

ENVIRONMENTAL PRODUCT DECLARATION

in accordance with ISO 14025 and EN 15804

Owner of the Declaration	Bundesverband Kalksandsteinindustrie e.V. (Registered Association of German Calcium Silicate Producers)
Publisher	Institut Bauen und Umwelt e.V. (IBU)
Programme holder	Institut Bauen und Umwelt e.V. (IBU)
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Valid to	02.03.2021

Calcium silicate masonry units

Bundesverband Kalksandsteinindustrie e.V.
(Registered Association of German Calcium Silicate Producers)

www.bau-umwelt.com / <https://epd-online.com>



1. General information

**Bundesverband
 Kalksandsteinindustrie e.V.
 (Registered Association of German
 Calcium Silicate Producers)**

Programme holder

IBU – Institut Bauen und Umwelt e.V.
 Panoramastr. 1
 10178 Berlin
 Germany

Declaration number

EPD-BKS-20160002-IAE1-EN

This declaration is based on the Product Category Rules:

Calcium silicate masonry units, 07.2014
 (PCR tested and approved by the Council of Experts (CoE))

Issue date

03.03.2016

Valid to

02.03.2021

Prof. Dr.-Ing. Horst J. Bossenmayer
 (President of Institut Bauen und Umwelt e.V.)

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Calcium silicate masonry units

Owner of the Declaration

**Bundesverband Kalksandsteinindustrie e.V.
 (Registered Association of German Calcium
 Silicate Producers)**
 Entenfangweg 15
 30419 Hanover
 Germany

Declared product / Declared unit

1 tonne calcium silicate masonry units

Scope

Specific data from the plants organised in the Bundesverband Kalksandsteinindustrie e.V. (Registered Association of German Calcium Silicate Producers) was averaged as a basis. The Ecological Analysis comprises the recovery of raw materials and energy, raw material transport and the actual manufacturing phase for calcium silicate masonry units in gross density class 1.8.

The data is representative of production by the federal association. This average based on annual production volume for 2014 by the plants of the federal association. The owner of the Declaration is liable for the information and evidence on which it is based; IBU has no liability with regard to manufacturer's information, LCA data and evidence.

Verification

The DIN EN 15804 CEN standard serves as the core PCR.

Independent verification of the Declaration according to /ISO 14025/

internal external

Patricia Wolf,
 (Independent verifier appointed by the CoE)

2. Product

2.1 Product description

The products analysed in the LCA are average unreinforced blocks of various sizes made of calcium-silicate. Calcium-silicate is part of the group of steam-hardened building materials. The data is representative of production by members the federal association. The average was based on the annual production volume for 2014 by the plants of the federal association.

2.2 Application

Blocks for load-bearing and non-load-bearing walls

2.3 Technical data

Structural data

Description	Value	Unit
Gross density	1200 - 2600	kg/m ³
Stone compression strength class	10 - 60	N/mm ²
Thermal conductivity to /EN 1745/ P90	0.33 - 1.3	W/(mK)
Water vapour diffusion resistance factor to DIN 4108-4	See below	-
Moisture content at 23 °C, 80% humidity	2 - 3	% by mass

Water vapour diffusion resistance factor m as per /DIN 4108-4/: For RDK 1.0 - 1.4 $\mu= 5/10$
 For RDK 1.6 - 2.6 $\mu= 15/25$

Application rules as per /DIN EN 771-2/, /DIN V 20000-402/ and /DIN V 106/, and general technical approvals

2.4 Application rules

Directive (EU) No. 305/2011 applies for placing the product on the market in the EU/EFTA (with the exception of Switzerland) dated 9 March 2011. The products require a Declaration of Performance taking consideration of the /DIN EN 771-2: 2011-07, Specification for masonry units – Part 2: Calcium silicate masonry units; German version EN 771-2:2011/ and the CE marking.

Application of the products is subject to the respective national guidelines; in Germany:

DIN V 20000-402: 2005-06: Application of building products in structures – Part 402: Rules for using calcium silicate masonry units in accordance with DIN EN 771-2:2005-05

DIN V 106: 2005-10; Calcium silicate units with specific properties

and general technical approvals of the Deutsches Institut für Bautechnik, Berlin

2.5 Delivery status

The block formats produced range between 240 mm * 115 mm * 52 mm (length * width * height) and 998 mm * 365 mm * 623 mm.

2.6 Base materials / Ancillary materials

Base materials

Description	Value	Unit
Sand	65 - 85	% by mass
Gravel	0 - 45	% by mass
Crushed sand	0 - 10	% by mass
Burned lime	5 - 12	% by mass
Powdered rock	0 - 2	% by mass

3-6% water by mass (with reference to the solid materials) is also used.

Sand: The sand used is a natural raw material which contains quartz (SiO₂) as a primary mineral as well as natural minor and trace minerals. It is an essential base material for the hydrothermal reaction during steam curing. Other natural raw materials are also added in order to achieve certain product properties. These can include coarse and fine components such as 2-8 mm gravel, limestone grit, greywacke grit, basalt grit, quartz or limestone.

Gravel is a naturally rounded aggregate with a maximum grain size > 4 mm. 2-8 mm gravel is used for manufacturing calcium silicate masonry units. Gravel with a maximum grain size of 4 mm is referred to as gravel sand. Gravel is extracted by digging or suction from river or glacier areas.

Crushed sand refers to crushed natural sand in the calcium-silicate industry. The crushing process means

that the sand grains are angular and splintery instead of round. As an aggregate, it ensures good integration.

Burned lime: In accordance with /DIN EN 459/, burned lime serves as a binding agent and is manufactured by burning natural lime.

Powdered rock in the calcium-silicate industry refers to natural substances comprising natural rock, e.g. powdered limestone or quartz powder. These are aggregates serving to improve grain size distribution and processing.

Water: The availability of water is a fundamental basis for the hydraulic reaction undergone by the binding agents. Continuous process management demands the setting of a defined water content during pressing.

2.7 Manufacture

The formulae used are adapted to the respective raw material properties and vary within the fluctuations indicated in 2.6 Base materials / Ancillary materials. No other substances are included.

The raw materials (sand, burned lime and water) are dosed gravimetrically according to the respective recipe and intensively combined. Then the raw material mixture is stored intermediately in a reactor (reaction tank) which causes an exothermic reaction. This ensures that the burned lime is fully extinguished as hydrated lime prior to further processing. The mixed material leaves the reactor for a mixer where water is added to make it suitable for pressing. This is followed by the calcium silicate masonry unit presses compressing and shaping the raw mass in moulding boxes. The blanks are then automatically stacked on hardening cars and transported to the autoclave via a transfer table system on tracks.

The final characteristics of the masonry units are formed during the subsequent steam curing process over 6 to 12 hours at approx. 200 °C and pressure of approx. 16 bar in steam pressure vessels, so-called autoclaves, where calcium-silicate hydrates are formed from the substances used. The material reaction is concluded on removal from the autoclave. The steam is used for other autoclave cycles once the curing process is finished. Where technically possible, the condensate incurred is used as process water.

2.8 Environment and health during manufacturing

The general statutory regulations and the rules of the professional associations apply. No special measures need to be taken to protect employee health or the environment.

2.9 Product processing / Installation

Calcium silicate masonry units are processed by hand; lifting equipment is required for products whose mass exceeds 25 kg. Calcium silicate masonry elements are usually prefabricated in the calcium silicate factory and numbered before delivery to the construction site. Elements can also be delivered loose. Components are divided in a wet process using diamond saws. High-speed tools such as angle grinders used without water or extraction are unsuitable for processing calcium silicate masonry units on account of the dust they generate (which also includes fine quartz dust). Calcium silicate components are connected to each other and to other standardised building materials using normal or thin-bed mortar in accordance with

/DIN EN 998-2/ and /DIN V 18580/. The calcium silicate masonry units can be plastered, coated or painted. Panelling with small-format parts or fair-face cavity brickwork as per /DIN EN 1996-2/ is also possible. Calcium silicate masonry units for facing walls are used as facing shells.

2.10 Packaging

Calcium silicate masonry units are stacked on wooden pallets and bound using steel or plastic straps and/or welded in recyclable shrink film or even loaded as bulk material.

2.11 Condition of use

Calcium silicate masonry units do not alter their appearance after leaving the autoclave.

2.12 Environment and health during use

Calcium silicate masonry units do not emit any hazardous substances such as VOC. The naturally ionising radiation of calcium-silicate products is extremely low permitting unlimited use of this building material from a radiological perspective (see 7.1 Radioactivity).

2.13 Reference service life

Calcium silicate masonry units display unlimited resistance properties when used as designated.

2.14 Extraordinary effects

Fire

In the event of a fire, no toxic gases and vapours can arise. The products referred to comply with the requirements of building material class A1 ("non-combustible") in accordance with /DIN EN 13501-1/.

Fire protection

Description	Value
Building material class	A1

Water

When exposed to water (e.g. flooding), calcium silicate masonry units react slightly alkaline. No substances are washed out which could be hazardous to water.

Mechanical destruction

Mechanical destruction of calcium silicate masonry units does not pose any environmental risks.

2.15 Re-use phase

Calcium silicate masonry units outlast the service lives of the buildings in which they are used. When such buildings are de-constructed, the materials can be re-used without any restrictions in terms of durability. Set calcium silicate masonry units have seldom been re-used to date.

Residual calcium silicate masonry units from de-struction and demolition comply with the criteria of the /LAGA/ Z 0, i.e. the material is suitable for installation without reservations (e.g. as filling material in earthworks and road construction, as vegetation substrate and even in landfills) /test reports by Dr Wessling 2015/.

Calcium silicate masonry units are fully recyclable. Research results indicate that processed calcium silicate masonry rubble can be used for various recycling paths, e.g. in earthworks, road construction, vegetation layouts, landfill construction, concrete construction etc. /Fb 80 1994/, /Fb 86 1997/, /Fb 97 2003/, /Fb 106 2008/, /Fb 111 2010/, /Fb 115 2014/, /Fb 116 2014/, /Fb 118 2015/.

2.16 Disposal

Calcium silicate masonry units can be disposed of in class 0 landfills in accordance with the /German Landfill Ordinance (DepV)/.

Waste code in accordance with the /European Waste Catalogue/ (EWC): 17 01 01

2.17 Further information

Additional information available online at www.kalksandstein.de.

3. LCA: Calculation Rules

3.1 Declared unit

This Declaration refers to the manufacture of 1 tonne calcium silicate masonry units. The LCA results per m³ are obtained by multiplying the results by the gross density class, e.g. GDC 2.0.

Declared unit

Description	Value	Unit
Gross density	1800	kg/m ³
Declared unit	1000	kg

3.2 System boundary

Type of EPD: cradle to plant gate

The following processes were included in the A1-A3 product stages of calcium silicate manufacturing:

- Processes associated with supplying auxiliaries and energy
- Transporting the resources and preliminary products (lime, sand etc.) to the respective production site

- Manufacturing process in the plant including energy, manufacturing auxiliaries, disposing of any residual materials incurred
- Manufacturing the pro rata packaging

3.3 Estimates and assumptions

Data sets were not available for all raw materials in the GaBi data base. The manufacture of grey lime was estimated the same as for white lime as they are similar in terms of manufacturing and environmental impact.

3.4 Cut-off criteria

All operating data, i.e. all of the starting materials used, thermal energy, internal fuel consumption and electricity consumption, all direct production waste as well as all emission measurements available were taken into consideration in the analysis. Primary data on the transport distances was available for all relevant inputs and outputs. Accordingly,

material and energy flows with a share of less than 1 per cent were also considered. It can be assumed that the total of all processes ignored does not exceed 5% in the effective categories. Machinery, plants and infrastructure required in the manufacturing process were not considered.

3.5 Background data

The software system for comprehensive analysis /GaBi 6/ developed by thinkstep AG was used for modelling the process for calcium silicate masonry unit production. The consistent data sets contained in the GaBi data base are documented in the online /GaBi documentation/. The basic data in the GaBi data base was applied for energy, transport and consumables. The Life Cycle Assessment was modelled for Germany as a reference area. This means that apart from the production processes under these marginal conditions, the pre-stages also of relevance for Germany such as provision of electricity or energy carriers were used. The power mix for Germany 2011 was applied.

3.6 Data quality

All of the background data records of relevance for manufacturing were taken from the GaBi 6 software data base. Primary data was supplied by the Bundesverband Kalksandsteinindustrie e.V. (Registered Association of German Calcium Silicate Producers). The background data used was last revised less than 1 year ago. The production data involves up-to-date

industrial data supplied by the Bundesverband Kalksandsteinindustrie e.V. (Registered Association of German Calcium Silicate Producers) from 2014. The data quality can be regarded as good.

3.7 Period under review

The data applied for this LCA is based on data recorded for the manufacture of calcium silicate masonry units in 2014. The volumes of raw materials, energy, auxiliaries and consumables used were considered as average annual values in the plants.

3.8 Allocation

Production data from 40 plants was made available for manufacturing the products under review. The requisite raw materials were allocated to the respective products in line with their recipes.

Allocation of the product-specific applications entailed allocating fuels and packaging materials by volume produced while electricity and diesel requirements as well as indirectly allocable raw materials were allocated by mass.

3.9 Comparability

As a general rule, a comparison or an evaluation of EPD data is only possible if all the data sets to be compared were created according to /EN 15804/ and the building context and/or the product-specific characteristics of performance are taken into account.

4. LCA: Scenarios and additional technical information

Reference Service Life

Description	Value	Unit
Reference Service Life	80 - 150	a

5. LCA: Results

The environmental impacts of 1 tonne calcium silicate masonry units manufactured by the Bundesverband Kalksandsteinindustrie e.V. (Registered Association of German Calcium Silicate Producers) are outlined below. The modules marked "x" as per /EN 15804/ in the overview are addressed; the modules marked "MND" (Module not declared) do not form a component of the analysis.

The following tables depict the results of the indicators concerning impact estimates, use of resources as well as the waste and other output flows with reference to the declared unit.

DESCRIPTION OF THE SYSTEM BOUNDARY (X = INCLUDED IN LCA; MND = MODULE NOT DECLARED)

Production stage			Construction process stage		Use stage							End-of-life stage				Benefits and loads beyond the system boundaries
Raw material supply	Transport	Manufacture	Transport from manufacturer to site	Assembly	Use / Application	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Deconstruction / Demolition	Transport	Waste processing	Disposal	Reuse, recovery or recycling potential
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
X	X	X	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND

RESULTS OF THE LCA - ENVIRONMENTAL IMPACT: 1 tonne calcium silicate masonry units

Parameter	Unit	A1-A3
Global warming potential	[kg CO ₂ equiv.]	1.36E+2
Depletion potential of the stratospheric ozone layer	[kg CFC11 equiv.]	1.54E-9
Acidification potential of soil and water	[kg SO ₂ equiv.]	8.93E-2
Eutrophication potential	[kg (PO ₄) ³⁻ equiv.]	1.71E-2
Formation potential of tropospheric ozone photochemical oxidants	[kg ethene equiv.]	2.39E-3
Abiotic depletion potential for non-fossil resources	[kg Sb equiv.]	2.89E-5
Abiotic depletion potential for fossil resources	[MJ]	9.43E+2

RESULTS OF THE LCA - RESOURCE USE: 1 tonne calcium silicate masonry units

Parameter	Unit	A1-A3
Renewable primary energy as energy carrier	[MJ]	1.75E+2
Renewable primary energy resources as material utilisation	[MJ]	0.00E+0
Total use of renewable primary energy resources	[MJ]	1.75E+2
Non-renewable primary energy as energy carrier	[MJ]	9.97E+2
Non-renewable primary energy as material utilisation	[MJ]	0.00E+0
Total use of non-renewable primary energy resources	[MJ]	9.97E+2
Use of secondary materials	[kg]	4.76E+0
Renewable secondary fuels	[MJ]	0.00E+0
Non-renewable secondary fuels	[MJ]	0.00E+0
Net use of fresh water	[m ³]	3.09E-1

RESULTS OF THE LCA – OUTPUT FLOWS AND WASTE CATEGORIES: 1 tonne calcium silicate masonry units

Parameter	Unit	A1-A3
Hazardous waste for disposal	[kg]	3.39E-4
Non-hazardous waste for disposal	[kg]	1.17E+1
Radioactive waste for disposal	[kg]	2.18E-2
Components for re-use	[kg]	IND
Materials for recycling	[kg]	IND
Materials for energy recovery	[kg]	IND
Exported electrical energy	[MJ]	IND
Exported thermal energy	[MJ]	IND

The results of the impact estimates only represent relative statements. They do not make any claims concerning impact category limits, exceeding threshold values, safety limits or risks.

6. LCA: Interpretation

The environmental impacts of calcium silicate masonry unit production are dominated by the manufacture of raw materials (especially limestone) and consumption of (thermal) energy in the plant.

The upstream processes of lime production have a significant influence on the results of global warming potential in particular.

The global warming potential associated with calcium silicate masonry unit production accounts for 136 kg CO₂ equiv. per tonne.

The manufacture of 1 tonne calcium silicate masonry units requires almost 1000 MJ non-renewable primary energy. Additionally, 175 MJ renewable primary energy are also used.

The use of non-renewable primary energy is determined by the use thermal energy to a relevant to significant degree but also by the raw materials used, and especially lime. Consideration of the AP and EP impact categories also indicates that relevant

influencing factors are attributable to the respective results of the use of resources (especially lime and sand) and thermal energy/electricity. A less significant role is played by transport and/or emissions associated with the production process or any necessary packaging materials.

Greenhouse gases (GWP) are largely emitted during the manufacture of burned lime, followed by the generation of necessary thermal energy.

7. Requisite evidence

7.1 Radioactivity

Method: Measurement of the nuclide content in Bq/kg, determining the Activity Index I

Summarising report: /BFS-SW-14/12/, Gehrke, Hoffmann, Schkade, Schmidt, Wichterey: Natural radioactivity in construction materials and the ensuing radiation exposure, Salzgitter, November 2012

Result: The samples were evaluated in accordance with the /European Commission Guideline "Radiation Protection 112" (*Radiological Protection Principles concerning the Natural Radioactivity of Building Materials*, 1999). The Index values I established are in all cases lower than the exclusion level which dispenses with a requirement for any additional controls. From a radiological perspective, the natural

radioactivity of the building material permits unlimited use thereof.

7.2 Leaching

Measuring agency: Wessling GmbH, Hanover

Method: Chemical testing in accordance with the German Landfill Ordinance (DepV)

Report: Examination of calcium silicate masonry specimen samples in terms of disposal

Result: All criteria for landfilling in class 0 landfills are complied with in accordance with the Landfill Ordinance dated 27.04.2009 and 02.05.2013 applicable in Germany.

8. References

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General principles for the EPD range of Institut Bauen und Umwelt e.V. (IBU), 2013-04

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ISO 14025

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DIN EN 15804

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