ENVIRONMENTAL PRODUCT DECLARATION

as per /ISO 14025/ and /EN 15804/

Owner of the Declaration	Xella Baustoffe GmbH
Programme holder	Institut Bauen und Umwelt e.V. (IBU)
Publisher	Institut Bauen und Umwelt e.V. (IBU)
Declaration number	EPD-XEL-20170147-IAD1-EN
Issue date	09/11/2017
Valid to	08/11/2022

Ytong® Autoclaved Aerated Concrete

Xella Baustoffe GmbH

Institut Bauen und Umwelt e.V.

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

YTONG®

1. General Information

Xella Baustoffe GmbH	Ytong® Autoclaved Aerated Concrete
Programme holder IBU - Institut Bauen und Umwelt e.V. Panoramastr. 1 10178 Berlin Germany	**Owner of the Declaration** Xella Baustoffe GmbH Düsseldorfer Landstraße 395 47259 Duisburg
Declaration number EPD-XEL-20170147-IAD1-EN	**Declared product / Declared unit** 1 m³ unreinforced Ytong® Autoclaved Aerated Concrete with an average gross density of 438 kg/m³.
This Declaration is based on the Product Category Rules: Aereated Concrete, 07.2014 (PCR tested and approved by the SVR)	**Scope:** This LCA is based on consideration of each of the 10 German Autoclaved Aerated Concrete plants operated by the Xella Group and the data from 2016.
Issue date 09/11/2017	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.
Valid to 08/11/2022	**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)	Patricia Wolf (Independent verifier appointed by SVR)

2. Product

2.1 Product description / Product definition

The products under review are unreinforced components of various formats made of Autoclaved Aerated Concrete (AAC). AAC is classified as a porous, steam-cured lightweight concrete.
Directive (EU) No. 305/2011 /CPR/ applies for placing the product on the market in the EU/EFTA (with the exception of Switzerland). The product requires a Declaration of Performance taking consideration of the /EN 771-4:2015-11/ and CE marking. Use is governed by the respective national regulations.

2.2 Application

Unreinforced components for masonry, monolithic, supporting and non-supporting walls. Direct contact with water is avoided for technical structural reasons.

2.3 Technical Data

The product's performance values correspond with the Declaration of Performance in terms of its essential properties in accordance with /EN 771-4:2015-11/.

Technical construction data

Name	Value	Unit
Gross density	250 - 800	kg/m³
Compressive strength	1.6 - 10	N/mm²
Tensile strength	0.24 - 1.2	N/mm²
Bending tensile strength	0,44 - 2,2	N/mm²
Modulus of elasticity	750 - 3250	N/mm²
Equilibrium moisture content at 23 °C, 80%	< 4	M-%
Shrinkage acc. to /DIN EN 680/	< 0,2	mm/m
Thermal conductivity acc. to /DIN 12664/	0.07 - 0.18	W/(mK)
Water vapour diffusion resistance factor acc. to /DIN 4108-4/	5/10	-
Sound insulation acc. to /DIN EN ISO 717-1/ für m' ≤ 250 [kg/m²]	R'w,R=28*log(m')-18	[dB]
Sound insulation acc. to /DIN EN ISO 717-1/ für m' > 250 [kg/m²]	R'w,R=28*log(m')-20	[dB]

2.4 Delivery status

Components in accordance with /DIN 20000-404/ and /DIN 4166/.

2.5 Base materials / Ancillary materials

Sand	50 – 70% by mass
Cement	15 – 30% by mass
Unhydrated lime	10 – 20% by mass
Anhydrite/Gypsum	2 – 5% by mass
Aluminium	0.05 – 0.1% by mass
Mould oil	ancillary material

50–75% water by mass (with reference to the solid materials) is also used.

Sand: The sand used is a natural raw material which contains quartz (SiO_2) 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.
Cement: In accordance with /DIN EN 197-1/, cement serves as a binding agent and is largely manufactured from lime marl or a mixture of lime and clay. The natural raw materials are burned before being ground.
Unhydrated lime: In accordance with /DIN EN 459-1/, unhydrated lime serves as a binding agent and is manufactured by burning natural lime.
Anhydrite / Gypsum: In accordance with /DIN EN 13279-1/; the sulphate agent used serves towards influencing the curing time for the AAC and originates from natural reserves or is produced technically.
Aluminium: Aluminium powder or paste serves as a pore-forming agent. Metallic aluminium reacts in the alkaline environment when hydrogen gas is added which forms the pores and then evaporates after the fermenting process.
Water: The availability of water is a fundamental basis for the hydraulic reaction undergone by the binding agents. Water is also required for manufacturing a homogeneous suspension.
Mould oil: Mould oil is used as a release agent between the mould and the raw AAC mixture. PAC (polycyclic aromatic carbons) are used - free mineral oils plus long-chain additives for increasing viscosity. This prevents it from running out of the mould and permits economical application.

2.6 Manufacture

The ground quartz sand is mixed with lime, cement and crushed recycled AAC material, adding water and aluminium powder or paste, in a mixer to form an aqueous suspension and cast in moulds. The water quenches the lime under heat generation. The aluminium reacts in an alkaline environment, whereby gaseous hydrogen is formed which generates the pores in the raw mixture and evaporates without residue. The pores usually have a diameter of 0.5 – 1.5 mm and are exclusively filled with air. The initial binding process results in semi-solid ingots from which the AAC components are automatically cut at high speed.
The final AAC characteristics are formed during the subsequent steam curing process over 5 to 12 hours at approx. 190 °C and pressure of approx. 12 bar in steam pressure chambers, so-called autoclaves, where the substances used form calcium silicate hydrates which correspond to the tobermorit mineral prevailing in nature. The material reaction is concluded on removal from the autoclave. The steam is used for other autoclave cycles once the curing process is finished. The condensate incurred is used as process water. This saves energy and avoids pollution by hot steam and waste water.
AAC components are then stacked on wooden pallets and shrink-wrapped in recyclable polyethylene (PE) foil.

2.7 Environment and health during manufacturing

The applicable regulations of the professional liability associations apply; no special measures need to be taken to protect employee health.

2.8 Product processing/Installation

AAC blocks are processed by hand; lifting equipment is required for components whose mass exceeds 25 kg. Components are cut using band saws or by hand-held carbide saws as they only generate coarse dust and no fine dust. High-speed tools such as angle grinders are not suitable for processing AAC as they release fine dust.
The AAC components are connected with each other and with other standardised construction materials in thin-bed mortar according to /DIN EN 1996-1-1/ in combination with /DIN EN 1996-1-1/NA/A2/ and /DIN EN 1996-2/ in combination with /DIN EN 1996-2/NA/ with or without mortared butt joints. In special cases, using normal or lightweight mortar (11 kg mortar / m³).
The AAC components can be plastered, coated or painted. Panelling with small-format parts or fair-face cavity brickwork is also possible.
The professional liability associations' rules apply. No special environmental protection measures need to be taken while processing the building product.

2.9 Packaging

Packaging and pallets incurred on the building site must be collected separately. Polyethylene shrink wrap foil is recyclable. Clean PE foil and reusable wooden pallets are taken back by the building trade (reusable pallets remunerated in the German deposit system) which returns them to the AAC plants which then redirect foils to the foil manufacturers for recycling.

2.10 Condition of use

As outlined under 2.6 "Manufacturing", AAC primarily comprises tobermorit, a natural mineral. It also contains non-reacting starting components, primarily rough quartz and possibly carbonates. The pores are full of air.

2.11 Environment and health during use

In accordance with the current state of knowledge, AAC does not emit any harmful substances such as VOC, for example.
The naturally ionising radiation of AAC products is extremely low permitting unlimited use of this material from a radiological perspective (see 7.1 Radioactivity)

2.12 Reference service life

AAC does not alter its appearance after leaving the autoclave. It displays unlimited resistance properties when used as designated.

2.13 Extraordinary effects

Fire
In the event of a fire, no toxic gases and vapours can arise

Fire safety acc. to /EN 13501-1/

Name	Value
Building material class	A1
Smoke gas development	s1
Burning droplets	d0

Water
When exposed to water (e.g. flooding), AAC reacts slightly alkaline. No substances are washed out which could be hazardous to water.

Mechanical destruction
No details.

2.14 Re-use phase
Sorted residual AAC can be taken back by the AAC manufacturers and re-used or recycled. This practice has been applied with broken product for decades. This material is either processed as granulate products or added to the AAC mixture as a substitute for sand.

2.15 Disposal
In accordance with the German Landfill Ordinance of 27.04.2009 /DepV/, AAC must be disposed of on Class I landfills (see 7.2 Leaching).
Waste key as per /AVV/: 17 01 01.

2.16 Further information
More information is available at www.ytong-silka.de

3. LCA: Calculation rules

3.1 Declared Unit
This Environmental Product Declaration refers to the product stage (Modules A1-A3) for 1 m³ Ytong® unreinforced AAC with an average gross density of 438 kg/m³.
The AAC blocks produced have a gross density of 350 kg/m³ to 700 kg/m³.
The results represent the average production mix for Xella (Germany)

Declared unit

Name	Value	Unit
Declared unit	1	m^3
Gross density	438	kg/m^3
Conversion factor to 1 kg	0.0022831	-

3.2 System boundary
Type of EPD: cradle to plant gate
The LCA for Ytong® AAC considers the life cycle phases of product manufacturing (A1-A3).
Product installation (Modules A4-A5) and the use stage (Module B) are not considered in this study. Nor is disposal (Module C) considered in this study.
Balancing the modules under review does not result in any credits or loads outside the system boundary

3.3 Estimates and assumptions
Specific /GaBi processes/ (software system for comprehensive analysis) are not available for all additives and ancillary materials. The following assumptions were made:
The percentage by mass is < 0.2% for the grinding media and cutting wires. The “DE sheet steel” data set represents steel production including further processing steps similar to those for grinding media and cutting wire

3.4 Cut-off criteria
With the exception of one ancillary material, all data from the operating data survey was taken into consideration in the analysis, i.e. all starting materials used according to the recipe, the thermal energy used as well as electricity and diesel consumption. As an ancillary material, sodium sulphite is ignored accounting for an input volume of < 0.001%.
Specific transport distances were considered for all raw materials weighted by mass; assumptions regarding transport expenses were made for the remaining inputs and outputs.
Accordingly, material and energy flows with a share of less than 1 per cent were also considered.
The manufacture of machinery, plants and other infrastructure required for production of the items under review was not taken into consideration in the LCA.
It can be assumed that the processes ignored would have contributed less than 5% to the impact categories under review

3.5 Background data
The “GaBi 7.3” software system for comprehensive analysis developed by thinkstep AG was used for modelling the AAC production process. The consistent data sets contained in the GaBi data base are documented in the online GaBi documentation /GaBi ts/. 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 2013 is applied.

3.6 Data quality
All of the background data of relevance for production was taken from the GaBi 7.3 /GaBi ts/ software data base or supplied by Xella. The background data used was last revised less than 3 years ago.

3.7 Period under review
The data applied for this LCA is based on data recorded for the manufacture of AAC in 2016. The volumes of energy and raw materials, ancillary materials and consumables used were considered as average annual values in 10 plants.

3.8 Allocation
AAC products of various formats are manufactured in the plants. They can be reinforced and unreinforced. The production of reinforced AAC was not considered in this study. Reinforced AAC is produced by Xella at three locations in Germany. Energy and material inputs for AAC with and without reinforcement were allocated and/or calculated separately for these locations and in accordance with the production data.
Production incurs AAC rubble which is largely refined as AAC granulate. The environmental impacts of AAC manufacturing and the rubble used for manufacturing AAC granulate were allocated by mass. Approx. 10% of the environmental loads and raw materials used are allocated to AAC granulate (see /EPD AAC granulate/).
During the production process, AAC rubble and AAC powder are also incurred which are redirected to the production process (closed-loop recycling). This internal recycling was considered in the calculation.

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.
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4. LCA: Scenarios and additional technical information

Modules A4-D are not taken into consideration in this LCA.

5. LCA: Results

The environmental impacts of 1 m³ Ytong® unreinforced AAC with an average gross density of 438 kg/m³, manufactured by Xella in Germany, are outlined below.
Modules marked "x" in the following overview as per /DIN EN 15804/ are not addressed here.
The following tables depict the results of the indicators of the estimated impact, use of resources, waste and other output flows in relation to 1 m³ Ytong® AAC.

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	MND	MND	MND	MND	MNR	MNR	MNR	MND	MND	MND	MND	MND	MND	MND

RESULTS OF THE LCA - ENVIRONMENTAL IMPACT: 1 m³ Ytong® Autoclaved Aerated Concrete

Parameter	Unit	A1-A3
Global warming potential	[kg CO_2-Eq.]	167.00
Depletion potential of the stratospheric ozone layer	[kg CFC11-Eq.]	1.62E-10
Acidification potential of land and water	[kg SO_2-Eq.]	1.83E-1
Eutrophication potential	[kg $(PO_4)^{3-}$-Eq.]	2.33E-2
Formation potential of tropospheric ozone photochemical oxidants	[kg ethene-Eq.]	1.68E-2
Abiotic depletion potential for non-fossil resources	[kg Sb-Eq.]	4.48E-4
Abiotic depletion potential for fossil resources	[MJ]	1.00E+3

RESULTS OF THE LCA - RESOURCE USE: 1 m³ Ytong® Autoclaved Aerated Concrete

Parameter	Unit	A1-A3
Renewable primary energy as energy carrier	[MJ]	1.98E+2
Renewable primary energy resources as material utilization	[MJ]	1.65E+2
Total use of renewable primary energy resources	[MJ]	3.63E+2
Non-renewable primary energy as energy carrier	[MJ]	1.02E+3
Non-renewable primary energy as material utilization	[MJ]	6.87E+1
Total use of non-renewable primary energy resources	[MJ]	1.09E+3
Use of secondary material	[kg]	0.00
Use of renewable secondary fuels	[MJ]	0.00
Use of non-renewable secondary fuels	[MJ]	0.00
Use of net fresh water	[m³]	2.47E-1

RESULTS OF THE LCA – OUTPUT FLOWS AND WASTE CATEGORIES: 1 m³ Ytong® Autoclaved Aerated Concrete

Parameter	Unit	A1-A3
Hazardous waste disposed	[kg]	4.02E-6
Non-hazardous waste disposed	[kg]	1.45E+1
Radioactive waste disposed	[kg]	3.21E-2
Components for re-use	[kg]	0.00
Materials for recycling	[kg]	0.00
Materials for energy recovery	[kg]	0.00
Exported electrical energy	[MJ]	0.00
Exported thermal energy	[MJ]	0.00

Note on the first indicator in the third table “Hazardous waste for landfilling”: in accordance with the /DIN EN 15804/, hazardous waste for landfilling is modelled until it reaches its end-of-waste status.

6. LCA: Interpretation

Within the framework of a dominance analysis, it is apparent that the environmental impacts of AAC manufacturing are dominated by the preliminary products in most impact categories. Energy requirements only have a significant influence during manufacturing in the fossil abiotic depletion of resources (**ADP** fossil) impact category.
The anhydrite has a significant impact in the elementary abiotic depletion of resources (**ADP** elements) impact category. The binding agents have a relevant influence here.
Both the binding agents and aluminium have a relevant influence on the ozone depletion potential (**ODP**). All other categories are dominated by the binding agents

7. Requisite evidence

A manufacturer's declaration is available according to which the composition of base materials, the manufacturing process and product features of the Xella® products under review have remained unchanged since the evidence outlined below was issued. Accordingly, the evidence applies in full.

7.1 Radioactivity

Method: Measurements of the nuclide content in Bq/kg, determining the Activity Index I
Summarising report: /BfS-SW-14-/12/, 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

Leaching by landfilled AAC is of significance for assessing its environmental impact after use. /LGA 2007/, /LGA 2011/
Measuring agency: LGA Institut für Umweltgeologie und Altlasten GmbH, Nuremberg
Result: All criteria for landfilling in class I landfills are complied with in accordance with the Landfill Ordinance /DepV/ dated 27.04.2009 applicable in Germany. In accordance with the Council Decision (2003/33/EC) dated 19 December 2002, AAC is to be allocated to the “Non-hazardous waste” landfill class.

8. References

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DIN EN 1996-2/NA: 2012-01; Nationaler Anhang - National festgelegte Parameter - Eurocode 6: Bemessung und Konstruktion von Mauerwerksbauten - Teil 2: Planung, Auswahl der Baustoffe und Ausführung von Mauerwerk

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DIN EN ISO 717-1:2013-06; Akustik - Bewertung der Schalldämmung in Gebäuden und von Bauteilen - Teil 1: Luftschalldämmung

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DIN EN 197-1: 2011-11; Zement - Teil 1: Zusammensetzung, Anforderungen und

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DIN EN 680: 2005-12; Bestimmung des Schwindens von dampfgehärtetem Porenbeton

EN 771-4: 2015-11; Festlegungen für Mauersteine - Teil 4: Porenbetonsteine; Deutsche Fassung EN 771-4:2011+A1:2015

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EPD Porenbetongranulat:
Ytong® - Granulat
EPD-XEL-20170148-IAD-1-DE

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