COMPREHENSIVE TESTING OF STRUCTURAL POWDER MASS WATER REPELLENTS BASED ON SILICONE

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Abstract

Silicon structural powder mass water repellents become a functional component of a whole variety of modern building materials. The largest application of these admixtures is in a wide range of dry mortar mixtures. The current technical standards do not provide a methodology for reliable measurement of their hydrophobic effect. Methodology for determination of durability and effect of these admixtures to materials where they are applied, has not been assessed, either. Thus, this work is devoted to compilation a methodology for a comprehensive testing of structural powder mass water repellents by means of both load and application way with the help of laboratory-simulated and real climatic conditions. The attention in this paper was particularly paid on water repellents based on silicon. However, the all research has been also focused on their comparison with waterproof metallic soaps and substances based on hydrophobised polyvinyl acetates.

Key words

powder mass water repellents, silane, siloxane, metal soaps, oleate, stearate

Introduction

Powder structural mass water repellents are an integral active compound of many products from an assortment of dry mortar admixtures. They provide their hydrophoby, increased durability, decreased origination of efflorescence on their surface, and also provide further functions improving these products. These include applications in the jointing materials, coating isolations, sanitation mortars, wide variety of mineral polymer/silicate plasters, and purely polymer plaster pastes.

Structural powder mass water repellents can be divided from a chemical point of view into the following groups:

- Oleate
- Stearate
- Mixed products (Oleate + Stearate)

- Silicone based (Silane/Siloxane)
- Hydrofobized polyvinylacetate based binders

Current test standards do not include procedures for obtaining information on the effectiveness and durability of structural powder mass water repellents, we can only use current basic test methods for testing mortars and concretes (Fig. 1) providing an overview of the impact of water repellents on volume mass, air content, and consistency of a fresh mortar. Furthermore, we can determine an effect of water repellents on mechanical properties of mortars and water vapour permeability. The main observed quantity is, of course, minimisation absorptivity of a hydrophobised mortar which can be verified by whole-body or surface methods.

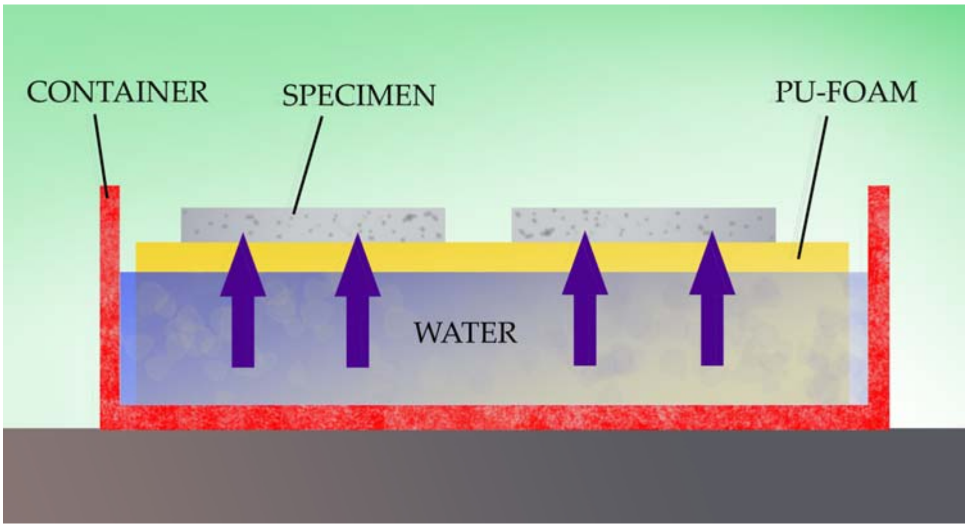

Fig. 1 *Surface Water-uptake method according to UNI 10859 (similar to DIN 52617). (The test specimen were dried in an oven and then kept on water saturated polyurethane soft foam (density 25-30 g/l). The water absorption is determined in mg/cm² by weighing the specimen after 10 min, 20 min, 30 min, 60 min, 4 h, 6 h, 24 h, 48 h, 72 h.) [1]*

Standart methods of durability testing

These basic methods, however, do not provide predicative information about development of these substantial quantities in time and, thus, a capacity of hydrophobic effect as well. We can use standard methods for verification of durability for this, namely

a) frost-proof (change of water uptake and mechanical strength after frost and thaw cycles),
b) resistance againts frost in the presence of defrosting desolved salts (quality hydrofobizer have to stop transportation of salts into or out of mortar) – Fig. 2 and Fig. 3,
c) resistance against cycling of drying and getting wet (risk of leaching of hydrofobizer from mortar) – Fig. 4.

Fig. 2 *Cement mortar with Ca Stearate after 50 frost/defrost cycles in presence of salts*

Fig. 3 *Cement mortar without hydrofobizer after 50 frost/defrost cycles in presence of salts*

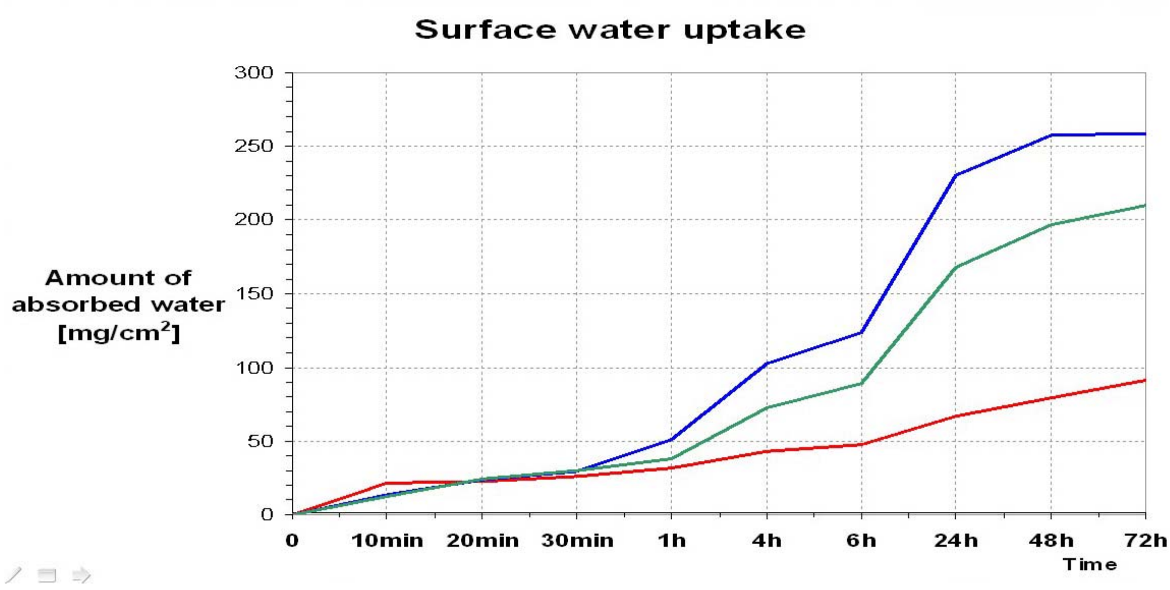

Fig. 4 *Illustrating example of losing of hydrophobic effect after 1st (red line), 4th (green line) and 5th (blue line) repeating of Surface Water-uptake metod*

However, even these methods are not entirely predicative because real load acting on hydrophobised products is a synergy of all weather conditions (frost, rain, condensation, presence of salts, temperature changes, solar UV radiation, mechanical water erosion, and cyclic soaking with water and drying).

Therefore, our effort is to establish a test procedure exposing hydrophobised mortars to all of these effects and thus give a quality overview of individual powder structural water repellents.

Complex endurance test

A new comprehensive method of testing durability consists of two parts:

Application test

Water repellents are applied to a mixture of a real product where they interact with additives and polymers. Testing begins already 3 to 4 days after batching. Three sets of samples are made (a Q-UV test set, a reference set, and a set exposed to an actual climate).

The implementation of application test consists in an application of mortars (Table 1) on the test plates which are subsequently placed in the Q-UV apparatus (Fig. 5). The device is able to simulate cyclic exposure to solar UV radiation, condensation of air humidity, and simulation of wind-driven rain by water nozzle washing.

Application test has 2 main outputs:

a) Visual comparison of the Q-UV tested samples, the samples subjected to a climate, and reference samples (range of salt efflorescence and change of mortar colour).

b) Mutual comparison of the samples by measuring the surface absorptivity.

LIST OF Q-UV TESTED HYDROFOBIZERS (APPLICATION TO THE RED PIGMENTED CEMENT PLASTER WITH POLYMER BINDER MODIFICATION)

Table 1

No.	symbol	characterization	dosage (%)
1	REF	blend without hydrofobizer	-
2	Sil 1	monofunctional silicone based hydrofobizer	0.5
3	Sil 2	monofunctional silicone based hydrofobizer	0.5
4	Sil 3	monofunctional silicone based hydrofobizer	0.5
5	Sil 4	monofunctional silicone based hydrofobizer	0.5
6	NaO	90% Natrium oleate	0.5
7	Sil 5	silicone based anti-efflorescence hydrofobizer	0.5
8	Sil 6	silicone based anti-efflorescence agent	0.5
9	H-PVA	water repellent polymer binder (PVA based)	1.2*

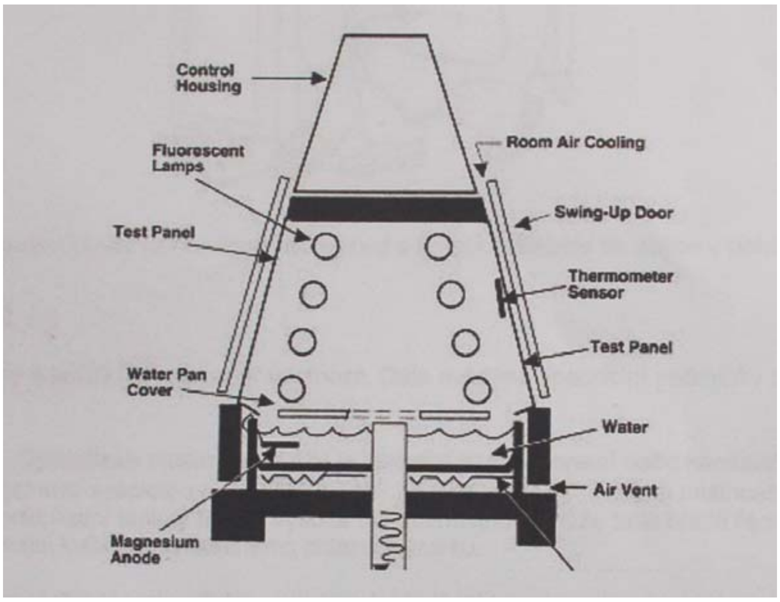

Fig. 5 *Scheme of Q-UV apparatus*

Comprehensive loading test (CLT)

The comprehensive loading test consists in cycling extreme climatic conditions. Samples of hydrophobised mortars are immersed in water for 4 hours, then frozen at -20 °C for 4 hours, and then dried at a temperature of 65 °C [2]. A simple silicate system, in which there is no reaction with the additives, is used for the production of samples. A dose of water repellents is chosen unified for all compared types (Table 2).

The following physico-mechanical characteristics of mortars are tested after 0, 20, 40, and 80 cycles of a comprehensive load test:

- Whole cubature water up-take after 24hours
- Surface water up-take (UNI 10859) – Fig. 7
- Compressive strength – Fig. 6
- Tensile strength.

The current experiment focuses on the comparison of mono-functional water repellents on basis of silane / siloxane [3]. The attention in the next step will be devoted to testing of metallic soaps.

LIST OF HYDROFOBIZERS IN CLT Table 2

No.	symbol	characterization	dosage (%)
1	REF	blend without hydrofobizer	-
2	Sil 1	monofunctional silicone based hydrofobizer	0.5
3	Sil 2	monofunctional silicone based hydrofobizer	0.5
4	Sil 3	monofunctional silicone based hydrofobizer	0.5
5	Sil 4	monofunctional silicone based hydrofobizer	0.5

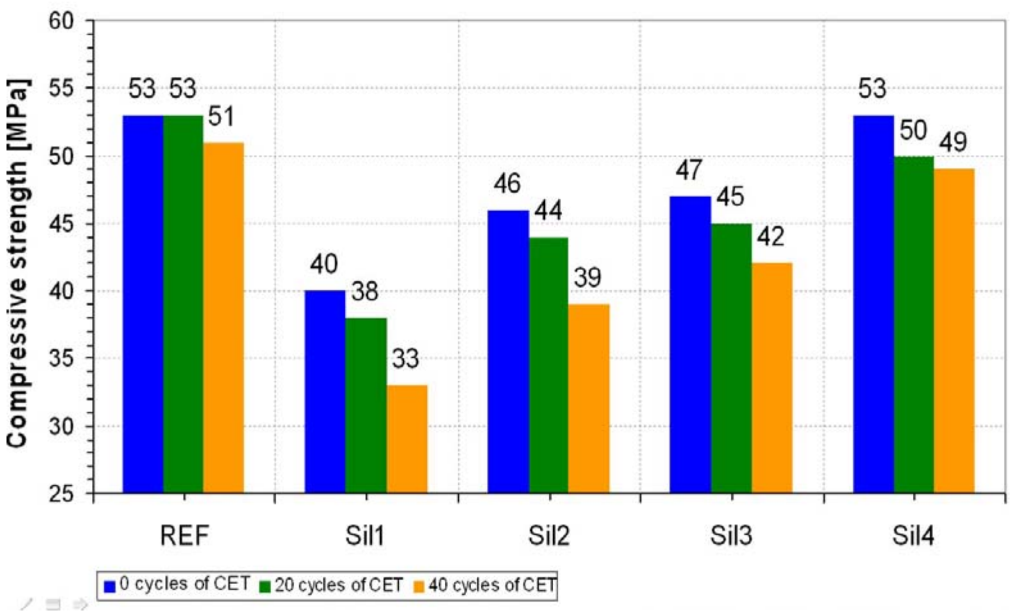

Fig. 6 *Progression of compressive strength after 0.20 and 40 cycles of CLT*

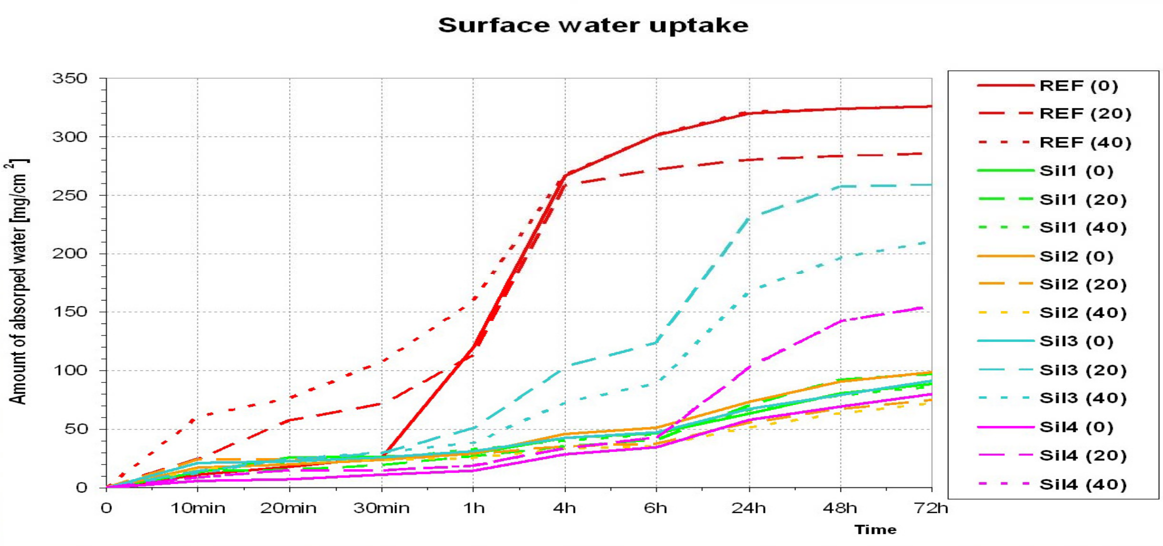

***Fig.** 7 Surface water up-take (UNI 10859) of compared monofunctional silicone based hydrofobizers after 0, 20, 40 cycles of CLT*

Conclusions

The work deals with the methodology for a comprehensive testing of structural powder mass water repellents by means of load and application way with the help of laboratory-simulated and real climatic conditions. From the material point of view, the research was focused on water repellents based on silicon. The material properties of these repellents were compared with properties of waterproof metallic soaps and substances based on hydrophobised polyvinyl acetates.

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References:

[1] QUADRELLI, M., KÖNIG, F., ROOS, M., STADTMUELLER, S., WEYERSHAUSEN, B.: *New powdery water repellents for dry mortar application.* Dry mortar yearbook 2007

[2] NOVÁČEK, J.: *Ověření účinnosti hydrofobizačních přísad určených ke strukturální hydrofobizaci silikátových maltových směsí: diplomová práce.* Brno, 2008. 66 s. Vysoké učení technické v Brně. Fakulta stavební. Ústav technologie stavebních hmot a dílců.

[3] Technical sheets of compared mass water repellents