TÜV Rheinland LGA Products GmbH
Chemie Nürnberg

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Test Report
No.: 1060971

Die Steinwerkstatt Weiler GmbH
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Client:	See addressee
Order date:	22 April 2010
Order content:	Determination of the stability of Maggia-Gneiss natural stone when used in swimming pools
Samples received:	26 May 2010
Evaluation carried out:	31 May until 28 June 2010
Number of attachments:	-

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In a letter dated 22 April 2010, the Nürnberg Chemistry Department of TÜV Rheinland LGA Products GmbH was commissioned to examine the samples of (Maggia-Gneiss) natural stone provided by the client in relation to their suitability for use in a swimming pool.

Scope and methods of investigation

Preparation of samples

When viewed under a microscope, the surfaces of the stone samples reveal individual loose particles which can be removed using a brush. The samples were therefore brushed off using a stiff brush, cleaned with deionised water and dried at 105°C in a drying cabinet.

Chlorine resistance

There are currently no norms or guidelines that cover the investigation of the chlorine resistance of stone. For the test, two samples were dried for 24 hours in a drying cabinet at a temperature of (105 ± 5) °C until constant mass solids content was reached. A container was then filled with sodium hypochlorite solution with a free chlorine content of 7000 mg/l and the samples placed in this solution. Half of each sample was immersed in the solution while the other half was exposed to the air in the steam chamber. The container was then sealed in order to prevent the concentration of the highly volatile chlorine from decreasing too rapidly. After 21 days, the samples were examined under a direct light microscope and the difference in mass was measured.

Crystallisation experiment using sodium sulphate in accordance with DIN EN 12370

The crystallisation experiment carried out using a 14% $Na_2SO_4.10H_2O$ solution is designed to assess a natural stone's resistance to weathering. The experiment exposes the samples to internal stresses which are exerted by crystallisation pressure. These stresses occur because pure sodium sulphate crystallises anhydrously at temperatures above 32.4°C and re-crystallises into Glauber's salt, with 10 water molecules and a considerable increase in volume, at low temperatures.
Five of the stone samples provided by the client were tested over 15 cycles in accordance with the above mentioned norm. After the experiment, changes in weight were measured and changes in the surface condition of the stone were examined with the naked eye and under a microscope.

Findings

Chlorine resistance

Sample Name	Dry weight (m_0)	Dry weight (m_1)	Weight change (%)
Sample 1	522.99	523.01	< 0.01
Sample 2	520.41	520.49	< 0.01
Sample 2	529.12	529.16	< 0.01
		Average value	< 0.01

Crystallisation experiment with sodium sulphate in accordance with DIN EN 12370 using a 14% $Na_2SO_4.10H_2O$ solution

Sample number	Dry weight (m_0)	Dry weight (m_1)	Weight change (%)
Sample I	530.75	530.07	- 0.13
Sample II	526.37	525.68	- 0.13
Sample III	531.94	531.26	- 0.13
Sample IV	529.37	528.75	- 0.12
Sample V	526.13	525.52	- 0.12
		Average value	-0.13

Summary

The experiments carried out revealed the following:

Chlorine resistance

Chlorine, in the form of chlorine gas, hypochlorite or hypochloric acid or chlorine dioxide, is used to disinfect the water in swimming pools. The most common form of disinfection is so-called chlorination, which involves the use of automated devices to maintain a steady supply of chlorine to the water, thus ensuring that the concentration of chlorine in the water remains constant.
DIN 19 643 Part 1 sets out the following **limits** for the amount of free chlorine in swimming pool water:

- General: 0.3-0.6 mg/l Cl_2
- Heated whirlpools: 0.7 – 1.0 mg/l Cl_2

The experiment using sodium hypochlorite solution with a free chlorine content of 7000 mg/l (a concentration 7000 – 10000 times higher than the allowed maximum content) revealed no significant changes in weight over a 21 day period. The surfaces which were immersed in the solution lost a little of their sheen and became slightly lighter in colour. It is not expected that this loss of sheen or lightening will occur in “normal” swimming pool water.

Crystallisation experiment with sodium sulphate in accordance with DIN EN 12370

The crystallisation experiments revealed only slight changes in weight after 15 cycles. No significant changes were observed on the surfaces of the samples.
The stone did begin to crumble very slightly during the test; however, under “normal conditions” this process will occur in only very attenuated fashion. Nevertheless, provision should be made for additional pool and filter cleaning.

The Maggia-Gneiss natural stone successfully passed all the tests performed. Changes in weight were only very slight. No significant changes in the surface condition were observed.

Based on these experiments, Maggia-Gneiss natural stone can currently be considered resistant to both swimming pool water and chlorine.

No conclusions can be drawn from these results with regard to the long-term characteristics of the stone in relation to the above influences. Given the wide variety of possible influences, any attempt to simulate the weathering process of stone over a short time in the laboratory must be limited to imitating individual factors. The significance of such experiments must therefore always be qualified.

Nürnberg, 29 June 2010

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