

SlagSil

SYSTEM

System for efflorescence-free and resistant concrete components



Water permeable stone with Maleki-SlagSil



Water permeable stone without Maleki-SlagSil

Maleki-SlagSil

| What is Maleki-SlagSil?

SlagSil is the result of 4 years of research and development on a new concrete formulation. The result of the investigations carried out on pavers, precast concrete parts and pavement slabs is a unique formulation of the concrete, which has the following advantages:

- Efflorescence-free paving stones or concrete parts
- Permanently improved salt water resistance
- Improved freeze-thaw resistance
- Higher compressive strength
- Earlier stackability (for paving stones)
- Increase in early strength
- Permanently improved acid resistance
- Environmentally friendly use of raw materials

What is Maleki-SlagSil?

SlagSil is a stoichiometrically adapted concrete formulation. With the use of extra-adapted GGBS (Grand granulated blast furnace slag) and our liquid silicate Maleki-DW 100, it is possible to replace cement and at the same time to achieve some interesting advantages that have not been possible until now. In this formulation, cement particles in the concrete are replaced by GGBS in a ratio of 1: 1.

The remuneration of mortars or concrete with GGBS or other secondary raw materials, however, requires the most exact adjustment to the particular application in order to achieve an optimum result. GGBS is a latent hydraulic raw material, which reacts very slowly and thus takes more time to develop its compressive strength than Portland cement.

With the stoichiometrically matched combination of cottage sand and our liquid silicate activating agent Maleki-DW 100, even higher compressive strength is achieved and the product also has the above-mentioned advantages. Maleki-DW 100 is added simultaneously with the mixing water to the concrete mix.

Maleki-SlagSil

| Concrete improvement with secondary raw materials



Concrete remuneration with secondary raw materials - Maleki technology for sustainable construction

Since our foundation in 2007 as Maleki GmbH, we have mainly occupied ourselves with the effective use and the associated upcycling of a wide range of secondary raw materials, and this is internalized as part of our company philosophy. The goal is both the reduction of carbon dioxide emissions and the production of high-quality construction products for a wide range of applications.

SlagSil is an important component in mortars and concrete to ensure enduring protection.

Cement-based materials such as concrete have the strength-giving calcium silicate hydrates (CSH) and $\text{Ca}(\text{OH})_2$ (portlandite) after curing or hydration. While portlandite plays an important role in the reinforcement of reinforced concrete, it is also responsible for unwanted concrete corrosion. Acids can dissolve $\text{Ca}(\text{OH})_2$ into salts which occur on the surface as efflorescences. The most efficient protection of the materials described is the conversion of concentrated calcium ions into stable calcium silicate hydrate phases, which are permanently resistant to pollutants. The transformation of the molecular structure is achieved by a specially coordinated binder system. The proportion of portlandite in the end product is effectively reduced to a minimum and the resistance to various corrosive influences is significantly increased. This effect could be demonstrated by means of X-ray analysis in cooperation with external test sites.



Maleki-SlagSil

| Improved acid resistance



Prüfbericht
Nr. 160502-28-MAL-16-05

Table 1: Results of the University of Siegen: Portlandite content of concrete samples with and without SlagSil and linking with the tendency to white efflorescence on the concrete surface

	Portlandit concentration of the final product	Efflorescences on the surface
With Maleki-SlagSil	0,3 %	No
Without Maleki-SlagSi	2,8 %	Yes

Improved acid resistance

Concrete slabs without Maleki-SlagSil (left) and with Maleki-SlagSil (right) after 120 days of storage in 0.5% sulfuric acid. In the left sample, the damaged concrete surface is clearly visible. The conventional formulation provides a weak surface for corrosive substances.

After the acid deposition, there is no damage to the concrete structure in the treated specimen. The Maleki-SlagSil System effectively protects the concrete from damaging influences by adapting the formulation.



Untreated test object



Treated test object

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| Reduction of efflorescence



Table 2: Results of the quantitative phase analysis using the Rietveld method (in% by mass)

Sample title	Quartz	Alkali feldspars	Calcite	Portlandite	Overview
IWKS	SiO ₂	(K/Na)AlSi ₃ O ₈	CaCO ₃	Ca(OH) ₂	Mineral content
Industrial Paving stones (zero-sample)	81,3	0,9	11,4	2,9	3,5
Industrial paving stones with SlagSil	73,4	7,5	-	0,2	18,9
Water permeable stones (zero-sample)	79,7	1,3	10,8	3,6	4,6
Water permeable stones with SlagSil	66,6	4,6	2,9	0,2	25,7

In contrast to cement, a latent-hydraulic binder cannot react with water alone, but requires activation by other substances. When Maleki-DW 100 is added simultaneously to the mixing water, the sand is stimulated. By this excitation and chemical character, free Ca-ions are bound to calcium silicate hydrates (CSH). This achieves the above-mentioned advantages. Similar hardening processes (CSH phases) take place in the GGBS instead of as in the case of Portland cement, but no excess Ca-ions are formed here. Portlandite, or calcium hydroxide, is a surplus product that arises during the hardening of the Portland cement. Due to its reactivity, the portlandite is the main target for aggressive media. In the course of the useful life of a building or component, Ca-salt in the form of white efflorescence on the concrete surface is formed due to the carbonation reaction of the portlandite or by salt or acid stress. As a result of the surplus of portlandite, corrosive damage / weathering reactions occur as a result of acid attacks or insufficient freeze-thaw resistance.

Maleki-SlagSil

| Improved freeze-thaw resistance

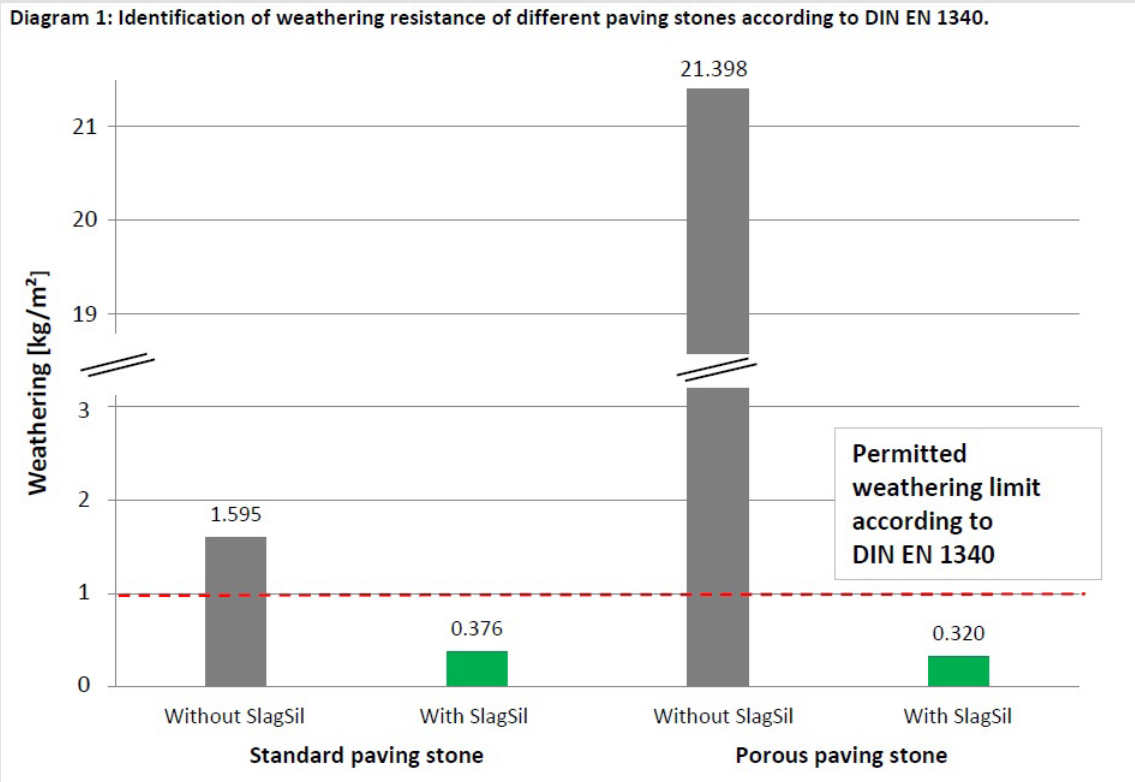


Table 2: Results of weathering test according to DIN EN 1340

	Standard paving stone	Porous paving stone
With SlagSil	Test passed (0.376 kg/m ²)	Test passed (0.320 kg/m ²)
Without SlagSil	Test failed (1.595 kg/m ²)	Test failed (21.398 kg/m ²)

In the SlagSil system, on the other hand, the portlandite serves to stimulate the GGBS and is used up during the hardening process. This can effectively utilize the actually harmful excess from cement curing. In this way, it is possible to significantly reduce the cement content in the concrete or mortar since the GGBS also contributes to strength. The hardening of GGBS leads in most cases to a denser pore structure and therefore to a higher strength compared to conventional portland cement

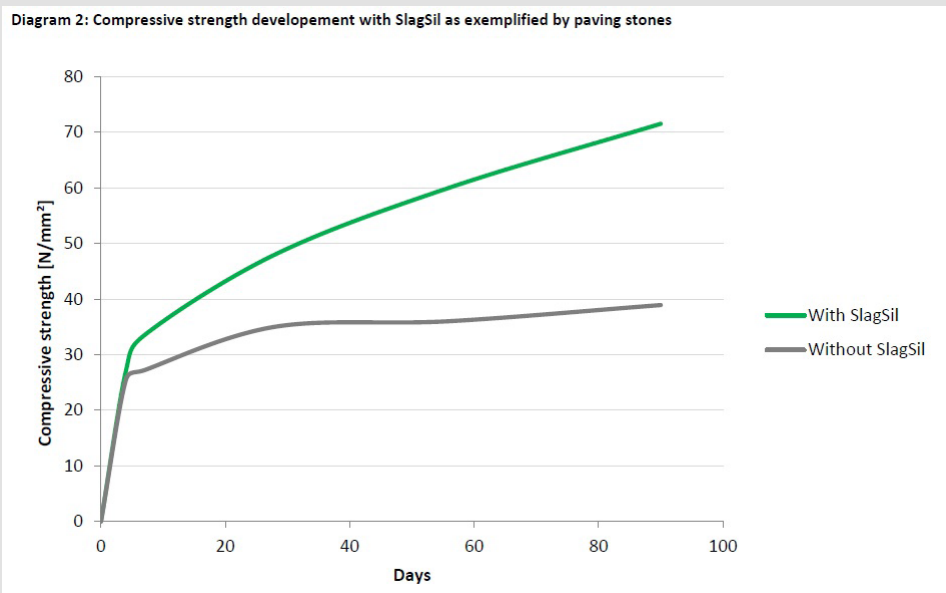
Maleki-SlagSil

| Increase of compressive strength & reduction of cement



Application in the factory

The addition of GGBS and Maleki-DW 100 leads to the effective reduction of the portlandite content in dry mortar as well as in concrete, thus increasing the chemical and physical resistance. Due to the prolonged curing, firmer, denser and, above all, more stress-relieving products can be developed. The remuneration of mortars or concrete with GGBS or other secondary raw materials, however, requires the most exact adjustment to the particular application in order to achieve an optimum result. Maleki-DW 100 is added simultaneously to the mixing water during the production process and can thus be used without much effort. The silicate ingredients can thus act from the beginning in the entire product.



Without Maleki-SlagSil

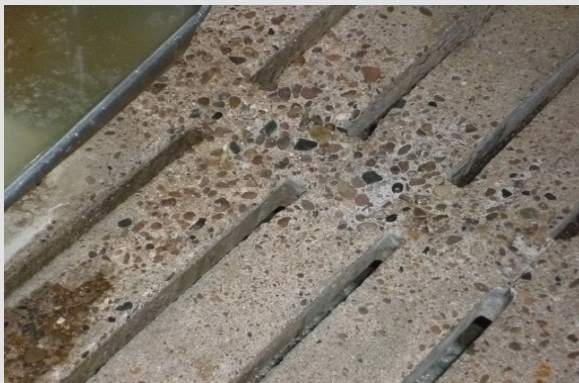


With Maleki-SlagSil

Maleki-SlagSil

| Concrete improvement with secondary raw materials

Subsequent and complex treatment with various coating and impregnation materials is therefore no longer necessary. Conventional silane-siloxane-based impregnating agents also provide only a superficial hydrophobicity and do not permanently protect them. The addition of Maleki-DW 100 accelerates the curing of the concrete. The waiting times to the stackability of the final finished product can be reduced by more than 50% depending on the formulation. This makes production and storage much more effective. Maleki GmbH is a service provider for the formulation and optimization of your formulation. In addition to the simple reduction of Portland cement, specific properties can also be optimized.



Split tiles without Maleki-SlagSil



Split tiles with Maleki-SlagSil

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