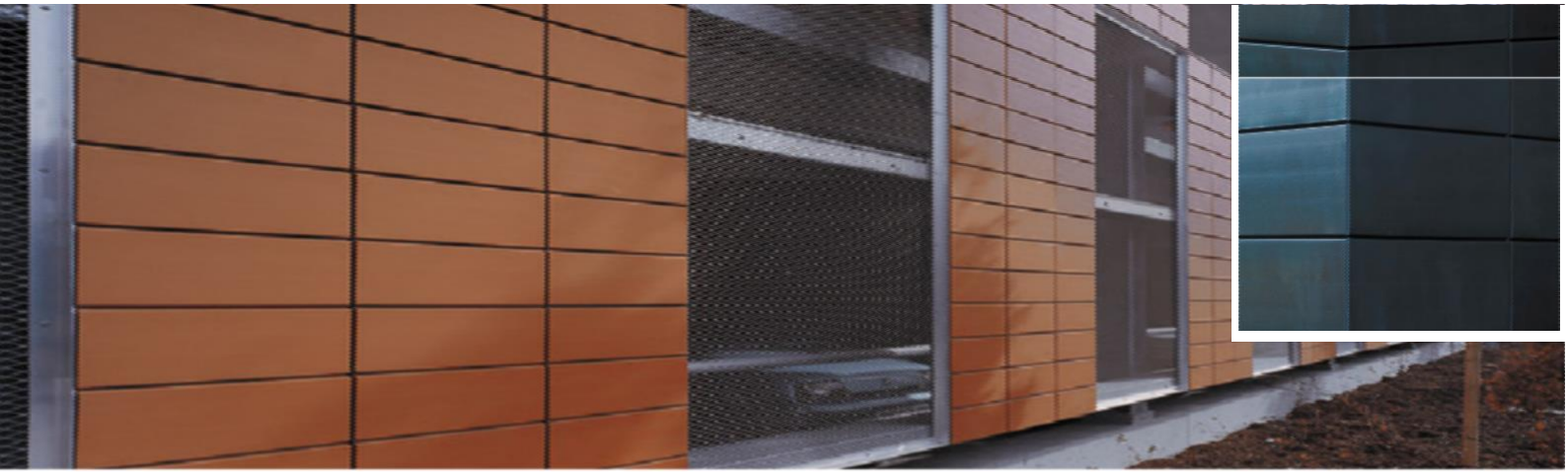
ENVIRONMENTAL PRODUCT DECLARATION

according to /ISO 14025/ and /EN 15804/

Owner of the Declaration	**TONALITY GmbH**
Publisher	Institut Bauen und Umwelt e.V. (IBU)
Program Holder	Institut Bauen und Umwelt e.V. (IBU)
Declaration number	EPD-TON-20190011-IBA1-DE
Date issued	06.03.2019
Valid until	05.03.2024

TONALITY®
Ceramic Facade Elements
TONALITY GmbH

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



1. General Details

TONALITY GmbH	TONALITY®
Owner of the Program IBU - Institut Bauen und Umwelt e.V. Panoramastr. 1 10178 Berlin Deutschland	**Holder of the Declaration** TONALITY GmbH In der Mark 100 56414 Weroth
Declaration Number EPD-TON-20190011-IBA1-DE	**Declared Product / declared unit** 1 m² ceramic cladding panels with substructure **Area of Validity:**
This declaration is based upon Product Category Regulations: Ceramic Cladding, 07.2014 (PCR tested and approved by the German independent Council of Experts (SVR))	This EPD refers to ceramic façade panels from the production plant in Weroth (In der Mark 100, 56414 Weroth), managed by TONALITY GmbH using the trade name TONALITY®.
Date of issue 06.03.2019	The owner of the declaration is liable for the details and proofs this is based upon; any liability of the IBU with regards to manufacturers information, Life Cycle Assessment data and proofs is excluded.
Valid until 05.03.2024	**Verification** The European Norm /EN 15804/ serves as core PCR Independent verification of the declaration and details acc. to / ISO 14025:2010/ ☐ internal ☒ external
Prof. Dr.-Ing. Horst J. Bossenmayer (President, Institut Bauen und Umwelt e.V.)	Matthias Schulz, Independent verifier appointed by the SVR
Dr. Alexander Röder (Chairman of the Board IBU)	

2. Product

2.1 Product description/Product definition

The declared product concerns flat, level ceramic façade panels made of clay. The panels are made of different clay solids and receive their surface finish or their color through agreed fire curves. They are single skin panels as well as also panels with hollow cavities for suspended, back-ventilated rainscreen facades. The cladding panels are affixed using system-oriented aluminum sub-structures on primary façade support systems.

The respective national regulations apply for their use, in Germany the national technical approval with No. Z-10.3-796 of the German Institute for Building technology dated 15/11/2018 and the national technical approval with No. Z-10.3-798 German Institute for Building technology dated 16/05/2018.

2.2 Application

TONALITY® is used as a cladding material for suspended, back-ventilated rainscreen cladding as well as for decorative internal designs. The façade panels are also used for suspended ceilings, reveals and coverings.

2.3 Technische Data

Technical Data

Classification	Value	Unit
Raw density	2000 - 2200	kg/m³
Thermal conductivity according to /EN 60672-2/	1,17	W/(mK)
Breaking strain dependent on thickness and height	0.5 – 6.67	kN
Water take-up according to /EN 539- 2/	2 - 5	%

The degree of sound absorption is not relevant for application cases of ceramic façade panels.

2.4 Delivered Condition

Dimensions and tolerances of TONALITY® façade panels in accordance with the national technical approvals named in Point 2.1:
Thickness 22 mm:
Grid height 150, 175, 200, 225, 250, 300 mm

In lengths up to 1,200 mm
Thickness 26 mm:
Tile grid 150, 175, 200, 225, 250, 300, 400 mm
Delivered in lengths up to 1,600 mm (for grid heights 150 mm and 175 mm to 1,200 mm)

2.5 Basic Materials/Ancillary Materials

TONALITY® ceramic façade panels are comprised of ceramic façade panels and a system-relevant aluminum sub-structure. The ceramic façade tiles are comprised of the following basic materials and ancillary materials:

Classification	Value	Unit
Clay	40 - 70	Mass %
Chamotte *(fire clay)*	20 - 35	Mass %
Color pigments	1 - 3	Mass %
Engobe/Glaze	0 - 3	Mass%

During production another 20% water or so is still required during the shaping process.
Clays and chamottes (fire clays) originate from regional occurrences in near to our factory (in Germany's Westerwald).
color pigments and surface coatings are bought in, purchased from renown manufacturers of these materials.

According to the manufacturer, the aluminum sub-structure is comprised 35% of alloy AlMg3 H22/24 and 65% of alloy AlMg 4.5MnH24. Apart from this, the manufacturer confirms that 20% of the aluminum is secondary aluminum and 80% is primary aluminum.

The product/ at least a part of the product contains materials on the list of substances of very high concern (27.06.2018) above 0.1 mass by%: no.

The product/ at least a part of the product contains further CMR materials in category 1A or 1B, which are not on the list of substances of very high concern, above 0.1 mass by % in at least a part of the product

The construction product on hand had biocidal products added to it or was treated with biocidal products (we are concerned here with a processed good in the spirit of the Biocide Product Regulation (EU) Nr. 528/2012): no

2.6 Manufacture

The manufacture of the ceramic cladding panels is divided into eight process steps:
During **raw material preparation** doses of components required are measured out, they are homogenized and mixed into aplastic workable solid mass through adding water.
Shaping gives the plastic solid mass its desired shape through extrusion (pultrusion).
During the **drying** process step, the water contained in the extruded blank is expelled from the product in a preservative manner.
The dried tiles are engobed or glazed during **surface finishing**. The **façade elements** receive their technical characteristics through firing in a rolling oven, and their special appearance.
Façade elements are cut exactly to the length desired during **cutting**.
These are inspected visually by random sampling during the **Quality Control step,** and dimensions are measured and checked.
In the final production step **packaging**, the façade elements are packaged securely for transport in accordance with the customer's wishes.

2.7 Health and the Environment during Production

Efforts are made during the entire production process, to keep the effects on the environment as small as possible.

Strict limiting values force TONALITY GmbH to take technical precautions and should it be necessary to use specially agreed Personal Protective Equipment (P.P.E).
Emissions are measured annually internally and every two years externally in accordance with production approval.
Waste from the production process is either recycled internally and fed back into this again or are disposed of externally in an expert and correct manner, with evidence being recorded.
Noise loadings for neighbors and for employees are regularly monitored by TONALITY GmbH and these are followed corresponding to statutory boundary values. Appropriate P.P.E. is also provided for employees here.

2.8 Product Processing /Installation

Installation takes place via a system-oriented sub-structure. Information on installing in the national technical approvals must be followed. When drilling and cutting the ceramic material, appropriate Personal Protective Equipment must be worn (respiratory protection P2/FFP2, protective eyeglasses and ear defenders)
Sufficient ventilation must be guaranteed in the place of work.
Tools with low dust exposure (e.g. wet cutting equipment) must be used.
For re-, normal tools customary in trade can be used for working on the system-specific aluminum sub-structures. When doing this, likewise the Health & Safety at work regulations must be followed.
The ceramic façade panels are fixed in place by hanging the support lobes on the reverse onto hooks in the substructure. Additional security against unauthorized removal is possible.

2.9 Packaging

Packaging for the products is carried out on re-usable Euro palettes, in part with cardboard intermediate layers of cardboard or wood a using polyethylene shrink wrap film.
The re-usable palettes can be returned against repayment of a deposit. All other packaging materials are returned through the building materials trade and are directed to the recycling process.

2.10 Condition for Use

Following the production process, ceramic façade elements no longer change. The façade elements are resistant to weathering according to /EN 10545/ and are resistant to frost and acids as well as lye according to /EN 1304/.

2.11 Health & the Environment during Use
The façade elements do not emit any materials which are harmful to the environments and health.
The natural ionizing radiation is extremely low and is comparable with other construction products.

2.12 Reference Working Life
Ceramic façade elements no longer change after the end of the production process. These are extremely long-lasting with use according to regulations.

2.13 Extraordinary Influences

Fire
Ceramic façade elements fulfil the requirements according to /EN 13501/. In case of fire, no toxic gases and steam, or ones obstructing vision arise.

Fire Protection

Classification	Value
Building material class	A1
Falling burning drops	No
Smoke gas development	No

Wasser
Based on secure ceramic compounds, no material contents which are dangerous to the water supply are washed out.

Mechanical Destruction
Ceramic cladding tiles can be destroyed mechanically. No negative effects on the environment should occur when this is carried out.

2.14 After-Use Phase
With the correctly directed demolition of buildings, it may be possible to reuse ceramic facades. Homogenous ceramic elements from a single source may6 be reworked into chamotte (dead clay) and in this way may be fed back into the production process. Ceramic elements obtained from demolitions can also be used for road building and civil engineering. Use as a floor covering for tennis courts is likewise possible. With correctly directed demolition, the sub-structure can also be re-used. It is also possible to submit the aluminum material to the recycling process.

2.15 Disposal
Where no recycling opportunities exist, cladding panels can be disposed of in the customary manner and sent for waste disposal
(Waste Key 31409 -Construction Waste according to /LAGA-Waste Catalogue/, Waste Key 170102 – Tiles according to /European Waste Catalogue/, Disposal Class I according to TA-Municipal Solid Waste).

2.16 Further Information
You can receive further information at
www.tonality-facades.de

3. LCA: Rules for Calculations

3.1 Declared Unit
This declaration refers to1 m² of ceramic façade tiles including system-oriented aluminum sub-structure. The average weight per unit area (ceramic façade panel (without sub-structure) is 40.8 kg/m², for the sub-structure it is 0.52 kg/m².

The raw density of the declared product is 2000-2200 kg/m³.

The re-calculation factor to 1 kg (incl. sub-structure) is 1/41.32=0.0242.

Declared Unit

Classification	Wert	Einheit
Declared Unit	1	m²
Weight per unit area (including sub-structure 0.52kg/m²)	41,32	kg/m²
Raw density	2200	kg/m³
Re-calculation factor for 1 kg (incl. sub-structure)	0,0242	-

3.2 System Limit
This declaration corresponds to an EPD of the type "Weigh up to the factory gates - with options".

The Life Cycle Assessment takes the extraction and supply of raw materials into consideration, transporting raw materials and the actual product manufacture as well as packaging materials (Modules A1-A3), the treatment of packaging materials in waste incineration plants following installation of the product (Module A5), as well as transport following demolition (Module C2) and End-of-Life of materials (Disposing of the facade panels at an inert materials waste site (Module C4) and recycling the aluminum sub-structure (Module D). The credit notes for electricity and thermal energy from the disposal of packaging materials were likewise considered (Module D).

Module C3 merely displays the MFR indicator (Materials for Recycling). The quantity of aluminum is shown here, leading to the credits in Module D.

The user phase (Module B) is not taken into consideration in this study.

3.3 Estimates and Assumptions
The data for specifying the sub-structure were supplied directly by the supplier. According to the manufacturer, the aluminum sub-structure is composed 35% of alloy AlMg3 H22/24 and 65% of alloy AlMg 4.5MnH24. Apart from this, the customer confirmed, that 20% of the aluminum is secondary aluminum and 80% is primary aluminum. As no exact datasets for the concrete alloys of the secondary aluminum are available in the in database /GaBi 8.7/, the dataset
„DE: Aluminium ingot (AlMg9) sec.“ was used as an estimate.

3.4 Cut-off regulations

All data recorded by the company i.e. of all the staring materials used in according to formulations, the thermal energy used as well as electricity requirements and co-products were considered in the assessment. The transport needs were taken into consideration for all the inputs examined.
In accordance with /PCR Part A/ material and energy streams with a proportion of less than 1 percent of the total of with reference to the overall mass of the product. were also considered at this time.

The manufacture of machinery, equipment and other infrastructure, die required for manufacturing the articles under consideration, was not considered in the Life Cycle Assessment.

3.5 Background Data

The software system developed by thinkstep AG for comprehensive assessment /GaBi 8.7/ was used for modelling for the ceramic cladding panels (incl. sub-structure). The consistent datasets contained in the GaBi database are recorded in online GaBi documentation. The basic data in the GaBi database were used for energy, forms of transport, and ancillary materials.

The Life Cycle Assessment was drawn up for the reference region of Germany. Therefore, the relevant pre-stages in Germany such as the electricity utility supply or power supply for the production process were also used under these background conditions. The Electricity-Mix in Germany for reference year 2014 was used. All further background data sets were taken from the year 2018.

Some of the emissions from the combustion process were recorded as primary data by means of measurements by TONALITY GmbH. As the emissions measurements were not complete, an adjustment was made according to the actual emissions and a Worst-Case approach was selected for missing data.

3.6 Data Quality

Data recorded by TONALITY GmbH during the 2017 production year were used for the production phase modelling for the ceramic cladding panels (incl. sub-structure). All

Other relevant background datasets were taken from the database for the software /GaBi 8.7/. These are no more than 10 years old according to the specifications.

3.7 Period under Consideration

The data basis for the Life Cycle Assessment is based on data recorded in the year 2017. The period under consideration was 12 months.

3.8 Allocation

Spoilt waste *('spillage')* from the ceramic cladding panels can be re-used. The firing waste is sent to a reprocessing plant free of charge. This firing waste can be used in different fields; for example, for building roads, as clay ashes for tennis courts, as chamotte (refractory clay) for producing stoneware goods etc.

The unfired solid is returned to the clay suppliers and is mixed in with secondary quality clay (Recycling). Die TONALITY GmbH receives no monetary payment for this.

As TONALITY GmbH supplies both co-products free of charge, no Co-Product-Allocation Rules are used. Both material streams depart the system boundaries without any implications on value or loads.

The Life Cycle Assessment considers the recycling potential of aluminum. Of the aluminum wastes occurring during manufacturing and End-of-Life of the sub-structure, first of all the required amount of secondary aluminum for manufacturing is fed back in or is saturated („closed loop"), after this a credit is granted for the remaining net quantity of scrap .

3.9 Comparability

Fundamentally, a comparison or assessment of EPD data is only possible, if all the datasets which must be compared have been drawn up according to /EN 15804/ and the context of the building, or the specific product performance characteristics were taken into consideration.
The background database used was /GaBi 8.7/.

4. LCA: Scenarios and further technical Information

The following technical data forms the basis for the declared modules or may be used for developing specific scenarios in the context of a building assessment, if modules have not been declared (MND).

Installation in the building (A5)
The following packaging materials occur on the building site:

Classification	Value	Unit
Wooden palettes	0,93	kg/m²
Carboard	0.13	kg/m²
(Plastic) films	0.12	kg/m²

End-of-Life (C1-C4)

Classification	Value	Unit
Waste types - separately (Metal & inert builders' waste)	41.32	Kg
As mixed construction waste collectively	0	kg
For re-use	0	kg
For Recycling (sub-structure without collective losses)	0.52	kg
To energy recovery	0	kg
To waste disposal (façade panel with no sub-structure)	40.8	kg
Transport for façade panels to End-of-life (Euro 6 truck)	50	km
Transport for the sub-structure to End-of-Life (rail + Euro 6 truck)	200 + 50	km
Loading	85	%
Volume loading factor	100	%

Potential for re-use, Energy Retrieval and

Recycling potential (D), relevant scenario details
End-of-Life of the declared products following the end of the user phase are included in the assessment.

A credit is awarded in Module D (without overall and re-melting conversion losses of a total of 10%, /EMPA 2008/) for the aluminum scraps arising from the sub-structures. We assume, that the aluminum sub-structure has reached the end of its waste characteristics immediately after the end of the user phase.

Module D also contains the credits for electricity and thermal energy because of thermal further processing of the packaging materials from Module A5.

5. LCA: Results

The following tables show the results of the indicators of effectiveness appraisal, the use of resources, as well as on wastes and other output streams referring to 1 m² ceramic cladding panels including system-oriented aluminum sub-structures.

DETAILS OF SYSTEM BOUNDARIES (X = CONTAINED IN THE LCA; MND = MODULE NOT DECLARED

Production stage			Stage of construction of the structure		Stage of use							Waste disposal stage				Credits and loads outside the system boundary
Raw Materials Supply	Transport	Manufacture	Transport from manufacturer to place of use	Installation	Use / Application	Maintenance	Repair	Replacement	Renewal	Energy used for operation of the building	Water used for operation of the building	Removal / Demolition	Transport	Waste treatment	Disposal	Potential for re-use, Recovery or Recycling.
A1	**A2**	**A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
X	X	X	MND	X	MND	MND	MNR	MNR	MNR	MND	MND	MND	X	X	X	X

RESULTS OF LIFE CYCLE ASSESSMENT OF ENVIRONMENTAL IMPATCS: 1 m² ceramic façade panels including system-oriented aluminum sub-structure

Parameter	Unit	A1-A3	A5	C2	C3	C4	D
Global Warming potential	[kg CO_2-Äq.]	4,17E+1	2,24E+0	9,66E-2	0,00E+0	6,50E-1	-4,58E+0
Depletion potential of the stratospheric ozone layer	[kg CFC11-Äq.]	2,26E-11	2,22E-14	2,03E-15	0,00E+0	1,45E-13	-7,28E-13
Acidification potential to the ground and water	[kg SO_2-Äq.]	7,09E-2	2,73E-4	9,58E-5	0,00E+0	3,84E-3	-1,46E-2
Eutrophication potential	[kg $(PO_4)^3$-Äq.]	7,79E-3	5,99E-5	2,25E-5	0,00E+0	5,31E-4	-1,09E-3
Potential for forming tropospheric ozone	[kg Ethen-Äq.]	6,18E-3	1,82E-5	3,78E-6	0,00E+0	2,99E-4	-8,68E-4
Potential for restricting abiotic resources – non-fossil fossil resources	[kg Sb-Äq.]	2,47E-4	3,19E-8	1,00E-8	0,00E+0	2,50E-7	-1,66E-6
Potential for abiotic degradation of fossil fuels	[MJ]	5,97E+2	4,61E-1	1,29E+0	0,00E+0	8,40E+0	-5,14E+1

RESULTS OF LIFE CYCLE ASSESSMENT OF USE OF RESOURCES: 1 m² ceramic façade panels including system-oriented aluminum sub-structure

Parameter	Unit	A1-A3	A5	C2	C3	C4	D
renewable primary energy as the energy source	[MJ]	7,77E+1	1,41E+1	8,72E-2	0,00E+0	1,08E+0	-1,88E+1
renewable primary energy for material use	[MJ]	1,41E+1	-1,41E+1	0,00E+0	0,00E+0	0,00E+0	0,00E+0
Total renewable primary energy	[MJ]	9,18E+1	9,21E-2	8,72E-2	0,00E+0	1,08E+0	-1,88E+1
non-renewable primary energy as the energy source	[MJ]	6,33E+2	5,60E+0	1,30E+0	0,00E+0	8,71E+0	-6,36E+1
non- renewable primary energy for material use	[MJ]	5,09E+0	-5,09E+0	0,00E+0	0,00E+0	0,00E+0	0,00E+0
Total non-renewable primary energy	[MJ]	6,38E+2	5,10E-1	1,30E+0	0,00E+0	8,71E+0	-6,36E+1
Use of secondary materials	[kg]	1,02E-1	0,00E+0	0,00E+0	0,00E+0	0,00E+0	0,00E+0
Renewable secondary fuels	[MJ]	0,00E+0	0,00E+0	0,00E+0	0,00E+0	0,00E+0	0,00E+0
Non-renewable secondary fuels	[MJ]	0,00E+0	0,00E+0	0,00E+0	0,00E+0	0,00E+0	0,00E+0
Use of freshwater resources	[m³]	1,09E+2	5,40E+0	1,01E-1	0,00E+0	1,66E+0	-3,48E+1

RESULTS OF LIFE CYCLE ASSESSMENT OF OUTPUT STREMAS AND WASTE CATEFROIES: 1 m² ceramic façade panels including system-oriented aluminum sub-structure

Parameter	Einheit	A1-A3	A5	C2	C3	C4	D
Dangerous waste sent for disposal	[kg]	6,20E-7	4,76E-10	8,31E-8	0,00E+0	1,50E-7	2,55E-8
Non-dangerous waste disposed of	[kg]	1,92E+0	6,68E-3	9,66E-5	0,00E+0	4,09E+1	-8,27E-1
Radio-active waste disposed of	[kg]	1,62E-2	1,94E-5	1,56E-6	0,00E+0	1,25E-4	-4,82E-3
Components for recycling	[kg]	0,00E+0	0,00E+0	0,00E+0	0,00E+0	0,00E+0	0,00E+0
Materials to recycling	[kg]	0,00E+0	0,00E+0	0,00E+0	4,42E-1	0,00E+0	0,00E+0
Materials for energy recovery	[kg]	0,00E+0	0,00E+0	0,00E+0	0,00E+0	0,00E+0	0,00E+0
Electrical energy exported	[MJ]	0,00E+0	2,96E+0	0,00E+0	0,00E+0	0,00E+0	0,00E+0
Thermal energy exported	[MJ]	0,00E+0	6,92E+0	0,00E+0	0,00E+0	0,00E+0	0,00E+0

The calorific value in this Life Cycle Assessment is based exclusively on the raw materials used for the packaging: plastic film (calorific value 43 MJ/kg), paper (calorific value 15 MJ/kg) and wooden palette (calorific value 13 MJ/kg). The façade panel itself including the sub-structure is non-flammable.

6. LCA: Interpretation

In general, consumption of thermal energy and electricity has the greatest influence on all impact categories during the manufacture of ceramic façade panels, apart from with abiotic consumption of non-fossil resources (ADPe).

The manufacture of the sub-structure contributes to all impact categories apart from with ADPe, at a rate of about 10-30%. This must be ascribed to the energy demands during the electrolysis process during the manufacture of aluminum.
Of all the raw materials used, the color pigments contribute towards the most widely considered impact categories in a relevant manner. The Global Warming Potential (GWP), Acidification Potential (AP), Eutrophication Potential (EP), Petrochemical Ozone Creation Potential (POCP) and Abiotic Depletion of Fossil Resources (ADPf) are influenced by up to 10% to 25% by this preliminary product. This result is caused by the requirement for electricity during the production of „Ferrochrome“ in the initial supply chains.
In ADPe a different environmental profile is exhibited, compared to the other impact categories. In this case, about 80 % of the abiotic consumption of resources is caused by the manufacture of the color pigments and ca. 15% is caused by the color coating of the surface. This results from the energy requirements during the manufacture of aluminum oxide (aluminum oxide is a component of the glaze formula).
Other raw material such as clay and chamotte (refractory clay) contribute towards 2% to 8% of all impact categories, apart from with ADPe. This is principally the result of the energy requirement of the two manufacturing processes.
Transport and energy needs for packaging are less significant in comparison to the other sub-systems defined.

7. Proofs

7.1 Radioactivity

Radioactivity is not relevant for the ceramic facade elements.

7.2 Exudation of Lye

Testing Institute: Forschungsinstitut für Anorganische Werkstoffe Glas/Keramik GmbH (FGK).

Protocol: Chemical Investigations in accordance with /LAGA Directive No.20/ (Status: 05.11.2004), Table II 1.4-5 and Table II 1.4-6 and in accordance with Waste Disposal Ordinance (DepV) (Status: 16.07.2009)

Date: Test report 1092-11-2 of 29.02.12.

Outcome: The concentrations measures in the eluate are significantly below the boundary values.

8. Literary References

National technical approval:
National technical approval No. Z-10.3-796 of the Deutsches Institut für Bautechnik (DIBt) dated 15.11.2018

National technical Approval:
National technical approval No. Z-10.3-798 of the Deutsches Institut für Bautechnik (DIBt) dated 16.05.2018

/EN 1304/
DIN EN 1304:2013-08, Clay roofing tiles and fitting – Product definitions and specifications; German version EN 1304:2013

/EN 60672-2/
DIN EN 60672-2:2000-10, Ceramic and glass Insulating materials - Part 2: Testing methods (IEC 60672- 2:1999); German version EN 60672-2:2000

/EN 539-2/
DIN EN 539-2, - Clay roofing tiles for discontinuous laying – Determination of physical characteristics - Part 2: Test for frost resistance; German version EN 539- 2:2013.

/EN 13501/
DIN EN 13501-1:2010-01, Fire classification of construction products and building elements – Part 1: Classification using data from reaction to fire tests; German version EN 13501-1:2007+A1:2009.

/EN 10545/
DIN EN 10545:1997-12, Ceramic tiles and panels - Part 12: Determination of frost-resistance (ISO 10545-12:1995); German version EN ISO 10545-12:1997**/**

Institut Bauen und Umwelt e.V. (publ.): Product Category Rules for Construction Products Part B: requirement of the EPD for ceramic cladding, v1.6, 2017

Institut Bauen und Umwelt e.V. (publ.): Product Category Rules for construction referenced Products and Services. Part A: Calculation rules for the Life Cycle Assessment and requirements of the Project Report, Version 1.7, 2018.

/EMPA/

EMPA (*Swiss Material Testing and Research Institution*): Embodied Energy in aluminium building products under consideration of the corrected value allocation, Dübendorf, 2008

GaBi 8.7: thinkstep AG: GaBi 8.7: Software System and Database for overall assessment. Copyright, TM. Stuttgart, Echterdingen, Germany. Program version 8.7., 1992-2018. http://www.gabi-software.com/international/ support/

LAGA (German Federal and State Waste Working Group) Directive No. 20: (Status 05.11.2004), Table II 1.4-5 and Table II 1.4-6 and in accordance with Depositing Regulation (DepV) Status 16.07.2009

/European Waste Catalogue (EAK)/
European Waste catalogue (EAK) in der edition of the resolution of the Commission 2001/118/EG dated 16. January 2001 on changing decision 2000/532/EG on a List of Wastes.

/IBU 2016/
IBU (2016): General EPD program instructions from Institut Bauen und Umwelt e.V. (IBU). Version 1.1, Institut Bauen und Umwelt e.V., Berlin.

/ISO 14025/
DIN EN /ISO 14025:2011-10/, Environmental characteristics and declarations - Type III Environmental Declarations – principles and procedures.

/EN 15804/
/EN 15804:2012-04+A1 2013/, Sustainability of Built Structures- Environmental Product Declarations – basic rules for the product category construction products.

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