ENVIRONMENTAL PRODUCT DECLARATION

as per /ISO 14025/ und /EN 15804/

Declaration owner	**Bundesverband der Gipsindustrie e.V.**
Publisher	Institut Bauen und Umwelt e.V. (IBU)
Programme holder	Institut Bauen und Umwelt e.V. (IBU)
Declaration number	EPD-BVG-KNGI-20150175-IAG1-EN
Date of issue	12.04.2018
Valid to	27.09.2021

Knauf K-Sentials Flowing Screed Compounds

Knauf Gips KG

Institut Bauen und Umwelt e.V.

www.ibu-epd.com / https://epd-online.com

KNAUF

The following products belong to the product familiy of
Knauf K-Sentials flowing screed compounds:

Duralpha F 2003, Duralpha F 2202, Duralpha F 2201, Duralpha M 2011, Duralpha M 2211, Duralpha M 2015, Duralpha M 2215, Durhydrit F plus, Durhydrit M W, Durhydrit M WoF

GIPS
Bundesverband der Gipsindustrie e.V.

GIPS
Bundesverband der Gipsindustrie e.V.
Industriegruppe Estrichstoffe

1. General Information

Bundesverband der Gipsindustrie e.V.
Industriegruppe Estrichstoffe

Calcium sulphate flowing screed and conventional calcium sulphate screed

Programme holder
IBU - Institut Bauen und Umwelt e.V.
Panoramastr. 1
10178 Berlin
Germany

Owner of the Declaration
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Kochstraße 6-7
10969 Berlin

Declaration number
EPD-BVG-KNGI-20150175-IAG1-EN

Declared product / Declared unit
1 kg screed (dry, prior to adding water), delivered loose in a silo, truck mixer or mobile mixing plants

This Declaration is based on the Product Category Rules:
Mineral factory-made mortar, 07.2014
(PCR tested and approved by the SVR)

Scope:
This EPD is an association EPD for all member companies of the Bundesverband der Gipsindustrie e.V. and the Industriegruppe Estrichstoffe in accordance with the list of members on www.gips.de.

The LCA result comprises the manufacture of screed with calcium sulphate binding agents in Germany and can be used in particular for planning purposes prior to awarding contracts. The market for screeds with calcium sulphate as a binding agent is well covered by the members of the Bundesverband der Gipsindustrie e.V. and the Industriegruppe Estrichstoffe.

The technical data was taken from the publications of the Bundesverband der Gipsindustrie e.V. and the Industriegruppe Estrichstoffe currently available as well as the manufacturers represented there. This document is translated from the German Environmental Product Declaration into English. It is based on the German original version EPD-BVG-20150175-IAG1-DE. The verifier has no influence on the quality of the translation.The owner of the declaration shall be liable for the underlying information and evidence; the IBU shall not be liable with respect to manufacturer information, life cycle assessment data and evidences.

Issue date
28.09.2015

Valid to
27.09.2021

Verification

The CEN Norm /EN 15804/ serves as the core PCR
Independent verification of the declaration according to /ISO 14025/
☐ internally ☒ externally

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

Dr. Burkhart Lehmann
(Managing Director IBU)

Dr.-Ing. Wolfram Trinius
(Independent verifier appointed by SVR)

2. Product

2.1 Product description

This declaration refers to calcium sulphate flowing screed and conventional calcium sulphate screed.

1 kg of the dry mixture prior to adding water on the construction site is used as the declared unit. This dry mixture displays a dry bulk density > 1500 kg/m^3.

The primary binding agent is represented by bindable calcium sulphate which is hydrated as flowing screed (liquid) or conventional screed (moist) by adding water on the construction site, independent of the processing consistency.

The declaration is independent of delivery as a premixed dry mortar, ready-mixed mortar or binder compound only requiring the addition of aggregate or water.

Regardless of the fact that cement can also be added as an aggregate, this declaration does not apply for

cement screed where cement is used as the primary binding agent.

This declaration only applies for screed and binding compounds delivered loose in transport containers, i.e. not in bags.

2.2 Application

Calcium sulphate flowing screed and conventional calcium sulphate screeds are used in the installation of large screed surfaces without joints.
These products can be used for various screed constructions, e.g. as compound screed /DIN 18560-3/, screed on separation layer /DIN 18560-4/, screed on insulation layer /DIN 18560-2/, heated screed /DIN 18560-2/, screed on hollow floors /DIN EN 13213/.

2.3 Technical Data

Technical construction data can be derived from information supplied by the manufacturers and the designated screed constructions, e.g. regarding the nominal screed thickness. As the declaration applies only until delivery to the construction site, this technical data is not listed here. Reference is made to the leaflet "Calciumsulfat-Fließestriche" (Calcium sulphate flowing screeds) which provides information for planning /IGE Planning/.

		Calcium sulphate screed CA (moist application)	Calcium sulphate flowing screed CAF
Gross density	kg/dm^3	1.8 – 2.1	1.8 -2.1
Modulus of elasticity	N/mm^2	approx. 20,000	15,000 – 20,000
Water vapour diffusion resistance factor		approx. 10	approx. 10
Thermal conductivity	W/mK	approx. 1.2	approx. 1.2 - 1.8
Coefficient of thermal expansion	mm/mK	approx. 0.010	0.010 – 0.016
Reaction to fire		Non-flammable (construction product class A1 acc. to DIN 4102); in the event of a fire, calcium sulphate offers additional fire protection on account of the evaporated water of crystallisation.	

2.4 Placing on the market / Application rules

The /Construction Products Regulation/ applies for placing on the market in the EU/EFTA.
The products require a Declaration of Performance taking consideration of the harmonised /DIN EN 13813/ standard – Screed material and floor screeds, and /CE marking/.
Application of the products is subject to the respective national guidelines.

2.5 Delivery status

The declared unit is 1 kg of the dry mixture prior to adding water on the construction site. This dry mixture has a dry bulk density > 1500 kg/m^3. Delivery to the construction site is in the form of readymade screed or separately as binding compound and aggregate.

2.6 Base materials / Ancillary materials

This declaration refers to calcium sulphate flowing screed and conventional calcium sulphate screed. As a general rule, they comprise binding agents, aggregates and additives. Calcium sulphate flowing screed is delivered to the construction site as ready-mixed mortar or dry mortar or separately as binding agent and aggregate which are mixed at the construction site, e.g. using a mixing plant. Conventional screed is supplied with separate binding agent and aggregate which are then mixed on the construction site.

The primary binding agent is represented by bindable calcium sulphate which is hydrated as flowing screed or conventional screed by adding water on the construction site, independent of the processing consistency. Various calcium sulphate raw materials of natural or synthetic origin can be used and various manufacturing methods applied for achieving the binding capacity. These are outlined in the leaflet "Die Rohstoffe für Calciumsulfat-Fließestriche" (Raw materials for calcium sulphate flowing screed) /IGE raw materials/. This declaration takes consideration of all primary binding agents, i.e. natural anhydrite, alpha-hemihydrate, thermal anhydrite and HF anhydrite, and their upstream chains (FGD gypsum as a by-product of electricity production and HF anhydrite as a by-product of hydrofluoric acid production).

Limestone grit, aggregate particles (and natural anhydrite) and sand can be used as aggregates and cement as an additive.

Additives are applied to the products under review in percentages < 1% by weight in total and/or < 0.02% by weight in terms of individual additives in relation to the total mass of the dry mixture.

The products do not contain any substances of high concern /SVHC/.

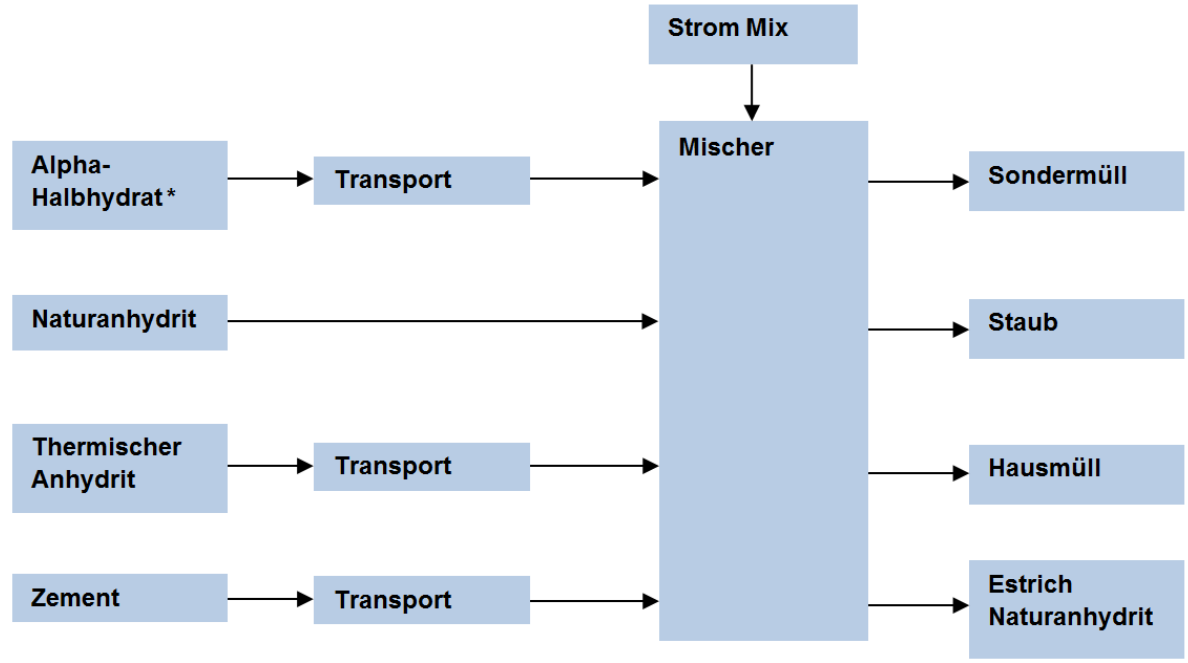
Regardless of the fact that small volumes of cement can also be added, this declaration does not apply for so-called cement screed where cement is used as the primary binding agent.

2.7 Manufacture

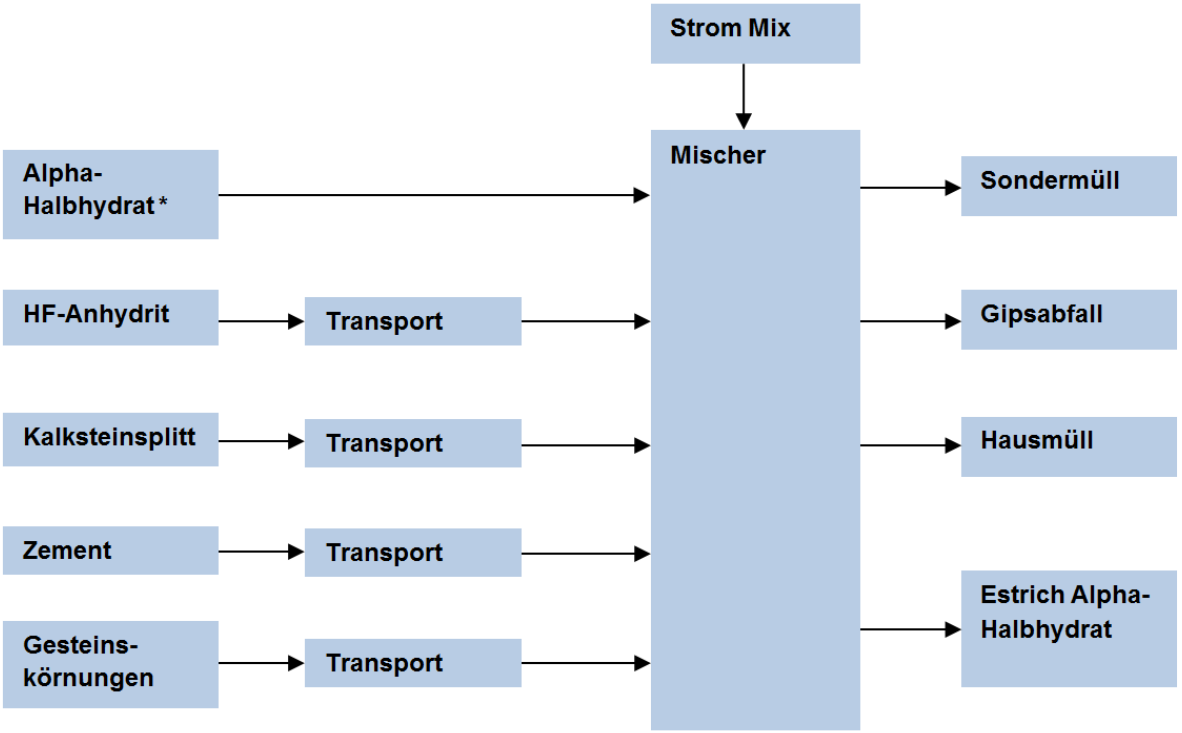
Various manufacturing processes can be used for the products. The plant with the greatest capacity for using natural anhydrite, alpha-hemihydrate, thermal anhydrite and HF anhydrite, respectively, as primary binding agents was modelled for this EPD.

The following (simplified) manufacturing processes were selected:

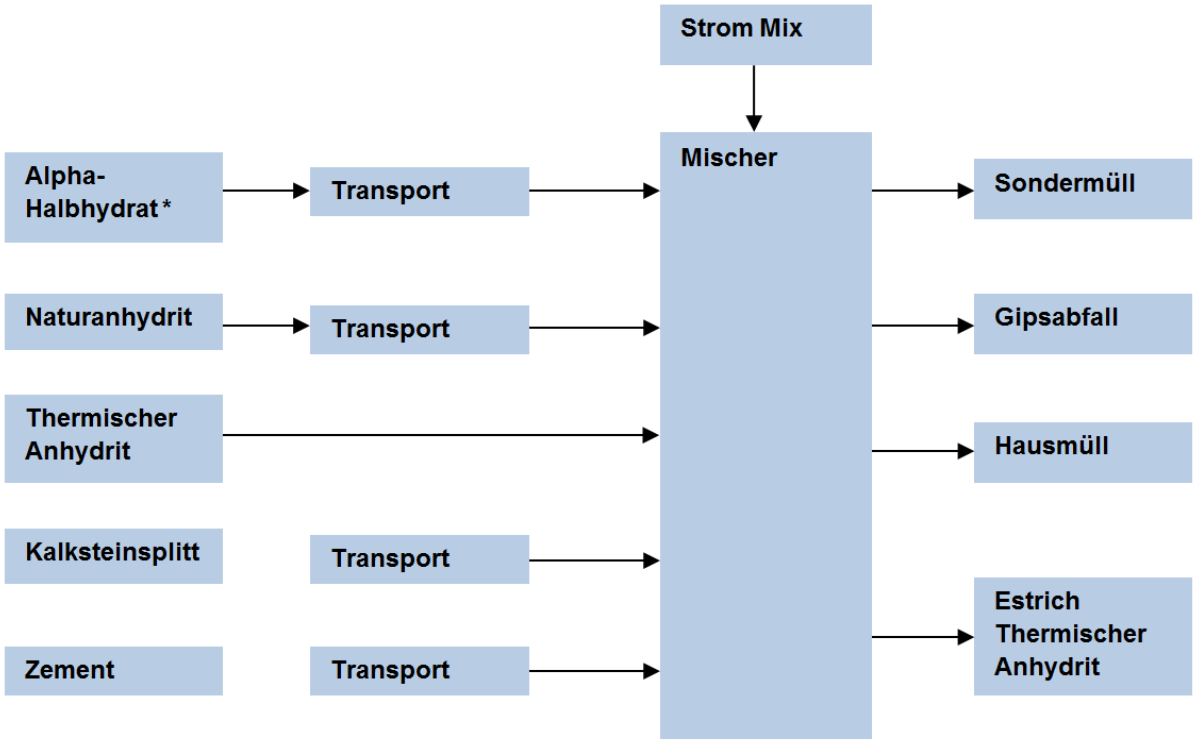
1. Screed made from natural anhydrite



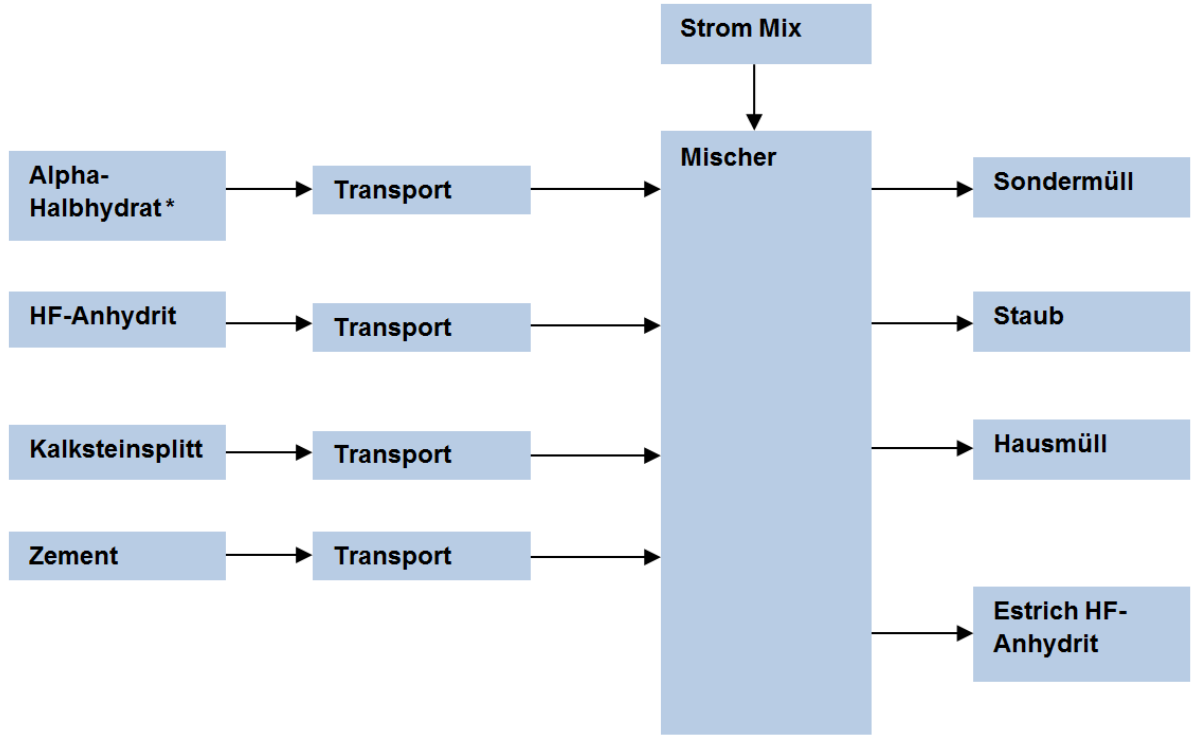
2. Screed made from alpha-hemihydrate



3. Screed made from thermal anhydrite



4. Screed made from HF anhydrite



* New LCA by KIWA GmbH TBU /KIWA screed/

[Legend:]
Alpha-Halbhydrat* - Alpha-hemihydrate*
Naturanhydrit - Natural anhydrite
Thermischer Anhydrit - Thermal anhydrite
Zement - Cement
Transport - Transport
Strom Mix - Electricity mix
Mischer - Mixer
Sondermüll - Hazardous waste
Staub - Dust
Hausmüll - Household waste
Estrich Naturanhydrit - Screed made from natural anhydrite
HF-Anhydrit - HF-anhydrite
Kalksteinsplitt - Limestone grit
Gesteinskörnungen - Aggregate particles
Gipsabfall - Gypsum waste

Estrich Alpha-Halbhydrat - Screed made from alpha-hemihydrate
Estrich Thermischer Anhydrit - Screed made from thermal anhydrite
Estrich HF-Anhydrit - Screed made from HF anhydrite

2.8 Environment and health during manufacturing

The products are manufactured in plants approved according to the Federal Immission Control Act (BImSchG). Health protection is ensured via occupational health and safety management systems.

2.9 Product processing/Installation

Flowing screed is generally processed manually. Depending on the processing consistency, a distinction is made between flowing screed and conventional screed which is moist to soft-plastic on installation. Water is added and mixed using suitable dosing and conveyor pumps for dry, pasty or liquid substances. Flowing screed is generally self-levelling and can be applied without any notable distribution or compression. Conventional screed must be distributed, compressed, levelled and possibly smoothed by hand using suitable tools.
During the construction planning, a joint plan must be drawn up prior to application of the screed which indicates the position and design of any requisite structural, edge and expansion joints /IGE M5 joints/.

2.10 Packaging

Flowing screed is usually filled into silos and delivered. The silos are reusable and are delivered by truck to the construction site or production facility processing the screed. No packaging waste is incurred in such cases or when delivered in a truck mixer or mobile mixing plants.

2.11 Condition of use

The mortars under review are intermediate products to which water is added on the construction site. After achieving the respective readiness for application, various coatings or topcoats can be applied.

Please refer to the leaflet “Calciumsulfat-Fließestriche in Feuchträumen” (Calcium sulphate flowing screed in wetrooms) /IGE M1 Wetrooms/ for using screed in wetrooms.
Screed should be protected by sealants in the case of floor drains and in basements and structural areas with ground contact.
The screeds are not suited for wetrooms according to /DIN 18195-1/.

2.12 Environment and health during use

If used as designated, no particular hazard for humans and the environment is to be expected during mixing and further production. In the event of an alkaline product, setting regulations on hazardous substances must be observed if the mortar is mixed with water and contact with skin or eyes is possible. A safety data sheet is available for these products.

2.13 Reference service life

According to the table “Nutzungsdauern von Bauteilen für Lebenszyklusanalysen nach dem Bewertungssystem Nachhaltiges Bauen (BNB)” (Useful life of components for the LCA according to the Sustainable Building assessment system), the useful life is > 50 years in line with code number 352.111 (flowing screeds: anhydrite screeds ...) or 352.113 (screeds as wear floors) /BNB service life 2011/.

2.14 Extraordinary effects

Fire
Calcium sulphate screeds are non-flammable; they correspond with construction product class A1 according to DIN 4102-1. In the event of a fire, they also offer additional fire protection in the form of evaporated water of crystallisation.

Water
Calcium sulphate screed must be protected from moisture. Temporary moisture penetration, e.g. following water damage, will not result in any damage to these screeds provided they are able to desiccate again afterwards. More extensive or recurrent moisture penetration can cause the coating to crumble while moisture penetration over long periods of time can diminish the strength of these screeds.

Mechanical destruction
Unforeseen mechanical destruction does not cause any environmental damage.

2.15 Re-use phase

Re-use depends on the plans for the screed component, e.g. as screed on an insulation layer, heating screed or screed on cavity floors. As preparation for use/re-use, screeds must be separated from other components and non-mineral coatings, and directed to processing plants capable of producing recycled construction materials.

2.16 Disposal

Waste code:
17 08 02 gypsum-based construction materials other than those mentioned in 17 08 01 (not contaminated by hazardous substances).

2.17 Further information

Additional information is available at www.gips.de.

3. LCA: Calculation rules

3.1 Declared Unit

These calculations refer to the arithmetic mean of data initially recorded separately for:
- 1 kg natural anhydrite screed
- 1 kg alpha-hemihydrate screed
- 1 kg thermal anhydrite screed
- 1 kg HF anhydrite screed

Details on declared unit

Name	Value	Unit
Declared unit	1	kg

3.2 System boundary

The declaration type corresponds with an EPD from the cradle to construction of the building structure.

The following information modules have been considered according to DIN EN 15804: raw material

supply (Module A1), transport (Module A2) and manufacture (Module A3), including supply of all substances, products and energy.

Information for Modules A4 and A5 is taken from the product declaration of the Industrieverband Werkmörtel e.V. (IWM).

3.3 Estimates and assumptions

Assumptions were made concerning the electricity mix and transport vehicle. The electricity mix for Germany 2014 was applied. A truck trailer (Euro 0-5) with a total weight of 34 - 40 tonnes and a useful load of 27 tonnes was assumed as the transport vehicle.

3.4 Cut-off criteria

All flows accounting for more than 1% of the total mass, energy used or environmental impacts by the system were considered in the study. It can be assumed that the processes ignored would have contributed less than 5% to the impact categories under review.
The screed manufacturing process data was provided by the Bundesverband der Gipsindustrie e.V. in 2014. The formula, transport of substances, starting materials used, electrical energy used and all direct production waste were considered in the LCA.

3.5 Background data

The primary data was made available by the Bundesverband der Gipsindustrie. The background data was taken from the GaBi software data base offered by PE INTERNATIONAL /GaBi 6/.
The provision of electricity and energy carriers for Germany as a reference area were used for the LCA. The power mix for 2014 and the diesel mix, at refinery, comprising crude oil and bio-components were used.

3.6 Data quality

The data for natural anhydrite and alpha-hemihydrate recorded in 2014 by the Bundesverband der Gipsindustrie e.V. was used for calculations associated with the manufacture of the screed product group.
All other data was taken from the current GaBi 6 software data base.

3.7 Period under review

The period under review for the data refers to the annual average.

3.8 Allocation

No allocations were used on receipt of the raw materials by the gypsum plant.
An allocation was made for FGD gypsum in accordance with the data from PE International (technical process steps exclusively for the manufacture of gypsum quality without considering the processes for reduction of SO2 emissions).
In line with the data from PE International, an allocation between hydrofluoric acid and anhydrite according to the market values was made for HF-anhydrite.

3.9 Comparability

Basically, 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, respectively the product-specific characteristics of performance, are taken into account.

4. LCA: Scenarios and additional technical information

The following technical information forms the basis for the declared modules or can be used for developing specific scenarios in the context of a building evaluation if modules are not declared (MND).

Information for Modules A4 and A5 is taken as follows from the IWM sample declaration /IWM sample/:

Transport to the construction site (A4) per kg screed (dry, prior to adding water)

Name	Value	Unit
Litres of fuel	0.001573	l/100km
Transport distance	100	km
Capacity utilisation (including empty runs)	50 - 85	%
Gross density of products transported	1500	kg/m^3

Installation in the building (A5) per kg screed (dry, prior to adding water)

Name	Value	Unit
Auxiliary	0	kg
Water consumption	0.0003	m^3
Other resources	0	kg
Electricity consumption	4.43E-05	kWh
Other energy carriers	0	MJ
Material loss	0	kg
Output substances following waste treatment on site	0	kg
Dust in the air	0	kg
VOC in the air	0	kg

These values can be accepted as there are comparable transport routes for the various manufacturing plants and installation sites of the Bundesverband der Gipsindustrie e.V. and the IWM, and the mortar is mixed with water in the same vehicles.

Reference Service Life

Name	Value	Unit
Reference service life	50	a

See section 2.13

5. LCA: Results

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

PRODUCT STAGE			CONSTRUCTION PROCESS STAGE		USE STAGE							END OF LIFE STAGE				BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARIES
Raw material supply	Transport	Manufacturing	Transport from the gate to the site	Assembly	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal	Reuse-Recovery-Recycling-potential
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
X	X	X	X	X	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND

RESULTS OF THE LCA - ENVIRONMENTAL IMPACT: 1 kg screed (dry, prior to adding water)

Parameter	Unit	A1-A3	A4	A5
Global warming potential	[kg CO_2-Eq.]	1.11E-1	4.55E-3	2.88E-5
Depletion potential of the stratospheric ozone layer	[kg CFC11-Eq.]	7.08E-12	5.61E-15	3.26E-16
Acidification potential of land and water	[kg SO_2-Eq.]	1.73E-4	1.15E-5	4.40E-8
Eutrophication potential	[kg $(PO_4)^{3-}$-Eq.]	2.52E-5	3.23E-6	6.39E-9
Formation potential of tropospheric ozone photochemical oxidants	[kg ethene-Eq.]	1.18E-5	-3.30E-6	3.43E-9
Abiotic depletion potential for non-fossil resources	[kg Sb-Eq.]	3.75E-8	2.35E-10	1.93E-11
Abiotic depletion potential for fossil resources	[MJ]	1.18E+0	6.20E-2	2.92E-4

RESULTS OF THE LCA - RESOURCE USE: 1 kg screed (dry, prior to adding water)

Parameter	Unit	A1-A3	A4	A5
Renewable primary energy as energy carrier	[MJ]	1.65E-1	4.74E-3	1.04E-4
Renewable primary energy resources as material utilization	[MJ]	IND	IND	IND
Total use of renewable primary energy resources	[MJ]	1.65E-1	4.74E-3	1.04E-4
Non-renewable primary energy as energy carrier	[MJ]	9.13E-1	6.22E-2	3.78E-4
Non-renewable primary energy as material utilization	[MJ]	IND	IND	IND
Total use of non-renewable primary energy resources	[MJ]	9.13E-1	6.22E-2	3.78E-4
Use of secondary material	[kg]	IND	IND	IND
Use of renewable secondary fuels	[MJ]	IND	IND	IND
Use of non-renewable secondary fuels	[MJ]	IND	IND	IND
Use of net fresh water	[m^3]	1.68E-1	2.97E-4	5.46E-5

RESULTS OF THE LCA – OUTPUT FLOWS AND WASTE CATEGORIES: 1 kg screed (dry, prior to adding water)

Parameter	Unit	A1-A3	A4	A5
Hazardous waste disposed	[kg]	6.32E-7	5.01E-8	3.64E-10
Non-hazardous waste disposed	[kg]	3.52E-1	4.17E-4	1.64E-8
Radioactive waste disposed	[kg]	5.90E-5	8.27E-8	3.44E-8
Components for re-use	[kg]	IND	IND	IND
Materials for recycling	[kg]	IND	IND	IND
Materials for energy recovery	[kg]	IND	IND	IND
Exported electrical energy	[MJ]	IND	IND	IND
Exported thermal energy	[MJ]	IND	IND	IND

6. LCA: Interpretation

The aggregation factors of the life cycle inventory analysis and the indicators of the life cycle impact assessment are interpreted as follows in relation to the declared unit. Interpretation of this study refers to the calcium sulphate screed manufacturing phase examined, including installation in the building by applying 1 kg dry product supplied as the declared unit.

Interpretation of the results is based on a dominance analysis of selected indicators.

Use of primary energy (PE)
As the percentage of primary energy used depends on the respective product, but follows a linear increase, the percentage of renewable and non-renewable PE remain the same. The use of primary energy is therefore shown below for the entire product group of calcium sulphate flowing screed.
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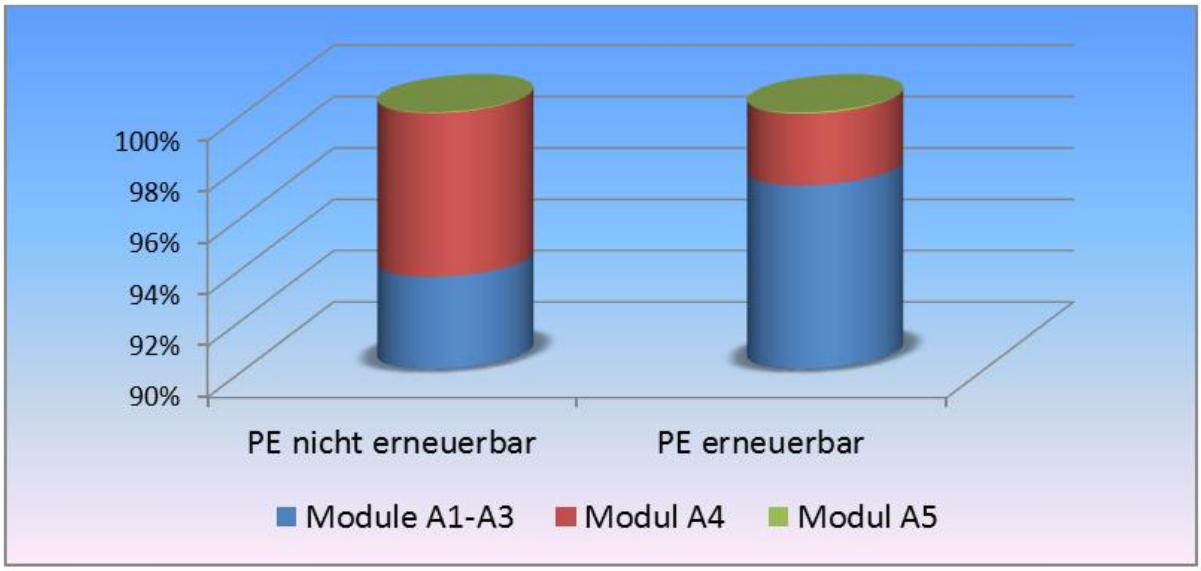


Use of primary energy for calcium sulphate screed

[Legend:]
PE nicht erneuerbar - Non-renewable primary energy
PE erneuerbar - Renewable primary energy
Module A1-A3 - Modules A1-A3
Modul A4 - Module A4
Modul A5 - Module A5

93.51% of non-renewable primary energy is caused by the manufacturing process. Renewable primary energy benefits in particular from the power mix for 2014 which comprises 25.8% renewable primary energy and 74.2% non-renewable primary energy.

Impact categories
The following graphic shows the impact categories for 1 kg calcium sulphate screed as per information modules A1 – A5.

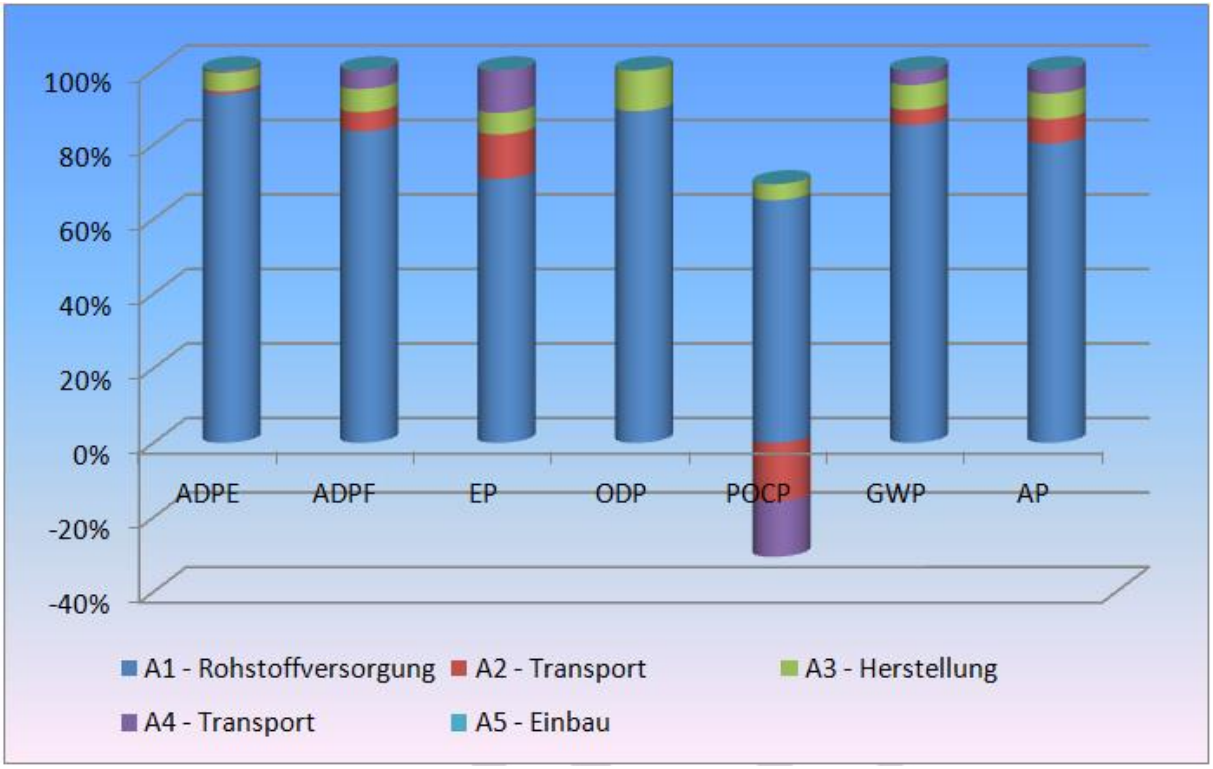
All impact categories are largely dominated by the supply of raw materials.

The Global Warming Potential of 1 kg calcium sulphate screed is dominated by Module A1 – Raw material supply, accounting for 85%.

Furthermore, Module A1 – Raw material supply also dominates the impact categories of Acidification Potential AP (80.38%), Eutrophication Potential EP (70.85%), Photochemical Ozone Creation Potential POCP (167.53%), Abiotic Depletion Potential of elementary resources ADPe (93.71%), Abiotic Depletion Potential of fossil fuels ADPf (83.58%) and Ozone Depletion Potential ODP (88.98%).

Creation of photo oxidants is almost entirely dominated by the delivery of base materials to the plant and site. However, it must be noted that the negative values of the Photochemical Ozone Creation Potential (POCP) are attributed to a reaction between nitrogen monoxide and ozone during transport.

The ozone is depleted following reaction with nitrogen monoxide creating nitrogen dioxide and oxygen which have a positive effect on the Photochemical Ozone Creation Potential (POCP) but also a more negative effect on the Global Warming Potential (GWP).



Impact categories for calcium sulphate flowing screed

[Legend:]
ADPE - ADPE
ADPF - ADPF
EP - EP
ODP - ODP
POCP - POCP
GWP - GWP
AP - AP
A1 – Rohstoffversorgung - A1 - Raw material supply
A2 – Transport - A2 - Transport
A3 – Herstellung - A3 – Manufacture
A4 – Transport - A2 - Transport
A5 – Einbau - A5 - Installation

7. Requisite evidence

7.1 Leaching
On analysis according to the Landfilling Ordinance, the product displays the sulphate concentration in the saturation range which is typical for gypsum (approx. 1500 mg/l), resulting in disposal options only from landfill class I upwards. Gypsum is classified as a listed substance in Water Hazard Class 1 (slightly hazardous for water). Heavy metal content is significantly lower than the allocation criteria for landfilling class I. The waste producer is responsible for the proper disposal. Proper disposal depends on parameters like use, sorting depth during de-construction, collection (separately or together with other construction waste) and treatment.

7.2 Radioactivity
The product can be used without restriction with overall dose contributions of significantly lower than 0.3 mSv/a, determined on the basis of the index calculation to RP 112 and the radon concentration /BfS report/.

7.3 VOC emissions
The requirements in accordance with the AgBB test scheme (version 2008) regarding all existing test values are complied with /Scherer 2010/.

$TVOC_3 \leq 10$ mg/m³
Carcinogens$_3$ EU cat. 1 and 2 ≤ 0.01 mg/m³
$TVOC_{28} < 1.0$ mg/m³
$SVOC_{28} \leq 0.1$mg/m³
Carcinogens$_{28}$ EU cat. 1 and 2 ≤ 0.001 mg/m³
Total VOC_{28} excl. LCI ≤ 0.1 mg/m³
Total VOC incl. LCI $R = \Sigma C_i / LCI_i < 1$

8. References

Institut Bauen und Umwelt
Institut Bauen und Umwelt e.V., Berlin(pub.): Generation of Environmental Product Declarations (EPDs);

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

ISO 14025

DIN EN ISO 14025:2011-10: Environmental labels and declarations — Type III environmental declarations — Principles and procedures

EN 15804
EN 15804:2012-04+A1 2013: Sustainability of construction works — Environmental Product Declarations — Core rules for the product category of construction products

AgBB
Ausschuss zur gesundheitlichen Bewertung von Bauprodukten (AgBB): Vorgehensweise bei der gesundheitlichen Bewertung der Emissionen von flüchtigen organischen Verbindungen (VOC und SVOC) aus Bauprodukten. 2008

Construction Products Regulation
Regulation (EU) No. 305/2011 dated 9 March 2011
ABl. (EU) L 88 / 5 ff. dated 4.4.2011

BfS report
Natural radioactivity in construction materials and the ensuing radiation exposure
Field of radiation protection and environment
K. Gehrcke, B. Hoffmann, U. Schade, V. Schmidt, K. Wichterey:
urn:nbn:de:0221-201210099810
Federal Office for Radiation Protection,
Salzgitter, November 2012
http://doris.bfs.de/jspui/bitstream/urn:nbn:de:0221-201210099810/3/BfS_2012_SW_14_12.pdf

BNB service life 2011
BBSR table "Service lives of components for LCA in accordance with BNB"
"Sustainable Building Information Portal" by the Federal Ministry of Transport, Building and Urban Affairs:
http://www.nachhaltigesbauen.de/baustoff-und-gebaeudedaten/nutzungsdauern-von-bauteilen.html; last revised: 03.11.2011

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