ENVIRONMENTAL PRODUCT DECLARATION

as per /ISO 14025/ and /EN 15804/

Owner of the Declaration	**Xella Aircrete Systems GmbH**
Programme holder	Institut Bauen und Umwelt e.V. (IBU)
Publisher	Institut Bauen und Umwelt e.V. (IBU)
Declaration number	EPD-IAD-20160116-IAC1-EN
Issue date	20/09/2016
Valid to	19/09/2021

Hebel Autoclaved Aerated Concrete
Xella Aircrete Systems GmbH

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

1. General Information

Xella Aircrete Systems GmbH	Hebel Autoclaved Aerated Concrete
Programme holder IBU - Institut Bauen und Umwelt e.V. Panoramastr. 1 10178 Berlin Germany	**Owner of the Declaration** Xella Aircrete Systems GmbH Düsseldorfer Landstraße 395 D-47259 Duisburg
Declaration number EPD-IAD-20160116-IAC1-EN	**Declared product / Declared unit** 1 m³ Hebel Autoclaved Aerated Concrete with an average gross density of 550 kg/m3, including 25.6 kg reinforcement.
This Declaration is based on the Product Category Rules: Aereated Concrete, 07.2014 (PCR tested and approved by the SVR)	**Scope:** The LCA is based on data for 2014 from the German Xella plants in Alzenau, Laußig and Rotenburg. In Germany, Xella only produces reinforced Autoclaved Aerated Concrete in these plants. 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 20/09/2016	
Valid to 19/09/2021	**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)	Patricia Wolf (Independent verifier appointed by SVR)

2. Product

2.1 Product description / Product definition

The products under review are reinforced elements of various formats made of Autoclaved Aerated Concrete (AAC). AAC is classified as a porous, steam-cured lightweight concrete.

/EU Directive No. 305/2011/ applies for placing the product on the market in the EU/EFTA (with the exception of Switzerland). The products require a Declaration of Performance taking consideration of the /DIN EN 12602: 2013-10 Prefabricated reinforced components of Autoclaved Aerated Concrete/ and CE marking.

2.2 Application

Reinforced components for roofs, ceilings and supporting and non-supporting walls. Direct contact with water is avoided for technical structural reasons.

2.3 Technical Data

Noise protection acc. to /DIN 4109/, at m(mean) 300 kg/m²:
R' w,R=28*log(m')-18 [dB] for m' ≤ 250 [kg/m²]
R' w,R=28*log(m')-20 [dB] for m' > 250 [kg/m²]

Name	Value	Unit
Compressive strength	2 - 8	N/mm²
Gross density	300 - 800	kg/m³
Tensile strength	0.24 - 1.2	N/mm²
Modulus of elasticity	750 - 3250	N/mm²
Thermal conductivity	0.08 - 0.22	W/(mK)
Water vapour diffusion resistance factor acc. to /DIN 4108-4/	5/10	-
Equilibrium moisture content at 23 °C, 80%	< 4	M.-%
Tensile bending strength (longitudinal)	0,44 - 2,2	N/mm²
Shrinkage acc. to /DIN EN 680/	< 0,2	mm/m

2.4 Delivery status

Reinforced AAC as per /DIN EN 12602: 2013-10/.

2.5 Base materials / Ancillary materials

Base materials

Name	Value	Unit
Sand	60-70	M-%
Cement	15-30	M-%

Unhydrated lime	8-20	M-%
Anhydrite/Gypsum	2-5	M-%
Aluminium	0.05-0.1	M-%

50-75% water by mass (with reference to the solid materials) is also used.
An average of 25.6 kg reinforced steel is also installed per m³.

Sand: The sand used is a natural raw material which contains quartz (SiO_2) as a primary mineral as well as 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: The sulphate agent used serves towards influencing the curing time for the raw mixture and originates from natural reserves or is produced technically.
Aluminium: Aluminium powder and paste serve as a pore-forming agent. Metallic aluminium reacts in the alkaline environment releases hydrogen gas which forms the pores and then evaporates after the fermenting process.
Steel: Produced in an electric light arc furnace, manufactured to wire rod, bonded to reinforced concrete mats by means of spot welding and assembled as cages.
Mould oil: Mould oil is used as a release agent between the mould and the raw AAC mixture. Mineral oils are used which are free of polycyclic aromatic hydrocarbons and with added long-chain additives to increase viscosity. This prevents it from running down in the mould and permits economical application.
Anti-corrosive agents: Anti-corrosive agents prevent reinforcement corrosion in assembly components. Primarily stable aqueous dispersions based on bitumen and organic polymers (oxidative crosslinking) are used.
Waterproofing agents: Waterproofing agents reduce water absorption by assembly components and are applied if so requested by the customer. Water-soluble methyl siliconates are used.
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

2.6 Manufacture
The ground quartz sand is mixed with the other base materials, adding water and aluminium paste, in a mixer to form a raw mixture and cast in moulds. The water hydrates the lime under heat generation.
Steel reinforcement is manufactured in the AAC plant. Prior to installation in the casting moulds, the reinforcing elements are treated by dipping in anti-corrosive agent.
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 panels are automatically cut with high precision.
The final characteristics of the components are formed during the subsequent steam curing process over 6 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 no waste water is incurred.

2.7 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.

2.8 Product processing/Installation
The reinforced AAC elements are processed using lifting gear. The components are not divided as the reinforced elements are already cut to size in the manufacturing plant. High-speed tools such as angle grinders must be equipped with a corresponding extraction unit as they release fine dust.
The AAC components are usually connected to the supporting construction using anchors; in special cases, with thin-bed mortar in accordance with /DIN EN 998-2/ or with normal or lightweight mortar (11 kg mortar / m³). The AAC components can be plastered, coated or painted. Panelling with small-format parts in a curtain-type facade or fair-face cavity brickwork as per /DIN EN 1996-1-1/ is also possible.
The corresponding IBU Declarations are to be considered for assessing mortar, coatings and adhesive.

2.9 Packaging
Hebel elements are stacked on pallets or squared timbers and strapped or welded in recyclable shrink-film made of polyethylene (PE).

2.10 Condition of use
As outlined in section 2.7 “Manufacturing”, AAC largely comprises tobermorite and non-reacting starting components, primarily 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 Hebel elements is extremely low permitting unlimited use of this material from a radiological perspective (see 7.1 Radioactivity).

2.12 Reference service life
Hebel AAC displays unlimited resistance properties when used as designated.

2.13 Extraordinary effects

Fire
In the event of a fire, no toxic gases or vapours can arise. Hebel AAC complies with the requirements of building material class A1 ("non-combustible") in accordance with /DIN EN 13501-1/.

Fire protection

Name	Value
Building material class	A1

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
In the case of mechanical destruction, e.g. during earthquakes, no substances are released.

2.14 Re-use phase
Sorted residual AAC can be taken back by the AAC manufacturers and re-used or further recovered. 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
AAC can be stored in class I landfills in accordance with the Landfill Directive /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 (see 7.2 Leaching).
Waste code in accordance with the /European Waste Catalogue/ (EWC): 17 01 01.

2.16 Further information
Additional information available online at www.hebel.de.

3. LCA: Calculation rules

3.1 Declared Unit
The declaration refers to the manufacture of 1 m³ reinforced HEBEL AAC with an average gross density of 550 kg/m³, including 25.6 kg reinforcing steel.

Deklared unit

Name	Value	Unit
Declared unit	1	m^3
Gross density	550	kg/m^3
Conversion factor to 1 kg	0.00182	-

In the case of AAC with deviating gross density, the environmental indicators and LCA parameters can be scaled via the mass as there is a direct connection between the use of materials/energy and gross density on the production side.
In comparison to the declared gross density of 550 kg/m³, for example, a gross density of 600 kg/m² increases the environmental impact and LCA parameters by 9%.

3.2 System boundary
Type of EPD: cradle to plant gate
The following individual processes are included in the Product stage A1-A3 of manufacturing the AAC products:

- Raw material, packaging and energy supply processes
- Transporting the raw materials to the production facility
- Manufacturing process in the plant including energy, manufacturing auxiliaries, disposing of any residual materials incurre.

3.3 Estimates and assumptions
The study does not require any approximations or assumptions in the background system. All raw materials and energy processes required are available as generic data sets in the GaBi data base /GaBi ts/.

3.4 Cut-off criteria
All data from the operating data survey was taken into consideration, i.e. all starting materials used according to the formula, the thermal and electrical energy used, in-plant transport, ancillary materials as well as waste and waste water treatment. Accordingly, material and energy flows with a share of less than 1 per cent were also considered.

3.5 Background data
The software system for comprehensive analysis /GaBi ts/ 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. The Life Cycle Assessment was modelled for Germany as a reference area.

3.6 Data quality
All of the background data records of relevance for manufacturing were taken from the /GaBi ts/ software data base. Primary data was supplied by Xella Aircrete Systems GmbH.
The background data used was last revised less than 1 year ago. The production data involves up-to-date industrial data from 2014.
The data quality can be regarded as good for modelling. The corresponding data sets are available in the GaBi data base for all of the relevant preliminary products and auxiliaries used.

3.7 Period under review
The data applied for this LCA is based on data recorded for the manufacture of average AAC in 2014. The volumes of raw materials, energy, ancillary materials and consumables used were considered as average annual values in the plants.

3.8 Allocation
Allocation for background data
Information on the individual data sets is documented at http://database-documentation.gabi-software.com/support/gabi/.
Allocation for primary data
In the plants, unreinforced AAC blocks/elements and some AAC granulate are manufactured as well as reinforced AAC. As the annual consumption data is only available aggregated with the corresponding product mixture, the input and output flows are allocated.
Raw materials, ancillary materials and water are allocated by mass. Exceptions are represented by the raw materials, all of which are used for reinforced products, e.g. corrosion protection in the form of bitumen layers and reinforced steel.

In terms of energy consumption, this LCA assumes that reinforced AAC requires twice the volume of electricity and thermal energy as the other products, based on individual measurements by Xella. Packaging expenses and output flows such as waste, waste water and emissions are allocated by mass.

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. The used background database has to be mentioned.

4. LCA: Scenarios and additional technical information

5. LCA: Results

The environmental impacts of 1 m³ HEBEL reinforced AAC manufactured by Xella are presented 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)

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 HEBEL reinforced Autoclaved Aerated Concrete (550 kg/m³)

Parameter	Unit	A1-A3
Global warming potential	[kg CO_2-Eq.]	307.03
Depletion potential of the stratospheric ozone layer	[kg CFC11-Eq.]	5.21E-9
Acidification potential of land and water	[kg SO_2-Eq.]	3.42E-1
Eutrophication potential	[kg $(PO_4)^{3-}$-Eq.]	4.12E-2
Formation potential of tropospheric ozone photochemical oxidants	[kg ethene-Eq.]	3.79E-2
Abiotic depletion potential for non-fossil resources	[kg Sb-Eq.]	2.16E-4
Abiotic depletion potential for fossil resources	[MJ]	1953.44

RESULTS OF THE LCA - RESOURCE USE: 1 m³ HEBEL reinforced Autoclaved Aerated Concrete (550 kg/m³)

Parameter	Unit	A1-A3
Renewable primary energy as energy carrier	[MJ]	346.65
Renewable primary energy resources as material utilization	[MJ]	40.54
Total use of renewable primary energy resources	[MJ]	387.19
Non-renewable primary energy as energy carrier	[MJ]	2110.20
Non-renewable primary energy as material utilization	[MJ]	25.97
Total use of non-renewable primary energy resources	[MJ]	2136.17
Use of secondary material	[kg]	0.00
Use of renewable secondary fuels	[MJ]	18.34
Use of non-renewable secondary fuels	[MJ]	281.80
Use of net fresh water	[m³]	1.10

RESULTS OF THE LCA – OUTPUT FLOWS AND WASTE CATEGORIES: 1 m³ HEBEL reinforced Autoclaved Aerated Concrete (550 kg/m³)

Parameter	Unit	A1-A3
Hazardous waste disposed	[kg]	1.22E-5
Non-hazardous waste disposed	[kg]	9.23
Radioactive waste disposed	[kg]	7.25E-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

6. LCA: Interpretation

The greatest contribution to the global warming potential (GWP) is made by cement, accounting for 38% during the manufacture of AAC. Lime (CaO) as a material is also of essential significance, necessitated by the energy-intensive firing process accompanied by the release of carbon dioxide through deacidification. Third place is taken by energy consumption during the production of AAC as one of the key causes of global warming potential and accounting for around 21%. Reinforced steel plays a subordinate role at 6%.

Packaging, transport, production and other raw materials used are of minor relevance.
Non-renewable primary energy (PENRT) does not display any fundamentally deviating image of distribution. Although the focus is on direct energy consumption accounting for approx. 46%, cement and lime are also the most important causes here. Accounting for 13%, steel is also of significance. The reason why cement plays a more minor role here in a comparison of the global warming potential analysis

concerns the use of secondary fuels, among others, which although they release CO2 when burned, do not contribute to primary energy consumption.
Distribution of the environmental impacts considered in detail here is also reflected in the other impact categories under review.

The following graphic aims to illustrate the environmental results:

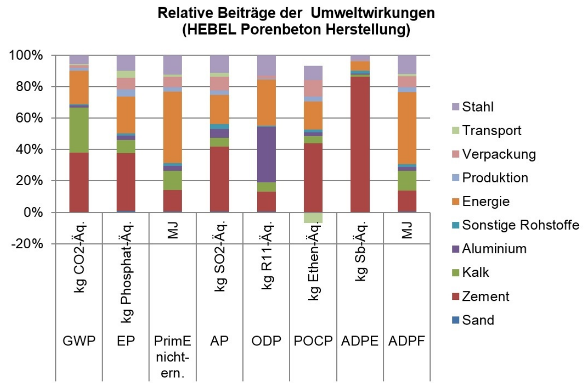

Fig.: Analysis of HEBEL production A1-A3 as an overview (relative contributions)

Relative Beiträge der Umweltwirkungen (HEBEL Porenbeton Herstellung)	Relative contributions to environmental impacts (HEBEL aerated concrete production)	ADPF [MJ]	ADPF [MJ]
		Stahl	Steel
		Transport	Transport
		Verpackung	Packaging
GWP [kg CO2-Äq.]	GWP [kg CO_2 equiv.]	Produktion	Production
EP [kg Phosphat-Äq.]	EP [kg phosphate equiv.]	Energie	Energy
PrimE nicht-ern. [MJ]	PENRE [MJ]	Sonstige Rohstoffe	Other raw materials
AP [kg SO2-Äq.]	AP [kg SO2 equiv.]	Aluminium	Aluminium
ODP [kg R11-Äq.]	ODP [kg R11 equiv.]	Kalk	Lime
POCP [kg Ethen-Äq.]	POCP [kg ethene equiv.]	Zement	Cement
ADPE [kg Sb-Äq.]	ADPE [kg Sb equiv.]	Sand	Sand

Cement displays shares of around 40% in the GWP, EP, AP and POCP impact categories. In terms of ADPE, cement accounts for approx. 85%, necessitated by the use of natural gypsum. Exceptions are represented by ADPF and PENRT which are only determined by 17% by cement.
Electricity and thermal energy, summarised in the “Energy” group, largely cause between 20 and 50% of environmental impact. An exception is represented by ADPE which only contributes to 6% of energy. The influence by energy is particularly high with regard to non-renewable primary energy and ADPF.
Unhydrated lime plays a role in the global warming potential in particular; approx. one third of the GWP is caused by extracting unhydrated lime. In other environmental impacts, the influence is of moderate significance with values of 12% for ADP fossil, 8% and less for eutrification.
Aluminium paste is of relevance to ozone depletion where it accounts for 35%. The high use of energy in the form of electricity in aluminium mining plays a significant role here.
Despite its high mass percentage, sand is of minor significance accounting for less than 2% in all environmental categories. The transport processes, packaging, production and other raw materials are also of very minor significance for the AAC environmental profile.
Depending on the impact category, the contribution made by steel accounts for between 3 and 13%, whereby primary energy consumption, ODP and POCP should be highlighted.

7. Requisite evidence

7.1 Radioactivity

Measuring agency: Bundesamt für Strahlenschutz (Federal Office for Radiation Protection), Salzgitter
Method: Measurement of the nuclide content in Bq/kg, determining the Activity Index I
Test report: /BfS-SW-14/12/, 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). All mineral base materials contain low volumes of natural radioactive substances. Measurements indicate that natural radioactivity permits unrestricted usage of this construction material from a radiological perspective.

7.2 Leaching

Leaching by landfilled AAC is of significance for assessing its environmental impact after use.
Measuring agency: LGA Institut für Umweltgeologie und Altlasten GmbH , Nuremberg
Test report 1: Leaching tests on AAC for evaluating environmental risks in relation to the de minimis thresholds (GFS) of the LAWA /IUA 2007249/ dated 07.12.2007
Test report 2: Examination of AAC in terms of disposal
/IUA 2009276/ dated 03.03.2010
Result: All criteria for landfilling in class I landfills are complied with in accordance with the Landfill Ordinance 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.

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

DIN EN 998-2: 2010-12; Festlegungen für Mörtel im Mauerwerksbau - Teil 2: Mauermörtel

DIN EN 1996-1-1: 2013-02; Eurocode 6: Bemessung und Konstruktion von Mauerwerksbauten - Teil 1-1: Allgemeine Regeln für bewehrtes und unbewehrtes Mauerwerk; Deutsche Fassung EN 1996-1-1:2005+A1:2012

DIN EN 12602: 2013-10 Vorgefertigte bewehrte Bauteile aus dampfgehärtetem Porenbeton

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