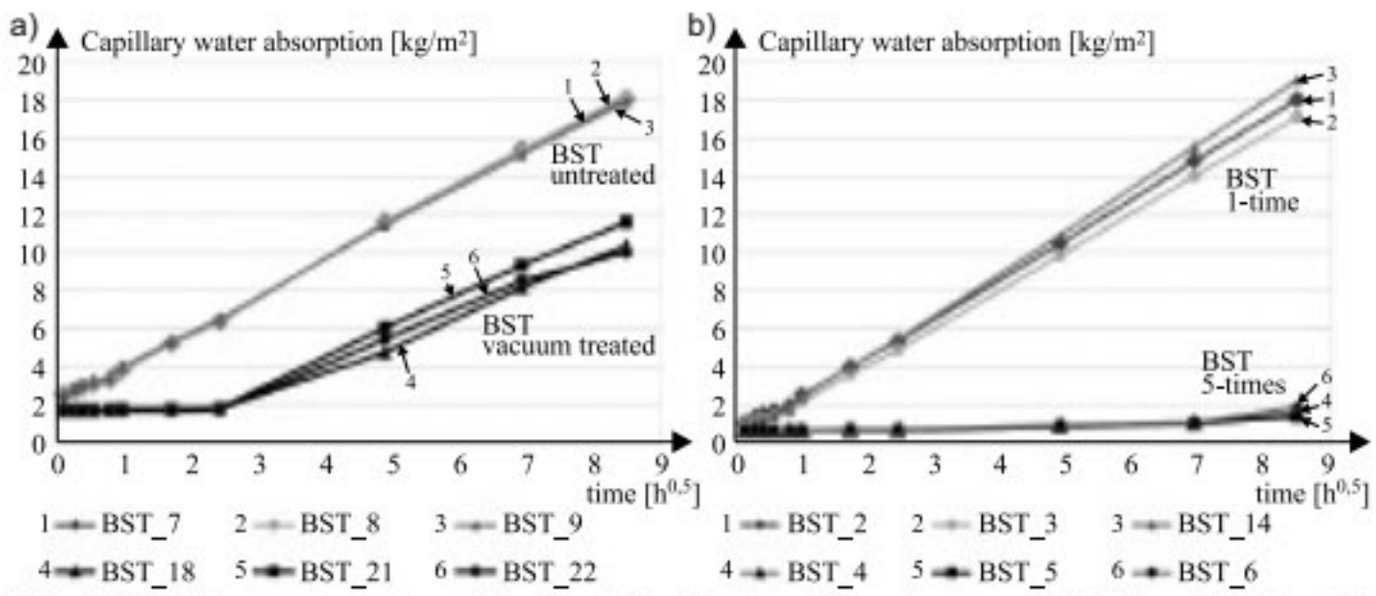

Fig. 2. Capillary water absorption [kg/m²] of untreated and vacuum (a), 1- and 5-time (b) impregnated BST with the stone strengthener KSE 100

Rys. 2. Absorpcja kapilarna wody [kg/m²] piaskowca BST nieimpregnowanego i impregnowanego w próżni (a) oraz impregnowanego 1 i 5 razy (b) środkiem do wzmacniania kamienia KSE 100

[1)] Technische Universität Dortmund, Department of Building Materials
[*)] Adres do korespondencji: jeanette.orlowsky@tu-dortmund.de