MALEKI SLAGSIL

MALEKI
GREEN BUILDING PRODUCTS

Durable and eco-friendly concrete

Maleki-SlagSil

www.malekigmbh.com

Innovative and sustainable

Maleki-SlagSil

What is Maleki-SlagSil?

Maleki-SlagSil is the result of 4 years of research and development on a new concrete formulation. The results of the tests carried out on paving stones, precast concrete elements and concrete split slabs have led to a unique concrete formulation with outstanding properties:

- Permanently improved acid resistance
- Long-term resistance to salt water
- Improved freeze-thaw and de-icing salt resistance
- Earlier stackability (for paving stones)
- Maintenance of early strength, higher final strength
- Reduces shrinkage and uncontrolled expansion
- Concrete or concrete components free from efflorescence
- Environmentally friendly use of raw materials

What is Maleki-SlagSil?

Maleki-SlagSil is a specially developed binder system that combines granulated blast furnace slag and Maleki silicate activation technology. With the aid of our silicate activator Maleki-SA 200, it is possible to replace cement whilst achieving a number of interesting benefits that were previously not possible on a permanent basis. In this formulation, the cement content in the concrete is replaced 1:1 by granulated blast furnace slag (GGBS). However, the addition of GGBS or other secondary raw materials to mortars and concrete requires extremely precise adjustment to the specific application in order to achieve an optimal result.

GGBS is a latent-hydraulic raw material which reacts very slowly and therefore requires more time to develop its compressive strength than Portland cement. The stoichiometrically adjusted combination of GGBS and our liquid silicate activator Maleki-SA 200 increases, amongst other things, the resistance and durability of the concrete, whilst also offering further benefits. To achieve this, Maleki-SA 200 is dissolved in the mixing water and added to the concrete mix in this form.

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Concrete improvement with secondary raw materials

Concrete improvement with secondary raw materials – Maleki technology for sustainable construction

Since its foundation in 2007, Maleki GmbH has focused primarily on the effective use and associated upcycling of a wide variety of secondary raw materials, and has made this an integral part of its corporate philosophy. In addition to reducing carbon dioxide emissions, the company has set itself the goal of developing and manufacturing environmentally friendly, high-quality building products.

Maleki-SlagSil as an important part in mortars and concrete to ensure permanent protection

Once cement-based materials such as concrete have set or undergone hydration, they contain, amongst other things, the strength-giving calcium silicate hydrates (CSH phases) and $Ca(OH)_2$ (portlandite). Whilst portlandite plays an important role in protecting the reinforcement from corrosion in reinforced concrete, it is also responsible for undesirable concrete corrosion. Acids can react with portlandite to form calcium salts, which appear as efflorescence on the concrete surface. The most effective protection for the materials described lies in the conversion of the concrete's own calcium ions into stable CSH phases that are permanently resistant to harmful substances. This transformation of the molecular structure is achieved through a specially formulated binder system. In this process, the proportion of Portlandite in the final product is effectively reduced to a minimum, whilst resistance to a wide range of corrosive influences is significantly increased. This effect has been verified by X-ray analysis in collaboration with external testing laboratories.

Dauerhaft und beständig

Maleki-SlagSil

Improved acid resistance

Universität Siegen

Prüfbericht Nr. 160502-28-MAL-16-05

Table 1: Portlandite content (in % by mass) of concrete samples with and without SlagSil und link to the tendency for white efflorescence to form on the concrete surface.

	Portlandite in final product	Efflorescence on the surface
With SlagSil	0.3 %	No
Without SlagSil	2.8 %	Yes

Improvement in acid resistance

Concrete split slabs without SlagSil (left) and with SlagSil (right) after 120 days of storage in 0.5 % sulfuric acid. In the left-hand sample, the damaged concrete surface is clearly visible. The conventional formulation provides a surface for corrosive substances to attack. In the case of the optimised concrete mix, there is no damage to the concrete structure. The Maleki-SlagSil System effectively protects the concrete against harmful effects.

Without SlagSil

With SlagSil

Maleki-SlagSil

Reduction of efflorescence

Fraunhofer ISC
PROJEKTGRUPPE IWKS

FRAUNHOFER-INSTITUT FÜR SILICATFORSCHUNG
FRAUNHOFER-PROJEKTGRUPPE FÜR WERTSTOFFKREISLÄUFE UND RESSOURCENSTRATEGIE IWKS

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

Sample name	Quartz	Alkali feldspars	Calcite	Portlandite	Other minerals
	SiO_2	$(K/Na)AlSi_3O_8$	$CaCO_3$	$Ca(OH)_2$	
Industrial paving stone (Reference)	81.3	0.9	11.4	2.9	3.5
Industrial paving stone With SlagSil	73.4	7.5	-	0.2	18.9
Porous stones (Reference)	79.7	1.3	10.8	3.6	4.6
Porous stones with SlagSil	66.6	4.6	2.9	0.2	25.7

Unlike cement, a latent-hydraulic binder cannot react with water on its own, but requires activation by other substances. When Maleki-SA 200 is added to the mixing water, GGBS is activated. Through this activation and the chemical properties of the activator, free calcium ions are converted into CSH phases. This results in the advantages already mentioned. Similar hardening processes (CSH phases) take place in GGBS as in Portland cement; however, no excess calcium ions are produced here, such as in the form of portlandite. Due to its reactivity, portlandite is the main target for attack by aggressive media. Over the course of a structure's or component's service life, insoluble calcium salts form as a result of the carbonation reaction of portlandite or due to salt or acid exposure; these manifest as white efflorescence on the concrete surface. As a result of the excess portlandite, corrosion damage and weathering reactions occur later on, caused by acid attack or insufficient resistance to frost and de-icing salt.

Widerstandsfähig und robust

Maleki-SlagSil

Improved freeze-thaw resistance

Diagram1 1: Identification of weathering resistance of different paving stones according to DIN EN 1340.

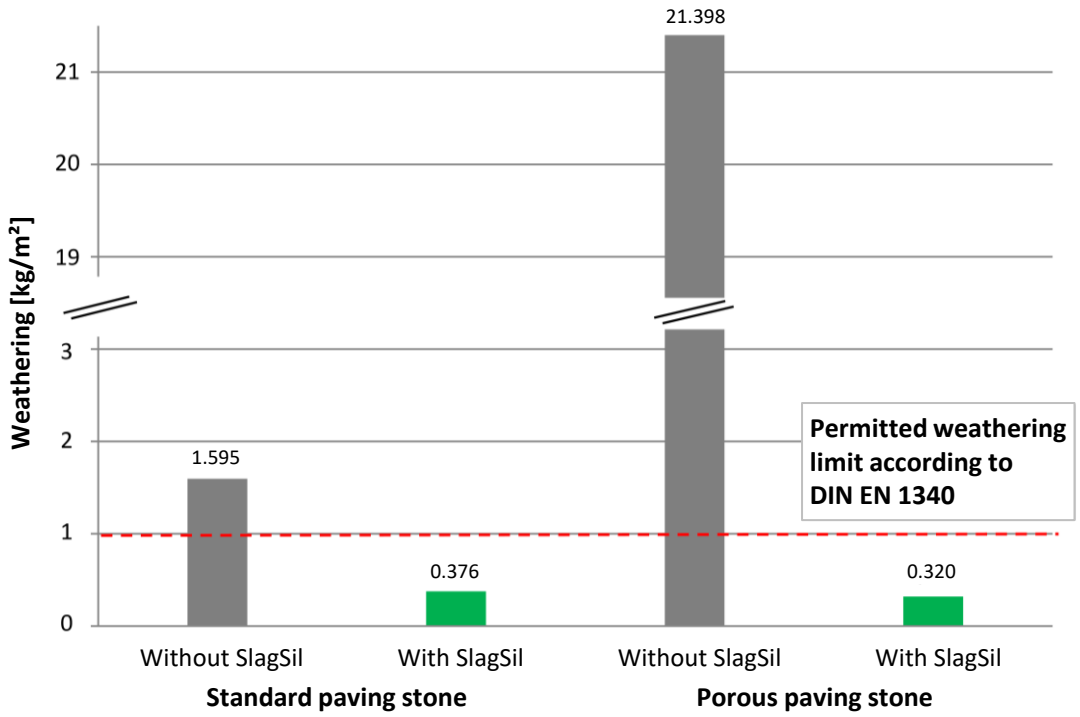

Table 3: Results of weathering test according to DIN EN 1340

	Standard paving stone	Porous paving stone
With Maleki-SlagSil	Test passed (0.376 kg/m²)	Test passed (0.320 kg/m²)
Without Maleki-SlagSil	Test failed (1.595 kg/m²)	Test failed (21.398 kg/m²)

In the SlagSil-System, Portlandite serves to activate GGBS and is itself consumed during hardening. This allows the normally harmful by-products of cement hardening to be put to effective use. In this way, it is possible to significantly reduce the cement content in concrete or mortar, as GGBS also contributes to strength. In most cases, the hardening of GGBS, due to a longer post-hardening period, results in a denser pore structure and thus greater strength compared with conventional Portland cement (Diagram 2).

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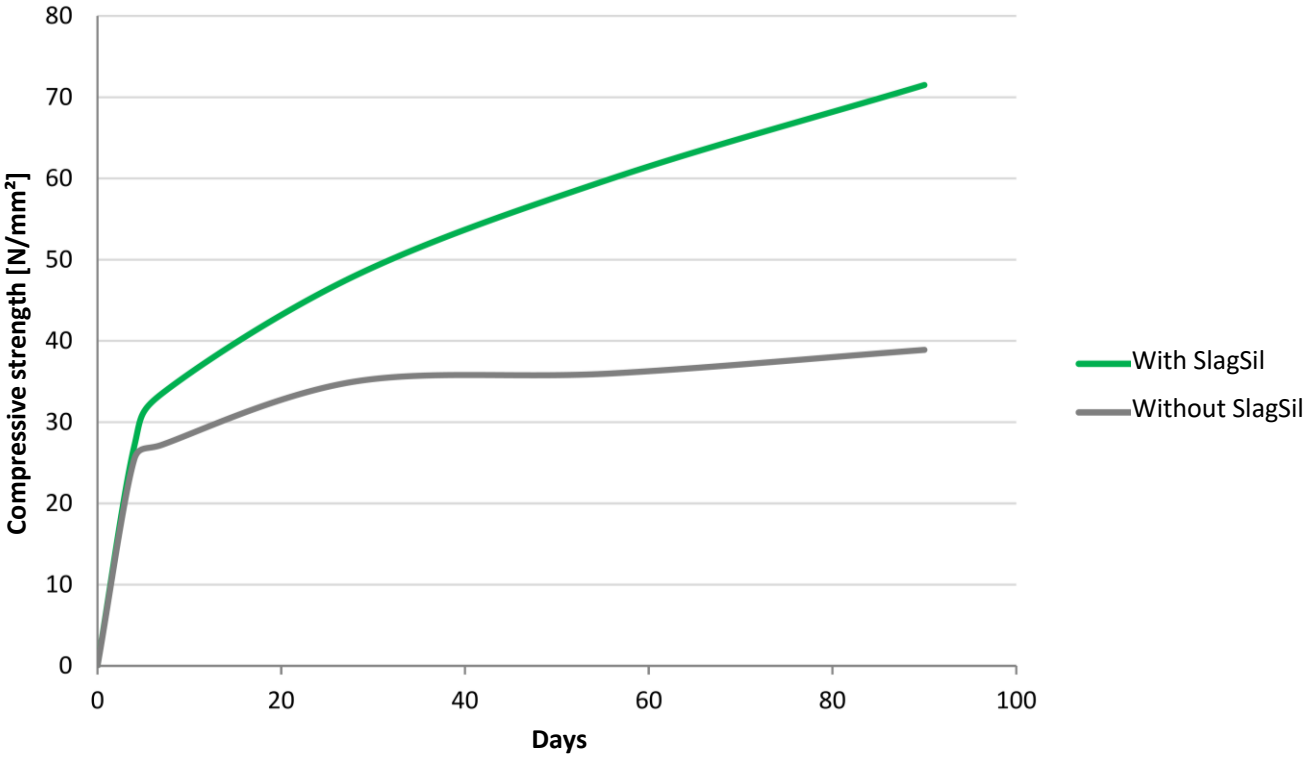
Increase of compressive strength & reduction of cement

Application in the factory

The addition of GGBS and Maleki-SA 200 leads to an effective reduction in the Portlandite content in both dry mortar and concrete, thereby increasing their chemical and physical resistance. The prolonged curing process enables the production of stronger, denser and, above all, lower-stress products. However, the addition of GGBS or other secondary raw materials to mortars or concrete requires extremely precise adjustment to the specific application in order to achieve an optimal result. Maleki-SA 200 is added to the mixing water during the production process and can therefore be used with minimal effort. This allows the silicate constituents to be effective throughout the product right from the start.

Diagram 2: Compressive strength development with SlagSil as exemplified by paving stones.



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Concrete improvement with secondary raw materials

Subsequent and complex treatment with a wide variety of coating and impregnating agents is therefore no longer absolutely necessary. Furthermore, conventional silane/siloxane-based impregnating agents only provide superficial hydrophobicity and do not offer permanent protection. The addition of Maleki-SA 200 initially accelerates the curing of the concrete. Depending on the formulation, the waiting times until the finished end product can be stacked may be reduced by more than 50%. This allows production and storage to be organised much more effectively. Maleki GmbH sees itself as a service provider for the adjustment and optimisation of your formulation. In addition to simply reducing the Portland cement content, specific properties can also be optimised in a targeted manner.

Split slabs without Maleki-SlagSil

Split slabs with Maleki-SlagSil

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