ENVIRONMENTAL PRODUCT DECLARATION

as per *ISO 14025* and *EN 15804+A2*

Owner of the Declaration	H+H Deutschland GmbH
Programme holder	Institut Bauen und Umwelt e.V. (IBU)
Publisher	Institut Bauen und Umwelt e.V. (IBU)
Declaration number	EPD-HHD-20220225-IBA1-EN
Issue date	29.11.2022
Valid to	28.11.2027

H+H Celcon Vertical Wall Panels - Precast Autoclaved Aerated Concrete Wall Elements

Institut Bauen und Umwelt e.V.

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1. General Information

Name of the manufacturer

Programme holder
IBU – Institut Bauen und Umwelt e.V.
Hegelplatz 1
10117 Berlin
Germany

Declaration number
EPD-HHD-20220225-IBA1-EN

This declaration is based on the product category rules:
Aerated concrete, 11.2017
(PCR checked and approved by the SVR)

Issue date
29.11.2022

Valid to
28.11.2027

Dipl. Ing. Hans Peters
(chairman of Institut Bauen und Umwelt e.V.)

Dr. Alexander Röder
(Managing Director Institut Bauen und Umwelt e.V.))

Name of the product

Owner of the declaration
H+H Deutschland GmbH
Industriestr. 3
23829 Wittenborn

Declared product / declared unit
H+H Celcon Vertical Wall Panels / 1 m3

Scope:
This EPD declaration applies to a declared unit of 1 m³ of H+H Celcon Vertical Wall Panel manufactured at the production facility in Wittenborn, Germany. The elements are autoclaved aerated concrete (aircrete) panels which are lightly reinforced with non-structural steel. The collection of primary data at the plant was done in 2020.

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.
The EPD was created according to the specifications of *EN 15804+A2*. In the following, the standard will be simplified as *EN 15804*.

Verification

The standard *EN 15804* serves as the core PCR
Independent verification of the declaration and data according to *ISO 14025:2011*
☐ internally ☒ externally

Prof. Dr. Birgit Grahl
(Independent verifier)

2. Product

2.1 Product description/Product definition

The product covered in this EPD is 1 m³ of H+H Celcon Vertical Wall Panels, with a maximum gross density of 600 kg/m³. These elements are autoclaved aerated concrete (aircrete) panels which are lightly reinforced with non-structural steel to give a lightweight, thermally insulating load-bearing material normally used to form walls.

As a result of the raw materials and manufacturing process, the cellular (small bubbles) internal structure of the blocks gives a low density but good compressive strength. Aerated concrete belongs to the group of porous steam-cured lightweight concretes.

Circulation of the product on the European and UK market is subject to Regulation (EU) No. 305/2011 *(CPR)* as it applies in the United Kingdom. This product requires a declaration of performance taking into consideration: *EN 12602:2016, Prefabricated reinforced components of autoclaved aerated concrete* and CE or UKCA marking. Relevant national regulations apply to its application and use.

2.2 Application

H+H Celcon Vertical Wall Panels are normally used as inner leaves to cavity walls, internal partition walls and separating party walls in houses and other buildings. This product is not intended for unprotected use. The declared product is manufactured in Germany, but is sold and installed in the UK.

2.3 Technical Data

H+H Celcon Vertical Wall Panels are manufactured to *EN 12602:2016, Prefabricated reinforced components of autoclaved aerated concrete*.

The product's compressive strength is ≥ 4.00 N/mm², its gross density is 575 +/- 25 kg/m³, its thermal conductivity is 0.155 W/(mK) and its shrinkage is ≤ 0.20 mm/m.

Constructional Data

Name	Value	Unit
Compressive strength	>/= 4	N/mm²
Gross density	600	kg/m³
Modulus of elasticity	2125	N/mm²
Thermal conductivity	0.155	W/(mK)
Water vapour diffusion resistance	5/10	-

factor acc. to EN 1745, Tab. A10		
Shrinkage acc. to EN 680 as amended	< 0.2	mm/m

The information contained within the constructional specifications table is based on the performance data of the product in accordance with the declaration of performance by *[H+H Deutschland GmbH 2022]* with respect to its essential characteristics according to *EN 12602:2016, Prefabricated reinforced components of autoclaved aerated concrete*.

2.4 Delivery status

H+H Celcon Vertical Wall Panels can be delivered by truck. The panels are available with the following dimensions: height < 3,520 mm, length: 500, 600 mm, wall thickness: 70, 75, 90, 100, 125, 150, 200 mm.

2.5 Base materials/Ancillary materials

The concrete mix proportions for the products are as follows:

Name	Value	Unit
Water	13.6	M-%
Steel	0,9	M-%
Sand	54.3	M-%
Fine grained aerated concrete	2.1	M-%
Quicklime	11.3	M-%
Cement	14.7	M-%
Aluminium paste	0.1	M-%
Anhydrite / gypsum	2.9	M-%

Sand: The sand used is a natural raw material which, in addition to the main mineral quartz (SiO2), contains natural secondary and trace minerals. It is an essential basic material for the hydrothermal reaction during steam curing.

Cement: according to EN 197-1; cement serves as a binder and is mainly produced from limestone marl or a mixture of limestone and clay. These natural raw materials are burned and then ground.

Quicklime: according to EN 459-1; quicklime serves as a binder and is produced by burning natural limestone.

Anhydrite / gypsum: acc. to EN 1169*;* sulphate carrier, serves to influence the setting time of the aerated concrete and comes from natural deposits or is produced technically.

Aluminium: Aluminium powder or paste is used as a porosity-enhancing agent.

Steel: The steel used in the product serves as reinforcement of the aerated concrete component during transport. The steel is not taken into account statically. The dimensioning follows EN 12602.

Water: Water is the medium and reaction partner for the hydraulic and hydrothermal reaction of the binders. Water is also necessary to produce a homogeneous suspension.

1) This product / article / at least one partial article contains substances listed in the candidate list (date: 21.06.2013) exceeding 0.1 percentage by mass: NO.

2) This product /article /at least one partial article contains other CMR substances in categories 1A or 1B which are not on the candidate list, exceeding 0.1 percentage by mass: NO.

3) Biocide products were added to this construction product or it has been treated with biocide products (this then concerns a treated product as defined by the (EU) Ordinance on Biocide Products No. 528/2012): NO.

2.6 Manufacture

The manufacturing process of the H+H Celcon Vertical Wall Panels is based on a combination of natural hydration reactions and accelerated curing processes.

The ground quartz sand is mixed with quicklime, cement and crushed aerated concrete recycled material, with the addition of water and aluminium powder or paste, mixed in a mixer to form an aqueous suspension and is poured into casting moulds. The water slakes the lime whereby heat is generated. The aluminium reacts in an alkaline environment with the water present. The hydrogen released in the process creates the pores in the raw material. After completion of the leavening process, the hydrogen escapes and air remains in the pores. The pores have a diameter of 0.5 to 1.5 mm. After the initial setting, semi-solid raw blocks are produced, from which the various formats of the aerated concrete components are cut with high precision using tensioned wires. The final autoclaved aerated concrete properties are created during the subsequent steam curing process over 5 to 12 hours at about 190 °C and a pressure of approx. 12 bar in steam pressure vessels known as autoclaves. Here, the substances used form calcium- silicate hydrates that correspond to the mineral tobermorite occurring in nature. The reaction of the material is completed when it is removed from the autoclave. The steam is used for further autoclave cycles after the hardening process is completed. The condensate produced is used as process water. In this way, energy is saved and pollution of the environment with hot exhaust steam and waste water is avoided. AAC blocks are then stacked on wooden pallets and shrink-wrapped in recyclable polyethylene (PE) film.

2.7 Environment and health during manufacturing

During the manufacturing process, no impacts on the environment and health are known. The regulations of the employers' liability insurance associations apply and special measures for health protection of employees do not have to be taken.

2.8 Product processing/Installation

H+H Celcon Vertical Wall Panels are typically handled using a crane with an appropriate clamp. Alternative handling equipment may also be used. If necessary, the Vertical Wall Panels may be cut on site, typically using a powered handsaw along with appropriate dust control measures. After installation and alignment, the Wall Panels are temporarily propped until adequate permanent restraint is achieved. Auxiliary items include a proprietary bagged mortar and appropriate ties and fixings which are applied / installed using hand tools.

In addition, the aerated concrete components can be plastered, coated or painted. Cladding with curtain walls or the installation of facing shells is also possible.

2.9 Packaging
H+H Celcon Vertical Wall Panels are delivered on wooden pallets. The product is fixed on the pallets with PE shrink film. Packaging and pallets accrued on the construction site must be collected separately. The resulting packaging waste can be thermally recycled.

2.10 Condition of use
The product consists mainly of mineral substances which may absorb atmospheric CO_2 and recarbonate. This will not affect its solidity or type of use.

2.11 Environment and health during use
Following manufacture, H+H Celcon Vertical Wall Panels are not deemed to be hazardous within the meaning of the *Health and Safety at Work etc. Act 1974*, nor are they chemically aggressive. Hence, no special precautions are required in use. Based on our current state of knowledge, as the main component, tobermorite, is a naturally occurring material, no emissions having an impact on the environment or human health will occur from intended use (cf. 7.1 Radioactivity). Other environmentally relevant material impurities are not known

2.12 Reference service life
Aerated concrete recarbonates naturally and thus absorbs atmospheric CO2 during its service life. The essential properties such as thermal conductivity and strength of aerated concrete do not change as a result after leaving the autoclave. Walls made of autoclaved aerated concrete products have a durability equivalent to that of walls made of conventional masonry and fulfil their intended function throughout the life of the building in which they are installed. The reference service life is 80 years based on *Bau EPD GmbH 2015* and *BNB 2017*.

2.13 Extraordinary effects

Fire

Fire Protection

Name	Value
Building material class	A1
Burning droplets	D0
Smoke gas development	S1

In the event of a fire, no toxic gases and fumes are generated.

Water
When exposed to water (e.g. floods), aerated concrete reacts slightly alkaline. No substances are washed out that could be hazardous to water.

Mechanical destruction
If the structural rules and building regulations are observed, destruction does not occur and is therefore not relevant.

2.14 Re-use phase
During dismantling, the product can be separated into the two components concrete and reinforcing steel. The steel can be recycled. Additionally, pure aerated concrete residues can be taken back by the aerated concrete manufacturers and recycled or reused. The material is then either processed into granular products or added to the aerated concrete mix as a sand substitute.

2.15 Disposal
While the steel can be recycled, the concrete requires landfilling.
Waste Code in accordance with the European Waste Catalogue: 17 01 01 – Concrete
Waste Code in accordance with the European Waste Catalogue: 17 04 05 – Iron and steel

2.16 Further information
Further information on the product is available on https://www.hhcelcon.co.uk/solutions/by-product/celcon-elements or hplush.com.

3. LCA: Calculation rules

3.1 Declared Unit
This EPD Declaration refers to a declared unit of 1 m³ of H+H Celcon Vertical Wall Panels. The product has a gross density of 600 kg/m³.

Declared Unit

Name	Value	Unit
Declared unit	1	m^3
Gross density	600	kg/m^3

3.2 System boundary
Type of EPD Declaration: Cradle to grave.
No maintenance is necessary during the use stage, which is why module B2 is not declared. Furthermore, there are no repair, replacement and renewal processes, so modules B3 to B5 are not relevant in this case. Modules B6 and B7 are also not declared, as the declared product has no relation to the energy or water used to operate the building. The following modules are considered in the LCA and declared over a service life of 80 years.

Module A1–A3
Life cycle module A1 comprises all relevant processes required for the provision of the raw materials and precursors. These are anhydrite and aluminium paste, as well as two Portland cements, quicklime, sand, water and reinforcing steel. In addition, fine grained aerated concrete is used in the manufacturing process.
Life cycle module A2 covers all relevant transport processes of the raw materials and precursors to the production site.
Life cycle module A3 describes the manufacturing of the declared product at the production site. In the production of "H+H Celcon Vertical Wall Panels", electricity, thermal energy from natural gas and process water are used, as well as the auxiliary material formwork release oil. In addition, life cycle module A3 covers the provision of the packaging

material (wooden pallet 39.38 kg/m³, PE film 0.051 kg).

Module A4–A5
Life cycle module A4 describes the transport of the product "H+H Celcon Vertical Wall Panels" from the production site to the construction site.
Life cycle module A5 describes the installation of the product in the building. A crane is used to position the wall panels in the building. The electrical energy required for the crane is included. Within life cycle module A5, also packaging waste for disposal is generated. The two packaging components are separated, transported and each disposed of in a suitable waste incineration plant.

Module B1–B5
Life cycle module B1 represents the recarbonation process.

Module C1–C4
Life cycle module C1 comprises the dismantling of the product. Analogous to installation, the product can be removed from the building with a crane. The electrical energy required for the crane is accounted for. During the dismantling process, the product can be separated into the components concrete and reinforcing steel.
Life cycle module C2 represents the transport to waste disposal (module C4). Within this module, the concrete fraction is transported to the waste disposal plant.
Life cycle module C3 does not require any material or energy flows.
Life cycle module C4 comprises the disposal of the demolition material (concrete). The demolition material is landfilled.

Module D
Module D includes reuse, recovery and/or recycling potentials. These are given as net flows and benefits. The dataset used for the reinforcing steel has no primary material content, therefore, no credits are given for it in life cycle module D. A credit for electrical energy is given which results from the incineration of the wooden pallet and stretch film. A credit for thermal energy is not given.

3.3 Estimates and assumptions
In the production process, fine grained aerated concrete is used. This is collected as pure demolition material on the construction site and enters the product system as burden-free secondary material.

3.4 Cut-off criteria
Machines, infrastructure and facilities used in the manufacturing of the product are not included in the system boundary and accordingly are cut-off.

3.5 Background data
The LCA software GaBi ts, Sphera Solutions GmbH, was used to create the LCA model. For the modelling, data sets from the *GaBi 10* database CUP 2021.2 were used with regard to background data.

3.6 Data quality
In the data collection process for the foreground system, it was ensured that the mass balance for the processes within the system boundary is closed. Hence, the completeness of the foreground system is considered to be high. The data provided for the foreground system was, for the most part, measured or calculated. Accordingly, their accuracy is considered to be high. The completeness and accuracy of the background data, all taken from the *GaBi 10* database 2021, are documented in the respective data sets. For the modelling of the foreground and background system, region-specific data were applied wherever possible. Where no region-specific data set was available, an alternative data set was applied from a country, which can be considered as closely representative as possible due to their high technological similarities. This relates to the incineration process of the PE film as well as landfilling at the end of life. The input and output flows of all mass and energy flows and the related processes and data sets are transparently documented and disclosed. Based on this information, it is possible to reproduce the results of this study when following the methodology and using the same data sets.

3.7 Period under review
The primary data of the mass and energy flows were collected in 2020. The data in the background system are taken from the *GaBi 10* database 2021 and are representative for the year of data collection.

3.8 Allocation
No further by-products or co-products are generated by the life cycle considered and the associated production processes. Therefore, no allocations were made in the foreground system. However, it cannot be ruled out that no allocations were made in the data sets from the *GaBi 10* database used for the background system. Allocations that were made for the background data of the GaBi databases can be found in the documentation of the data sets.

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 *GaBi 10* database CUP 2021 was used as background database.

4. LCA: Scenarios and additional technical information

Characteristic product properties
Information on biogenic carbon
Due to its material composition, the product has no biogenic carbon content at the factory gate. Wood is used as packaging material in the form of a wooden pallet, which contains 16.15 kg of biogenic carbon.

Information describing the biogenic carbon content at the gate

Name	Value	Unit
Biogenic carbon content in product	0	kg C
Biogenic carbon content in accompanying packaging	16.15	kg C

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Transport to the construction site (A4)
Although the declared product is produced in Germany, it is mainly sold and installed in the UK. For this purpose, the product is first transported by diesel truck from the production site to a port in Rotterdam (555 km). From Rotterdam, the product is transported by ferry to Felixstowe (290 km) or Immingham (445 km). Heavy oil container ships were assumed for this purpose. 60 % of the transport volume goes to Immingham and 40 % go to Felixstowe. From the ports in the UK, the product is transported to the construction site by diesel trucks (160 km).

Transport to the construction site (A4)

Name	Value	Unit
Litres of diesel	1.3	l/100km
Litres of heavy oil	0.17	l/100 km
Transport distance – truck	715	km
Transport distance – ferry	735	km
Capacity utilisation (including empty runs) – trucks	61	%
Capacity utilisation (including empty runs) – container ship	70	%
Gross density of products transported	600	kg/m^3

Installation into the building (A5)
The product is placed in the building by crane. The electrical energy required for the crane is estimated at 12.8 kWh. A British electricity mix is used.
Moreover, packaging waste is generated for disposal in Module A5. A collection rate of 100 % is assumed for the wooden pallet and the stretch film. For transport by truck to the disposal sites, a distance of 50 km each is assumed with a utilisation of 61 %. The packaging components are separated, transported and disposed of at a suitable waste incineration plant. Electricity generated from the incineration processes is exported and credited to Module D in a total amount of 118.8 MJ. This electricity credit is made up of 0.243 MJ for the incineration of the stretch film and 118.588 MJ for the incineration of the wooden pallet. A net calorific value of 36.0 MJ/kg is assumed for the stretch film and of 16.7 MJ/kg for the wooden pallet. The resulting credit represents the British electricity mix, since the electric energy resulting from the waste incineration is fed into the British power grid. The R1-value of the waste incineration plant is below 0.6.

Installation into the building (A5)

Name	Value	Unit
Auxiliary	0	kg
Water consumption	0	m^3
Other resources	0	kg
Electricity consumption	12.8	kWh
Other energy carriers	0	MJ
Material loss	0	kg
Output substances following waste treatment on site	39.43	kg
Dust in the air	0	kg
VOC in the air	0	kg

Use (B1)
In Module B1 of the product, recarbonation takes place. This is largely completed after 60 years. In total, 88.3 kg of CO2 are absorbed with a degree of recarbonation of 95 % (including the consideration of fine grained aerated concrete from granulate) *[Walther, H. 2021 (2)]*.

Name	Value	Unit
Degree of recarbonation	95	%
Reabsorbed CO2	88.3	kg

No other relevant energy or mass flows occur during the usage of the product. Inspection or maintenance are not required, furthermore, no repair as well as no exchange or replacement has to be carried out when the product is handled appropriately. Moreover, no improvement or modernisation is foreseen.

Reference service life
The service life is set for 80 years. However, this also depends on the operating life of the entire building.

Referenz Nutzungsdauer

Name	Value	Unit
Reference service life life (according to ISO 15686-1, -2, -7 and -8) [Bau EPD GmbH 2015 and BNB 2017]	80	a

End-of-life (C1-C4)
Analogous to installation, the product can be removed from the building by crane. The electrical energy required for the crane is estimated at 12.8 kWh. A British electricity mix is used. During deconstruction, the product can already be separated into the components concrete and reinforcing steel. As the steel dataset used has no primary material component, no separation of primary from secondary material takes place in Module C3, only the flow from secondary material results from this. This secondary material is completely fed back into Module A1 (5.31 kg). The concrete fraction is transported to waste disposal by diesel truck. The demolition material (aerated concrete) is classified as landfill class 1 and is disposed of accordingly.

End-of-life (C1-C4)

Name	Value	Unit
Collected separately Abfalltyp	0	kg
Collected as mixed construction waste	0	kg
Reuse	0	kg
Recycling	5.31	kg
Energy recovery	0	kg
Landfilling	595	kg
Litres of diesel	1.48	l/100 km
Transport distance	50	km
Capacity utilisation (including empty runs)	61	%

Reuse, recovery and recycling potentials (D), relevant scenario information
Module D includes reuse, recovery and/or recycling potentials. These are reported as net flows and benefits. The steel dataset used for the reinforcing steel has no primary material content, therefore no credits for steel are given in Module D.
An electricity credit of 118.83 MJ is generated, which results from the burning of the wooden pallet (39.38 kg) and the stretch film (0.05152 kg), each having a primary material content of 100 %, and represents the British electricity grid mix. No credit is given for thermal energy. No further loads or benefits are given.

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5. LCA: Results

In the following, the results of the impact assessment of selected environmental impacts, the use of resources as well as waste and other output flows for 1 m³ of H+H Celcon Vertical Wall Panels made of aerated concrete are shown. These are manufactured at a German production facility in Wittenborn, the gross density is 600 kg/m³.

All declared life cycle stages are marked with an "X" in Table 1, all non-declared ones are indicated with "ND" (Modules B3, B4 and B5 are not relevant and therefore indicated with "MNR"). The declaration of B1 is done over an RSL of 80 years.

DESCRIPTION OF THE SYSTEM BOUNDARY (X = INCLUDED IN LCA; ND = MODULE OR INDICATOR NOT DECLARED; MNR = MODULE NOT RELEVANT)

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	X	ND	MNR	MNR	MNR	ND	ND	X	X	X	X	X

RESULTS OF THE LCA - ENVIRONMENTAL IMPACT according to EN 15804+A2: 1 m³ H+H Celcon Vertical Wall Panel

Core Indicator	Unit	A1-A3	A4	A5	B1	C1	C2	C3	C4	D
GWP-total	[kg CO_2-Eq.]	1.83E+2	4.00E+1	6.99E+1	-8.83E+1	4.03E+0	2.25E+0	0.00E+0	8.77E+0	-1.04E+1
GWP-fossil	[kg CO_2-Eq.]	2.34E+2	3.86E+1	1.98E+1	-8.83E+1	3.94E+0	2.19E+0	0.00E+0	9.00E+0	-1.02E+1
GWP-biogenic	[kg CO_2-Eq.]	-5.06E+1	1.42E+0	5.01E+1	0.00E+0	9.18E-2	5.66E-2	0.00E+0	-2.61E-1	-2.37E-1
GWP-luluc	[kg CO_2-Eq.]	1.12E-1	3.06E-3	1.03E-3	0.00E+0	7.09E-4	3.30E-4	0.00E+0	2.65E-2	-1.83E-3
ODP	[kg CFC11-Eq.]	1.64E-11	1.14E-14	1.48E-13	0.00E+0	1.37E-13	4.81E-16	0.00E+0	3.53E-14	-3.54E-13
AP	[mol H^+-Eq.]	2.12E-1	2.70E-1	4.42E-2	0.00E+0	7.38E-3	6.91E-3	0.00E+0	6.41E-2	-1.91E-2
EP-freshwater	[kg P-Eq.]	1.67E-4	9.86E-6	3.87E-6	0.00E+0	3.01E-6	7.33E-7	0.00E+0	1.52E-5	-7.78E-6
EP-marine	[kg N-Eq.]	7.61E-2	9.31E-2	1.87E-2	0.00E+0	2.19E-3	3.25E-3	0.00E+0	1.66E-2	-5.66E-3
EP-terrestrial	[mol N-Eq.]	8.29E-1	1.02E+0	2.24E-1	0.00E+0	2.34E-2	3.57E-2	0.00E+0	1.83E-1	-6.05E-2
POCP	[kg NMVOC-Eq.]	2.14E-1	2.19E-1	4.83E-2	0.00E+0	6.16E-3	6.40E-3	0.00E+0	5.04E-2	-1.59E-2
ADPE	[kg Sb-Eq.]	1.96E-5	1.71E-6	1.53E-6	0.00E+0	1.39E-6	1.17E-7	0.00E+0	8.53E-7	-3.58E-6
ADPF	[MJ]	1.63E+3	5.30E+2	1.08E+2	0.00E+0	8.53E+1	3.00E+1	0.00E+0	1.19E+2	-2.20E+2
WDP	[m³ world-Eq deprived]	3.41E+0	4.76E-2	7.37E+0	0.00E+0	2.01E-1	3.17E-3	0.00E+0	9.64E-1	-5.18E-1

Caption	GWP = Global warming potential; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential of land and water; EP = Eutrophication potential; POCP = Formation potential of tropospheric ozone photochemical oxidants; ADPE = Abiotic depletion potential for non-fossil resources; ADPF = Abiotic depletion potential for fossil resources; WDP = Water (user) deprivation potential

RESULTS OF THE LCA - INDICATORS TO DESCRIBE RESOURCE USE according to EN 15804+A2: 1 m³ H+H Celcon Vertical Wall Panel

Indicator	Unit	A1-A3	A4	A5	B1	C1	C2	C3	C4	D
PERE	[MJ]	8.23E+2	5.36E+0	5.08E+1	0.00E+0	4.70E+1	7.58E-1	0.00E+0	1.61E+1	-1.22E+2
PERM	[MJ]	6.58E+2	0.00E+0	-6.58E+2	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
PERT	[MJ]	1.48E+3	5.36E+0	-6.07E+2	0.00E+0	4.70E+1	7.58E-1	0.00E+0	1.61E+1	-1.22E+2
PENRE	[MJ]	1.63E+3	5.30E+2	1.08E+2	0.00E+0	8.53E+1	3.02E+1	0.00E+0	1.19E+2	-2.20E+2
PENRM	[MJ]	1.85E+0	0.00E+0	-1.85E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
PENRT	[MJ]	1.63E+3	5.30E+2	1.06E+2	0.00E+0	8.53E+1	3.02E+1	0.00E+0	1.19E+2	-2.20E+2
SM	[kg]	5.62E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
RSF	[MJ]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
NRSF	[MJ]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
FW	[m³]	3.37E-1	3.26E-3	1.97E-1	0.00E+0	2.75E-2	2.34E-4	0.00E+0	2.94E-2	-7.12E-2

Caption	PERE = Use of renewable primary energy excluding renewable primary energy resources used as raw materials; PERM = Use of renewable primary energy resources used as raw materials; PERT = Total use of renewable primary energy resources; PENRE = Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials; PENRM = Use of non-renewable primary energy resources used as raw materials; PENRT = Total use of non-renewable primary energy resources; SM = Use of secondary material; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels; FW = Use of net fresh water

RESULTS OF THE LCA – WASTE CATEGORIES AND OUTPUT FLOWS according to EN 15804+A2: 1 m³ H+H Celcon Vertical Wall Panel

Indicator	Unit	A1-A3	A4	A5	B1	C1	C2	C3	C4	D
HWD	[kg]	2.73E-6	4.94E-9	2.94E-8	0.00E+0	2.62E-8	3.81E-10	0.00E+0	1.27E-8	-6.77E-8
NHWD	[kg]	8.78E+0	6.25E-2	5.73E-1	0.00E+0	8.60E-2	2.31E-3	0.00E+0	5.96E+2	-2.22E-1
RWD	[kg]	3.60E-2	6.31E-4	1.33E-2	0.00E+0	1.24E-2	4.83E-5	0.00E+0	1.23E-3	-3.20E-2
CRU	[kg]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
MFR	[kg]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	5.31E+0	0.00E+0
MER	[kg]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
EEE	[MJ]	0.00E+0	0.00E+0	1.19E+2	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
EET	[MJ]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0

Caption	HWD = Hazardous waste disposed; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed; CRU = Components for re-use; MFR = Materials for recycling; MER = Materials for energy recovery; EEE = Exported electrical energy; EET = Exported thermal energy

RESULTS OF THE LCA – additional impact categories according to EN 15804+A2-optional:
1 m³ H+H Celcon Vertical Wall Panel

Indicator	Unit	A1-A3	A4	A5	B1	C1	C2	C3	C4	D
PM	[Disease Incidence]	9.41E-6	3.41E-6	1.91E-7	0.00E+0	6.76E-8	3.86E-8	0.00E+0	7.96E-7	-1.75E-7
IRP	[kBq U235-Eq.]	3.68E+0	6.23E-2	1.28E+0	0.00E+0	1.20E+0	4.72E-3	0.00E+0	1.27E-1	-3.09E+0
ETP-fw	[CTUe]	3.00E+2	3.87E+2	6.24E+1	0.00E+0	5.49E+1	1.33E+1	0.00E+0	6.80E+1	-1.42E+2
HTP-c	[CTUh]	4.42E-8	7.35E-9	1.91E-9	0.00E+0	9.89E-10	2.58E-10	0.00E+0	1.00E-8	-2.55E-9
HTP-nc	[CTUh]	3.94E-6	3.71E-7	1.23E-7	0.00E+0	4.58E-8	1.44E-8	0.00E+0	1.11E-6	-1.18E-7
SQP	[-]	6.88E+3	4.10E+0	1.76E+1	0.00E+0	1.39E+1	4.31E-1	0.00E+0	2.52E+1	-3.59E+1

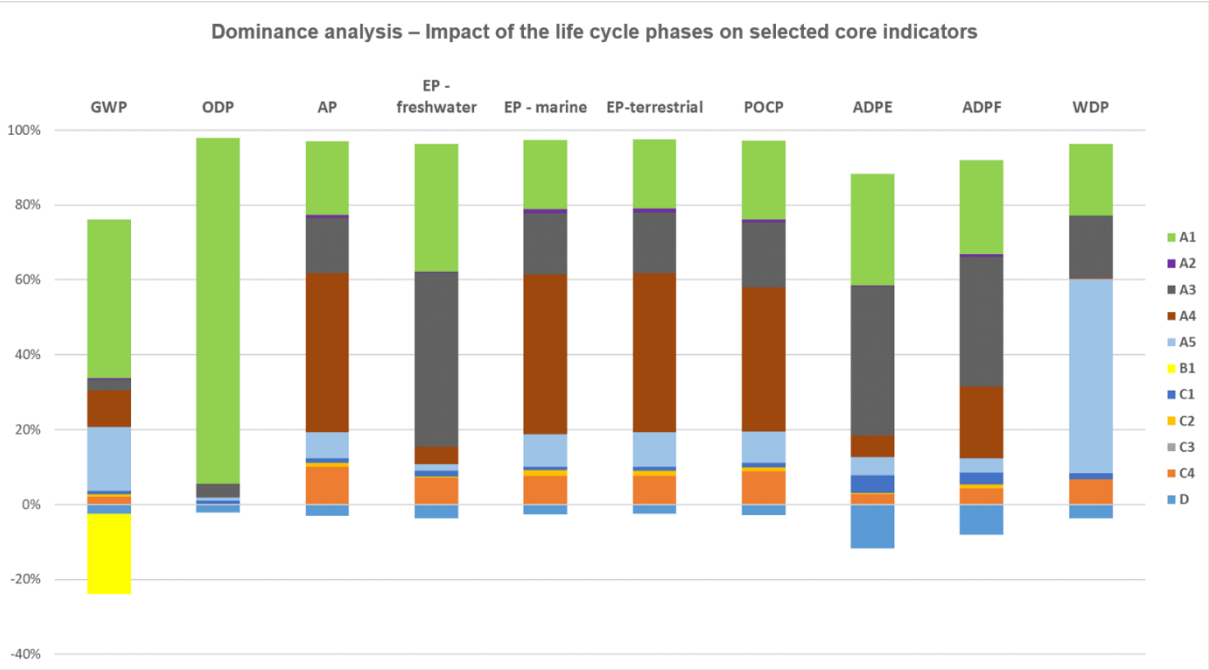
Caption	PM = Potential incidence of disease due to PM emissions; IR = Potential Human exposure efficiency relative to U235; ETP-fw = Potential comparative Toxic Unit for ecosystems; HTP-c = Potential comparative Toxic Unit for humans (cancerogenic); HTP-nc = Potential comparative Toxic Unit for humans (not cancerogenic); SQP = Potential soil quality index

Disclaimer 1 – for the indicator “Potential Human exposure efficiency relative to U235”.
This impact category deals mainly with the eventual impact of low dose ionizing radiation on human health of the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents, occupational exposure nor due to radioactive waste disposal in underground facilities. Potential ionizing radiation from the soil, from radon and from some construction materials is also not measured by this indicator.

Disclaimer 2 – for the indicators “abiotic depletion potential for non-fossil resources”, “abiotic depletion potential for fossil resources”, “water (user) deprivation potential”, “potential comparative toxic unit for ecosystems”, “potential comparative toxic unit for humans – cancerogenic”, “Potential comparative toxic unit for humans - not cancerogenic”, “potential soil quality index”.
The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experience with this indicator.

6. LCA: Interpretation

The interpretation is based on the assumptions and limitations described, both in terms of methods and data. A dominance analysis is used for interpretation.



The significant influence of life cycle module A1 on the environmental impact categories presented here is clearly evident. In particular, the raw material procurement of the mineral binders in module A1 is responsible for a large part of the potential environmental impacts. Transportation of the raw materials (A2) has only a negligible impact. The use of electrical energy and thermal energy from natural gas (A3) is relevant for some of the indicators presented and have a significant impact on EP and ADPf in particular. Transport by ship (A4) has a particular impact on the eutrophication potential of water bodies (EP). In module A5, environmental impacts result mainly from combustion emissions from packaging, including disposal of the wooden pallet. Recarbonation in module B1 has a positive effect on GWP. Landfilling of the product at the end of life (C4) is also showing in the indicators eutrophication potential and acidification potential (AP). The credits in module D result from generated electricity (incineration of the packaging), but has only a minor impact on the overall balance.

7. Requisite evidence

7.1 Radioactivity
Measuring station: TÜV SÜD Industrie Service GmbH Energie und Systeme, Westendstraße 199, 80686 Munich.
Method: Measurement of the nuclide content in Bq/kg for Ra-226+, Th-232+, K-40, U-235, U-238.
In accordance with inspection certificate G 7322, the above-mentioned product was subjected to a gamma spectrometric examination for the content of natural radioactivity. The upper limits of the confidence interval determined in the inspection report were inserted in the summation formulae according to Annex VIII Directive 2013/59/EURATOM. The result of the summation formula was below 1.
According to § 75 Directive 2013/59/EURATOM, compliance with this formula ensures compliance with the reference level of 1 mSv per year for indoor external exposure to gamma radiation from building materials.

8. References

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EN 459-1
DIN EN 459-1:2015-07, Building lime - Part 1: Definitions, specifications and conformity criteria.

EN 680
BS EN 680:2005, Determination of the drying shrinkage of autoclaved aerated concrete.
This standard is designed to determine the drying shrinkage of aerated concrete.

EN 771-4
BS EN 771-4:2011+A1:2015, Specification for masonry units autoclaved aerated concrete masonry units.
This standard defines the specifications for masonry blocks made of aerated concrete.

EN 998-2
BS EN 998-2:2017-02, Specification for mortar for masonry.
This standard defines the specifications for mortar in masonry construction.

EN 1169
DIN EN 1169:1999-10, Precast concrete products – General rules for factory production control of glass-fibre reinforced cement.

EN 1745
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This standard specifies masonry and masonry products and describes methods for determining thermal protection properties.

EN 1996
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This standard specifies the dimensioning and design of masonry structures and generally defines rules for reinforced and non-reinforced masonry.

EN 12602
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This standard specifies prefabricated reinforced elements made of steam cured aerated concrete.

EN 13501-1
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EN 15304
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DIN EN ISO 14025:2011-10, Environmental labels and declarations – Type III environmental declarations – Principles and procedures.

ISO 15686-1

ISO 15686-1:2011-05, Buildings and constructed assets – Service life planning – Part 1: General principles and framework.

ISO 15686-2
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ISO 15686-7
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ISO 15686-8
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Further References

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Abfallverzeichnis-Verordnung (AVV) vom 10. Dezember 2001 (BGBl. I S. 3379), die zuletzt durch Artikel 1 der Verordnung vom 30. Juni 2020 (BGBl. I S. 1533) geändert worden ist.
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Publisher
Institut Bauen und Umwelt e.V.
Hegelplatz 1
10117 Berlin
Germany

Tel +49 (0)30 3087748- 0
Fax +49 (0)30 3087748- 29
Mail info@ibu-epd.com
Web **www.ibu-epd.com**

Programme holder
Institut Bauen und Umwelt e.V.
Hegelplatz 1
10117 Berlin
Germany

Tel +49 (0)30 - 3087748- 0
Fax +49 (0)30 – 3087748 - 29
Mail info@ibu-epd.com
Web **www.ibu-epd.com**

Author of the Life Cycle Assessment
Fraunhofer-Institut für Bauphysik,
Abt. Ganzheitliche Bilanzierung
Wankelstraße 5
70563 Stuttgart
Germany

Tel 0711 / 970 3151
Fax 0711 / 970 3190
Mail gabi@ibp.fraunhofer.de
Web **www.ibp.fraunhofer.de**

Owner of the Declaration
H+H Deutschland GmbH
Industriestraße 3
23829 Wittenborn
Germany

Tel +49 4554 7000
Fax +49 4554 700 223
Mail info@hplush.de
Web **www.hplush.de**