ENVIRONMENTAL PRODUCT DECLARATION

B-EPD .BE
1234567-123
(contact program operator)

BC MATERIALS

COMPRESSED EARTH BLOCK – installed with Earth Adhesive mortar

ISSUED dd.mm.yyyy
VALID UNTIL dd.mm.yyyy

THIRD PARTY VERIFIED
in accordance with EN 15804+A2 and NBN/DTD B08-001

MODULES DECLARED
1 m² of indoor wall with Earth block installed with Earth adhesive mortar

A123	A4	A5	B2 B4	C	D
•	•	•	•	•	•

The intended use of this EPD is to communicate scientifically based environmental information for construction products, for the purpose of assessing the environmental performance of buildings. This EPD is only valid when registered on www.b-epd.be. The FPS Public Health cannot be held responsible for the information provided by the owner of the EPD.

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1 PRODUCT DESCRIPTION

1.1 Product name

Compressed block 140, CEB_140 installed with Léém Earth Adhesive Mortar (EB_EAM)

1.2 Product description and intended use

The Compressed Earth Block from BC Materials is a Belgian product used as load-bearing and non-load-bearing masonry protected from the elements. It is mainly used for internal walls. This product is suitable for damp rooms but must not be applied to areas in direct contact with water.
The product is sold as a block.

This EPD is specific to the BC Materials company and corresponds to only one site of production.

The Léém Compressed block range uses 3,85% (wt.) of cement as a stabiliser, and is more water-resistant, acoustic, fire-resistant and stronger. The aesthetics is more industrial through its aspect and colour.

1.3 Reference flow / declared unit

The declared unit is defined as "To build 1 m² of wall with 140 mm width compressed earth blocks installed with Earth adhesive mortar and with a lifetime of 60 years, in Belgium".
The lifetime is 60 years.

Packaging is included.
The weight per reference flow is 238.5 kg of blocks.
The gross density of the product is 1760 kg / m^3.

1.4 Installation

The masonry of Léém Compressed Earth Blocks is executed in accordance with the rules of craftsmanship. The blocks are put together using Léém Earth Adhesive Mortar. Blocks must be prewet before laying. Masonry is achieved using normal masonry tools. During construction, the wall must be protected from water at its top (infiltrations, ...) and bottom (stagnating water and splash water). The installation process is presented in the figure below.
The Léém Earth Adhesive Mortar is applied using 2-3 mm joints.


Dosage du Mortier et de l'eau pour le mélange


Mélange du Mortier

Detailed information on this scenario can be found in the chapter “Data of the underlying scenario’s”.

1.5 Composition and content

Components	Composition / content / ingredients	Quantity
Product	– Compressed Earth Block	25,66 pieces with 3 mm joints
Fixation & Jointing materials	– Earth Adhesive Mortar	For 3 mm joints without mortar loss in halfblock masonry wall. - 4,3 kg/m² for CEB_90 - 6,7 kg/m² for CEB_140 - 9 kg/m² for CEB_190
Treatments	– Not relevant	
Packaging	– Pallet and plastic film for CEB – Paper bag for Earth Adhesive mortar	- CEB_90: 192 pieces per pallet (1276 kg per pallet) - CEB_140: 128 pieces per pallet (1190 kg/pallet) - CEB_190: 96 pieces per pallet (1210 kg/pallet) - Paper bag for 25 kg of product

The Compressed Earth Block is composed of Loess loam, Crushed and washed concrete, Rhine sand and Cement. First both raw materials are secondary resources and represent more than 77% of the weight of the product.

The product does not contain materials listed in the “Candidate list of Substances of Very High Concern for authorization”.

1.6 Reference service life

The reference service life is estimated at 60 years.
The RSL is based on TOTEM reference.
The conditions under which this RSL is valid are as following: normal use of blocks which have been correctly installed.

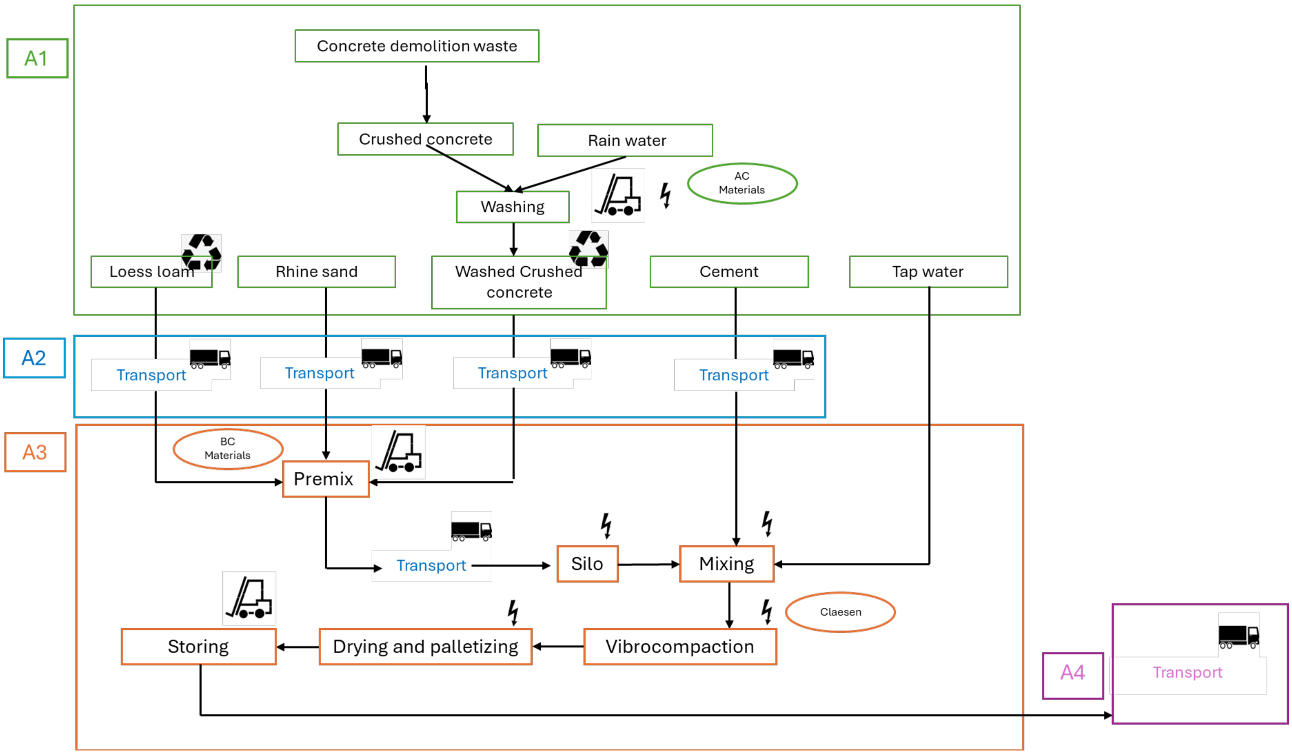
1.7 Description of geographical representativity

Compressed Earth block is produced in Brussels and Lummen, Belgium for the production of the block in itself. The Earth Adhesive mortar is produced in BC materials, in Brussels, Belgium
Data for this LCA are representative and relevant for this specific production.
Primary data inventory of described processes is representative of the BC materials product.
Installation (A4-A5), end-of-life (C) and benefits (D) are representative of Belgian practices. This study is in accordance with time, geography and technology compliance.
This study is representative of the Belgian market.

1.8 Description of the production process and technology

The production of Compressed Earth Block is performed in Brussels then in Lummen with the following process.
First, primary (Rhine Sand) and secondary (Loess loam and crushed washed concrete) resources come to the production site in Brussels by truck. Loess loam is considered as a secondary resource, since it is having the status of waste coming from the excavation site. Rhine sand is considered as a primary resource. They are both mixed with crushed washed concrete coming from the AC materials site. The concrete is recovered from demolition site and then crushed and washed with rainwater to obtain washed crushed concrete which is transported to the BC materials site. These three resources are then premixed on the Brussels site and then transported by truck to Claesen site. Here the premix is further mixed with Cem III 42,5, and Léém Compressed Earth blocks are produced in a process of vibrocompaction.

Figure below presents the present the scheme of Léém Compressed Earth Block production.



2 TECHNICAL DATA / PHYSICAL CHARACTERISTICS

Properties of the product are presented in the table below.

Technical property	Standard	Value	Unit	Comment
Gross / Net Density block CEB_90 CEB_140 CEB_190	EN772-13	1970/1970 1760/1970 1760/1970	kg/m³	90,140 or 190 mm of thickness
Compressive strength (full block)	EN772-01	9	N/mm²	
Tolerance Class	EN771-03	D2		
Plan parallelism of the bed faces	EN772-16	2.0	mm	
Flatness of faces	EN772-20	0.5	mm	
Equilibrium Moisture Content	EN772-10	1-2%		
Initial Water Absorption	EN772-11	IW 2		
Hygrometric Expansion	EN772-14	0.6	mm/m	
Compressive strength (half blocks mortared)	XPP13-901	7	N/mm²	Non flammable
Application Class	XPP13-901	CL1 (outside masonry exposed to elements)		
Water vapor diffusion number μ	XPP13-901	5/10		
Thermal conductivity λ	XPP13-901	1	W/m²K	
Fire reaction	XPP13-901	A1	Non flammable	Non flammable

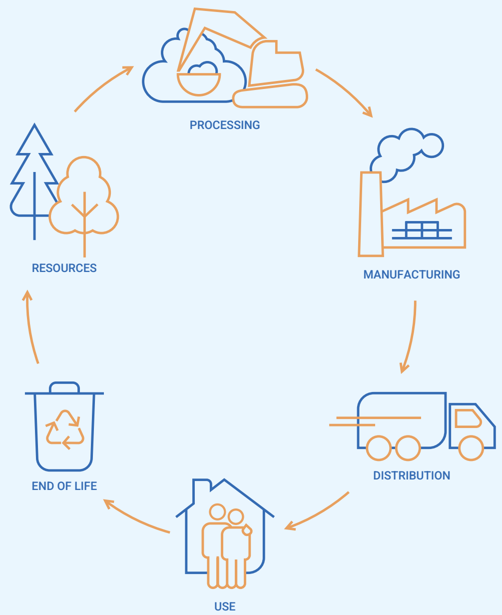
Once installed, the masonry has different properties which are presented in Table below.

Technical property	Standard	Léém Adhesive Mortar (2-3 mm)	Unit
Compressive Strength	EN1052-1	3	N/mm²
Static E-modulus	EN1052-1	3500	N/mm²
Flexural Strength	EN1052-2	⊥ 0.38 ‖ 0.15	N/mm²
Initial Shear Strength	EN1052-3	0.22	N/mm²
Bond Wrench Strength	EN1052-5	0.17	N/mm²

3 LCA-STUDY

3.1 Date of LCA-study

LCA has been performed from June 2024 to November 2024 and reviewed in November-December 2024.



3.2 Software

For the calculation of the LCA results, the software program Open LCA v2.2.0. has been used.

3.3 Information on allocation

Mass allocation has been used to model secondary resources included in the product (Washed concrete, Loam and Brussels sand) as well as for the modelling of module D. Secondary resources are 'free of environmental burden' because of their waste status.

3.4 Information on cut off

Concerning cut-off, the EN15084 rule has been applied: "In case of insufficient input data, or data daps for a unit process, the cut-off criteria shall be 1% of renewable, 1% of non-renewable primary energy usage, 1% of the total mass input of that unit process."
Furthermore, the EN15804 claims: "The total of neglected input flows per module, e.g. per module A1-A3, A4-A5, B1-B5, B6-B7, C1-C4 and module D shall be a maximum of 5 % of energy usage and mass. Conservative assumptions in combination with plausibility considerations and expert judgement can be used to demonstrate compliance with these criteria."
For Léém Earth Adhesive Mortar, the reversible aspect of the clay binder makes that all construction site remains can be reused, hence no waste during installation, as mentioned in the German PCR for Earth materials.
The packaging of raw materials (methylcellulose) for Earth Adhesive mortar is under the cut off rule with a weight of 0.5% in the mortar and the mortar representing 2.5% of the functional unit total weight.
The charges and benefits of paper in module D for paper bag packaging from Earth adhesive mortar are cut off due to the very small part of weight.
Except for direct infrastructure in the operational site, all flows of mass and energy have been taken into account.

3.5 Information on excluded processes

Following processes were excluded for the inventory:

- Employee transport and business travel
- Energy use, infrastructure and consumables from administrative departments (e.g. head offices and sales offices)
- Lighting, heating and cleaning of production sites, Consumables necessary for the functioning of the process (e.g. lubricating oil),
- Production, maintenance and end-of-life of equipment.

3.6 Information on biogenic carbon modelling

The product does not contain any biogenic carbon. The only biogenic carbon present in this scenario is the one included in the wood..

Globally, the biogenic carbon content is calculated according to the following formula:

kg C/UF = C content of component (kg C/kg) x quantity of component per UF (kg/UF) x characterization factor (+/-1)

The Carbon to CO_2 conversion is performed by multiplying the C content by the molar ratio of the two components: 44/12 = 3.667.

Concerning packaging, there is biogenic carbon:

- Wood pallet (A3): the quantity of carbon dioxide captured by wood is evaluated using the generic estimate for wood-based products of approximately 0.5 kg C/kg or 1.83 kgCO_2/kg.
- For 1 FU (market based): 1.99E-1 x 1.83 = 3.65E-1 kg CO_2/UF.

Other packaging component does not contain biogenic carbon.

	Biogenic carbon content (kg C/FU)
Biogenic carbon content of the product (at factory gate)	0 kg C/FU
Biogenic carbon content of packaging (at factory gate)	9.94E-2 kg C/FU

3.7 Information on carbon offsetting

Carbon offsetting is not allowed in the EN 15804 and hence not taken into account in the calculations. BC Materials does not take any carbon offsetting.

3.8 Information on carbonation of cementitious materials

There are cementitious materials in our scenario, both in the production step and in the installation steps.

During the lifetime of the Compressed Earth Blocks, the carbon dioxide present in the air will penetrate the blocks from the surface of the material. This carbon dioxide reacts with the calocium hydroxide ($Ca(OH)_2$), present in the block (cement). This phenomenon is called carbonation.

The quantity of carbon dioxide which is absorbed is linked on a stoichiometric base to the amount of calcium oxide (CaO) and responds to the following equation:

$Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$

1 kmol of $Ca(OH)_2$ (74.09 kg/kmol) allows the sequestration of 1 kmol of CO_2 (44.01 kg/kmol).

The washed concrete reused is assumed to be already fully carbonated and then its contribution is not taken into account.

Concerning the cement present in the blocks, we need 9.06 kg of cement that includes 51.9% of CaO (https://www.holcim.be/sites/belgium/files/documents/11_cem_iii_a_425_n_la_fr.pdf). The Annex G3 of the standard EN 16757 has been used.

Carbonatation for the blocks is then equal to 0.886 kg CO_2/m^2.

3.9 Additional or deviating characterisation factors

For the CEN indicators all CF are conform to EN 15804+A2: 2019 with EF 3.0 for normalization and weighting step. For toxicity, ionizing radiation and particulate matter the CF of JRC 2018 were used. For ADP following additional CF were used as applied in software OpenLCA v2.2.

For energy resources, the method "Cumulative Energy Demand (LHV)" is used. This method calculates Lower Heating Values.

Waste flows are calculated using EDIP 2003 method (Hauschild 2003).

The characterization factors from EC-JRC were applied. No additional or deviating characterisation factors were used.

3.10 Description of the variability

This study is related to the block of 140 mm width with installation using Earth Adhesive Mortar.

The thickness of the block can vary between 90 mm and 190 mm. For the 190 mm, a proportional rule can be applied due to the same density of the product.

For the 90 mm, the rule of weight is not direct. Indeed, the density of the block 90 mm is 1970 kg/m^3 while for the 140 and 190 mm, the density is 1760 kg/m^3. That means that block of 90 mm requires proportionally more matter than other width. Calculations from A1 to A4 are directly proportional to the mass of the blocks. Based on this, and the ratio between the density of the blocks (90 and 140/190), the proportional rule must be multiplied by 1.12 to obtain the results for modules A1 to A4.

Module A5 is directly proportional to the width of the blocks.

That means:

Impact of CEB 90 (A1 to A4) = Impacts of CEB 140 (A1 to A4) *90/140*1.12

Impact of CEB 190 = Impacts of CEB 140 * 190/140

Concerning modules B1 to D, results are extrapolated from block 140 to block 190. For the block of 90mm, only results from A1 to A5 can be obtained directly by following the previous rules.

3.11 Specificity

The data used for the LCA are specific for this product which is manufactured by a single manufacturer BC Materials in a single production site in Brussels (including mentioned operational sites as ASIAT, Claesen and Eurakor).

3.12 Period of data collection

Manufacturer specific data have been collected for the year 2023.

3.13 Information on data collection

.Inventory data for the compressed earth block production, its installation, its packaging as well as annex consumptions are primary data given by BC Materials and production site (Claesen).
The declared value is based on the CEB_140 installed with Earth Adhesive mortar.

3.14 Database used for background data

Background data come from Ecoinvent 3.10.
Accordingly to the EN 15804:2012+A2:2019 standard and the BC-PCR, when generic data from Ecoinvent V3 are used, the model of "allocation, cut-off by classification" is used.
Date of update : Ecoinvent v3.10 – June 2024

3.15 Energy mix

The Belgian residual mix in the background process in Ecoinvent V3.10 corresponds to 2020. It is used as it is.

Origin of energy	%
Nuclear	34,3%
Natural gas	19,2%
Imports	14,5%
Wind	13,3%
Hydro	1,4%
Photovoltaics	10,4%
Waste	2,5%
Biomass	2,6%
Oil	0,0%
Other	1,8%

4 PRODUCTION SITES

The production site is located in BC Materials, Brussels, Belgium.
For washed concrete, the production site is AC materials and located in Gent, Belgium.
The vibrocompaction into the Compressed Earth block is done at the factory Claesen Betonbedrijf, located Kanaalstraat, 13, 3650 Lummen Belgium
Concerning the Earth Adhesive Mortar, the secondary resources are prepared at ASIAT, located at Abbeelstraat, 1800 Vilvoorde, Belgium.
Concerning the Earth Adhesive Material, the packaging in paper bag is performed in Eurakor, Leuze en Hainaut, Belgium.

5 SYSTEM BOUNDARIES

Product stage			Construction installation stage		Use stage							End of life stage				Beyond the system boundaries
Raw materials	Transport	Manufacturing	Transport	Construction installation stage	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 = included in the EPD
☐ = module not declared

ADD A CLEAR DESCRIPTION OF THE SYSTEM BOUNDARIES, WITH SPECIAL ATTENTION FOR COPRODUCTS, EOW, WASTE PROCESSING, INPUT OF RECOVERED RAW MATERIALS, ...

6 POTENTIAL ENVIRONMENTAL IMPACTS PER REFERENCE FLOW

	Production			Construction process stage		Use stage							End-of-life stage				
	A1 Raw material	A2 Transport	A3 manufacturing	A4 Transport	A5 Installation	B1 Use	B2 Maintenance	B3 Repair	B4 Replacement	B5 Refurbishment	B6 Operational energy use	B7 Operational water use	C1 Deconstruction / demolition	C2 Transport	C3 Waste processing	C4 Disposal	D Reuse, recovery, recycling
GWP total (kg CO2 equiv/FU)	5,34E+00	2,52E+00	4,69E+00	3,59E+00	1,95E+00	-8,86E-01	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	6,66E-01	2,40E+00	3,62E-01	1,45E-01	-5,23E+00
GWP fossil (kg CO2 equiv/FU)	5,26E+00	2,51E+00	4,95E+00	3,59E+00	1,71E+00	-8,86E-01	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	6,66E-01	2,40E+00	3,59E-01	1,44E-01	-5,42E+00
GWP biogenic (kg CO2 equiv/FU)	7,62E-02	2,66E-03	-2,65E-01	2,66E-03	2,36E-01	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	8,78E-05	8,62E-04	3,18E-03	9,64E-04	1,90E-01
GWP luluc (kg CO2 equiv/FU)	2,12E-03	1,71E-03	2,18E-03	1,16E-03	1,46E-03	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	5,63E-05	8,70E-04	5,25E-04	1,09E-04	-2,67E-03
ODP (kg CFC 11 equiv/FU)	4,53E-08	1,33E-07	1,08E-07	6,93E-08	5,27E-08	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	9,93E-09	3,95E-08	9,70E-09	3,10E-08	-1,35E-07
AP (mol H+ eq/FU)	1,55E-02	9,20E-03	1,47E-02	7,26E-03	4,55E-03	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	5,85E-03	6,17E-03	1,81E-03	1,19E-03	-1,69E-02
EP - freshwater (kg (PO4)3- equiv/FU)	7,10E-04	1,87E-04	4,74E-04	2,36E-04	2,53E-04	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,89E-05	1,73E-04	7,45E-05	3,53E-05	-6,60E-04
EP - marine (kg (PO4)3- equiv/FU)	3,85E-03	3,21E-03	4,15E-03	1,75E-03	1,24E-03	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	2,72E-03	1,75E-03	5,82E-04	4,44E-04	-4,76E-03
EP - terrestrial (kg (PO4)3- equiv/FU)	4,27E-02	3,50E-02	4,46E-02	1,88E-02	1,31E-02	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	2,97E-02	1,90E-02	6,28E-03	4,82E-03	-5,24E-02
POCP (kg Ethene equiv/FU)	1,28E-02	1,30E-02	2,09E-02	1,21E-02	5,11E-03	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	8,87E-03	9,14E-03	1,96E-03	1,37E-03	-1,99E-02
ADP Elements (kg Sb equiv/FU)	4,26E-06	3,70E-06	1,00E-05	4,97E-06	2,44E-06	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	9,98E-08	3,32E-06	2,10E-06	4,45E-07	-8,49E-06
ADP fossil fuels (MJ/FU)	3,19E+01	3,37E+01	8,13E+01	4,87E+01	1,92E+01	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	8,43E+00	3,26E+01	9,18E+00	2,64E+00	-6,40E+01
WDP (m³ water eq deprived /FU)	6,25E-01	2,06E-01	8,80E-01	2,76E-01	2,67E-01	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	2,49E-02	1,84E-01	1,16E-01	7,04E-02	-1,05E+00

GWP TOTAL = TOTAL GLOBAL WARMING POTENTIAL (CLIMATE CHANGE); GWP-LULUC = GLOBAL WARMING POTENTIAL (CLIMATE CHANGE) LAND USE AND LAND USE CHANGE; ODP = OZONE DEPLETION POTENTIAL; AP = ACIDIFICATION POTENTIAL FOR SOIL AND WATER; EP = EUTROPHICATION POTENTIAL; POCP = PHOTOCHEMICAL OZONE CREATION; ADPE = ABIOTIC DEPLETION POTENTIAL – ELEMENTS; ADPF = ABIOTIC DEPLETION POTENTIAL – FOSSIL FUELS; WDP = WATER USE (WATER (USER) DEPRIVATION POTENTIAL, DEPRIVATION-WEIGHTED WATER CONSUMPTION)

7 RESOURCE USE

	Production			Construction process stage		Use stage							End-of-life stage				
	A1 Raw material	A2 Transport	A3 manufacturing	A4 Transport	A5 Installation	B1 Use	B2 Maintenance	B3 Repair	B4 Replacement	B5 Refurbishment	B6 Operational energy use	B7 Operational water use	C1 Deconstruction / demolition	C2 Transport	C3 Waste processing	C4 Disposal	D Reuse, recovery, recycling
PERE (MJ/FU, net calorific value)	2,53E+00	6,41E-01	6,60E+00	8,42E-01	4,06E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	5,21E-02	4,87E-01	1,40E+00	1,06E-01	-4,31E+00
PERM (MJ/FU, net calorific value)	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PERT (MJ/FU, net calorific value)	2,53E+00	6,41E-01	6,60E+00	8,42E-01	4,06E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	5,21E-02	4,87E-01	1,40E+00	1,06E-01	-4,31E+00
PENRE (MJ/FU, net calorific value)	3,05E+01	3,37E+01	8,13E+01	4,87E+01	1,92E+01	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	8,43E+00	3,26E+01	9,18E+00	2,64E+00	-6,33E+01
PENRM (MJ/FU, net calorific value)	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PENRT (MJ/FU, net calorific value)	3,05E+01	3,37E+01	8,13E+01	4,87E+01	1,92E+01	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	8,43E+00	3,26E+01	9,18E+00	2,64E+00	-6,33E+01
SM (kg/FU)	1,83E+02	0,00E+00	0,00E+00	0,00E+00	6,67E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
RSF (MJ/FU, net calorific value)	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
NRSF (MJ/FU, net calorific value)	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
FW (m^3 water eq/FU)	1,48E-02	5,04E-03	2,11E-02	6,76E-03	6,45E-03	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	6,05E-04	4,48E-03	2,83E-03	1,64E-03	-2,49E-02

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 = NET USE OF FRESH WATER

8 WASTE CATEGORIES & OUTPUT FLOWS

	Production			Construction process stage		Use stage							End-of-life stage				
	A1 Raw material	A2 Transport	A3 manufacturing	A4 Transport	A5 Installation	B1 Use	B2 Maintenance	B3 Repair	B4 Replacement	B5 Refurbishment	B6 Operational energy use	B7 Operational water use	C1 Deconstruction / demolition	C2 Transport	C3 Waste processing	C4 Disposal	D Reuse, recovery, recycling
Hazardous waste disposed (kg/FU)	1,21E-04	2,01E-04	4,02E-04	3,30E-04	1,29E-04	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	5,87E-05	2,24E-04	3,13E-05	5,67E-06	-3,95E-04
Non-hazardous waste disposed (kg/FU)	4,19E-01	1,35E+00	2,67E+00	2,37E+00	1,33E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	5,19E-03	1,57E+00	2,06E-02	5,15E+00	-1,85E+00
Radioactive waste disposed (kg/FU)	7,11E-05	5,31E-05	1,12E-04	1,58E-05	5,33E-05	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	9,33E-07	8,25E-06	6,71E-05	1,63E-05	-1,27E-04
Components for re-use (kg/FU)	0,00E+00	0,00E+00	0,00E+00	0,00E+00	9,81E+01	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Materials for recycling (kg/FU)	0,00E+00	0,00E+00	2,42E+00	0,00E+00	1,35E+02	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,35E+02	0,00E+00	0,00E+00
Materials for energy recovery (kg/FU)	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,70E-01	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Exported energy (MJ/FU)	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,86E+00

9 IMPACT CATEGORIES ADDITIONAL TO EN 15804

	Production			Construction process stage		Use stage							End-of-life stage				
	A1 Raw material	A2 Transport	A3 manufacturing	A4 Transport	A5 Installation	B1 Use	B2 Maintenance	B3 Repair	B4 Replacement	B5 Refurbishment	B6 Operational energy use	B7 Operational water use	C1 Deconstruction / demolition	C2 Transport	C3 Waste processing	C4 Disposal	D Reuse, recovery, recycling
PM (disease incidence)	1,23E-07	1,25E-07	3,38E-07	2,05E-07	6,63E-08	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,65E-07	1,43E-07	3,33E-08	6,92E-08	-2,54E-07
IRHH (kg U235 eq/FU)	2,88E-01	7,84E-02	4,43E-01	6,36E-02	1,75E-01	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	3,80E-03	3,34E-02	2,77E-01	2,04E-02	-4,66E-01
ETF (CTUe/FU)	6,33E+01	2,98E+01	6,31E+01	4,46E+01	2,46E+01	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	5,25E+00	3,21E+01	1,10E+01	1,78E+00	-6,82E+01
HTCE (CTUh/FU)	7,15E-09	1,41E-08	2,88E-08	2,48E-08	5,63E-09	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	2,54E-09	1,40E-08	6,56E-09	1,02E-10	-2,12E-08
HTnCE (CTUh/FU)	6,56E-08	2,28E-08	4,92E-08	3,58E-08	1,89E-08	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	3,59E-09	2,47E-08	7,50E-09	1,53E-09	-6,12E-08
Land Use Related impacts (dimensionless)	1,15E+01	2,19E+01	5,33E+01	2,63E+01	2,36E+01	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	5,57E-01	1,75E+01	4,90E+01	2,10E+00	-3,87E+01

HTCE = HUMAN TOXICITY – CANCER EFFECTS; HTNCE = HUMAN TOXICITY – NON CANCER EFFECTS; ETF = ECOTOXICITY – FRESHWATER; (POTENTIAL COMPARATIVE TOXIC UNIT)
PM = PARTICULATE MATTER (POTENTIAL INCIDENCE OF DISEASE DUE TO PM EMISSIONS);
IRHH = IONIZING RADIATION – HUMAN HEALTH EFFECTS (POTENTIAL HUMAN EXPOSURE EFFICIENCY RELATIVE TO U235);

9.1 Environmental impact categories explained

Global Warming Potential

The global warming potential of a gas refers to the total contribution to global warming resulting from the emission of one unit of that gas relative to one unit of the reference gas, carbon dioxide, which is assigned a value of 1.

It is split up in 4:

- Global Warming Potential total (GWP-total) which is the sum of GWP-fossil, GWP-biogenic and GWP-luluc
- Global Warming Potential fossil fuels (GWP-fossil) : The global warming potential related to greenhouse gas (GHG) emissions to any media originating from the oxidation and/or reduction of fossil fuels by means of their transformation or degradation (e.g. combustion, digestion, landfilling, etc).
- Global Warming Potential biogenic (GWP-biogenic) : The global warming potential related to carbon emissions to air (CO2, CO and CH4) originating from the oxidation and/or reduction of aboveground biomass by means of its transformation or degradation (e.g. combustion, digestion, composting, landfilling) and CO2 uptake from the atmosphere through photosynthesis during biomass growth - i.e. corresponding to the carbon content of products, biofuels or above ground plant residues such as litter and dead wood.
- Global Warming Potential land use and land use change (GWP-luluc): The global warming potential related to carbon uptakes and emissions (CO2, CO and CH4) originating from carbon stock changes caused by land use change and land use. This sub-category includes biogenic carbon exchanges from deforestation, road construction or other soil activities (including soil carbon emissions).

Ozone Depletion

Destruction of the stratospheric ozone layer which shields the earth from ultraviolet radiation harmful to life. This destruction of ozone is caused by the breakdown of certain chlorine and/or bromine containing compounds (chlorofluorocarbonsor halons), Which break down when they reach the stratosphere and then catalytically destroy ozone molecules.

Acidification potential

Acid depositions have negative impacts on natural ecosystems and the man-made environment incl. buildings. The main sources for emissions of acidifying substances are agriculture and fossil fuel combustion used for electricity production, heating and transport.

Eutrophication potential

The potential to cause over-fertilization of water and soil, which can result in increased growth of biomass and following adverse effects.

It is split up in 3:

- Eutrophication potential - freshwater: The potential to cause over-fertilization of freshwater, which can result in increased growth of biomass and following adverse effects.
- Eutrophication potential - marine: The potential to cause over-fertilization of marine water, which can result in increased growth of biomass and following adverse effects.
- Eutrophication potential - terrestrial: The potential to cause over-fertilization of soil, which can result in increased growth of biomass and following adverse effects.

Photochemical ozone creation

Chemical reactions brought about by the light energy of the sun creating photochemical smog. The reaction of nitrogen oxides with hydrocarbons in the presence of sunlight to form ozone is an example of a photochemical reaction.

Abiotic depletion potential for non-fossil ressources

Consumption of non-renewable resources, thereby lowering their availability for future generations. Expressed in comparison to Antimonium (Sb).

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 experienced with the indicator.

Abiotic depletion potential for fossil ressources

Measure for the depletion of fossil fuels such as oil, natural gas, and coal. The stock of the fossil fuels is formed by the total amount of fossil fuels, expressed in Megajoules (MJ).

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 experienced with the indicator.

Ecotoxicity for aquatic fresh water	The impacts of chemical substances on ecosystems (freshwater). 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 experienced with the indicator.
Human toxicity (carcinogenic effects)	The impacts of chemical substances on human health via three parts of the environment: air, soil and water. 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 experienced with the indicator.
Human toxicity (non-carcinogenic effects)	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 experienced with the indicator.
Particulate matter	Accounts for the adverse health effects on human health caused by emissions of Particulate Matter (PM) and its precursors (NOx, SOx, NH3)
Resource depletion (water)	Accounts for water use related to local scarcity of water as freshwater is a scarce resource in some regions, while in others it is not. 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 experienced with the indicator.
Ionizing radiation - human health effects	This impact category deals mainly with the eventual impact on human health of low dose ionizing radiation 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.
Land use related impacts	The indicator is the "soil quality index" which is the result of an aggregation of following four aspects: – Biotic production – Erosion resistance – Mechanical filtration – Groundwater The aggregation is done based on a JRC model. The four aspects are quantified through the LANCA model for land use. 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 experienced with the indicator.

10 DETAILS OF THE UNDERLYING SCENARIOS USED TO CALCULATE THE IMPACTS

10.1 A1 - raw material supply

This module considers the extraction and processing of all raw materials and energy which occur upstream to the studied manufacturing process.

To produce Léém Compressed Earth Blocks, four different raw materials are needed: Cement, Loess loam, Crushed and washed concrete and Rhine sand.
Concerning the Loess loam which are excavated on construction sites, the assumption is that there is no impact to produce these raw materials, considered in the A1 module. Indeed, they are legally considered as waste (of a construction site) the moment they leave the construction site.
For recycled concrete, only the washing process has been considered, the concrete in itself being a waste from demolition plant. End of life is after crushing.
For the modelling of Rhine sand, the MRPI-EPD called: "**Zand 0-4, in en nabij Nederland, geproduceerd door Cascade-leden, A1-A3, cat. 2" has been used.** The supplier is a member of Cascade.
All raw materials are transported in bulk.

10.2 A2 – transport to the manufacturer

The raw materials are transported to the manufacturing site. Transportation of raw materials is achieved using trucks. Table below shows information about transport of raw materials with the origin, the distance and the database used to model it.

Resource	Origin	Distance
Recycled concrete	Gent, Belgium	73
Loess loam	Brussels, Belgium	/
Rhine sand	Germany	1 250
Cement	Average distance	

For Loess loam, transportation from the demolition site to BC Materials is not considered. The supplier is an earthmover who excavates from a construction site and delivers directly to BC materials, bypassing a Temporary Storage Centre.
The type of lorry used is the one recommended by the BE-PCR for bulk materials. Concerning the range EURO, suppliers have confirmed their EURO6 certification for trucks and the Brussels region only allows EURO6 trucks on its territory starting from 1/1/2025.

10.3 A3 - manufacturing

This module considers the production process.
The first step is the premixing of loam, Rhine sand and recycled concrete at BC materials. The wheel loader used for premixing uses diesel. Once the premix achieved, it is loaded into a truck, using the same wheel loader. The truck transports this premix to Claesen site (83 km away) where the premix is stored in a silo and subsequently transferred to the mixer using a hopper where cement is added.

When the mix is finished, it goes to a vibrocompaction press to produce the blocks after which the blocks are stored in the curing/drying chamber. After curing/drying, the blocks are palletized by machine and receive a LDPE film for protection. Up until here, all processes at Claesen are electrified. The blocks are subsequently stored by a forklift on diesel. From this storage, blocks are transported to the construction site by Euro 6 truck and are to be installed on site by the contractor.

All operations are performed using machinery using diesel or electricity. Data are based on data collection with calculated and measured data on site.

10.4 A4 – transport to the building site

For the transportation to the construction site, statistics from the sales department are available and used to model the average transport.
Transportation mode is road, and the used database is "transport, freight, lorry 16-32 metric ton, EURO5 | transport, freight, lorry 16-32 metric ton, EURO6 | Cutoff, U – RER".
The average distance has been calculated as 72.5 km. This is a weighted average of all sold of Compressed Earth Block – 140 mm from 1/7/2023 to 30/6/2024.
During the transportation step, damage for blocks is estimated with 2% of losses.
The capacity utilisation including empty returns is the one given by default, as 50%.

10.5 A5 – installation in the building

The masonry can be achieved using Léém Earth Adhesive Mortar (2-3mm).
Léém Adhesive Mortar is used to "glue" Léém Compressed Earth Blocks in joints of 2-3mm. Proper tools such as Adhesive Mortar Spreader Box/Trowel are available in the Léém Earth Blocks accessories range, or generic adhesive mortar spreading trowels can also be used.
Concerning the installation stage, there are expected losses for blocks of 4%. For Léém Earth Adhesive Mortar, the reversible aspect of the clay binder makes that all construction site remains can be reused, hence no waste during installation, as mentioned in the German PCR for Earth materials.
The installation stage consists of building the wall using the appropriate mortar, prepared by mixing the product with water. For the Leem Earth Adhesive Mortar, around 25% of water should be added, however this water is not counted as it is not used for chemical binding, but rather evaporates back to the natural cycle after a few weeks. (See German Product Category Rules for Earth Mortar PKR_LMM 4.3).

Parts of the installation	quantity	Description
Processes necessary for the installation of the product - electricity		ELECTRICITY NEEDED FOR THE MIXING OF THE PRODUCT WITH WATER
Fixation materials	*25% of EAM* *6.7 kg*	WATER EAM
Jointing materials	*Not relevant*	/
Treatments	*Not relevant*	/
Material losses	*4%*	LOSSES DUE TO BREAKING OF BLOCKS
Packaging		PALLET, LDPE FILM, PAPER BAG

There is no ancillary materials for installation.
Concerning the end-of-life of packaging, default scenarios have been used and are presented in table below.

Nature of packaging	Scenario	%	Ecoinvent database
Paper/cardboard	Incineration	5	treatment of waste paperboard, municipal incineration | waste paperboard | Cutoff, U - GLO
	Recycling	95	Burdens/benefits out of boundaries
Pallet	Incineration	40	treatment of waste wood, untreated, municipal incineration | waste wood, untreated | Cutoff, U - GLO
	Recycling	40	Burdens and benefits out of boundaries (see module D)
	Reuse	20	Benefits out of boundaries
Big bag/Film	Landfill	5	treatment of waste polypropylene, sanitary landfill | waste polypropylene | Cutoff, U - RoW
	Incineration	60	treatment of waste polypropylene, municipal incineration | waste polypropylene | Cutoff, U - GLO
	Recycling	35	Burdens and benefits out of boundaries (see module D)

Transportation of waste is also considered according to the default values of BE-PCR:

- Transportation from the construction site to sorting plant: 30 km
- Transportation from sorting plant to landfill: 50 km
- Transportation from sorting facility to incineration plant/energy recovery: 100 km

The transportation mode is 100% with Lorry 16-32 ton (EURO 5).
The loads and benefits coming from the paper sack packaging are not considered, assumed to be under the cut off rule due to the low amount of this type of packaging in the average market.
Loads and benefits from the pallet and the big bags/LDPE end-of-life scenarios are included in module D.
Losses of blocks due to transportation and installation are also taken into account following the B-EPD default scenario with 5% of landfill and 95% of recycling.
Transportation of waste is taken into account according to the default values of BE-PCR:

- Transportation from the construction site to sorting plant: 30 km
- Transportation from sorting plant to landfill: 50 km

The transportation mode is 100% with Lorry 16-32 ton (EURO 5).
Concerning the sorting plant, it has a crusher and then a consumption of 0,0037 kWh of Belgian electricity per kg of crushed product has been used.
To charge and discharge waste, a diesel consumption of 5,9 MJ burned in building machine is assumed for 1 cubic meter of bulk waste (density of 1400 kg/m^3 and the bulk density of waste can be calculated as 0.9 x material density).
To take the infrastructure of sorting plant into account, a factor of 10^{-10} plant per kg of waste has been.

10.6 B – use stage (excluding potential savings)

There is no operation of maintenance or replacement, nor use of water or energy during the lifetime of the plaster.
B1: Carbonation of cement in blocks
B2:
B3:
B4:
B5:
B6:

10.7 C: End of life

A specific scenario for the compressed earth block wall could be modelled with the recovery of the product by making use of the easy separating qualities of clay-based building materials. The blocks and mortar can be easily separated by hand after wetting by a high-pressure water hose. There is no particulate matter during this dismantling. Blocks can be stored for reuse. (See German PCR for Earth blocks chapter 8)
In the case of use of Léém Adhesive Mortar and because of the reversible binding qualities of clay, this product has the exact same composition and unaltered chemistry as the initial product and can be reused without further processing in the C stage. (See German PCR for Earth Masonry Mortar chatper 8)
When Earth Block Masonry is wetted before demolition, no particulate matter is emitted, and hence this parameter is zero.
A take back program for the Leem blocks is in place, recommended in the public guide "General guide: Building sustainably with Léém" (download link) of use for this product and consists of the recovering of the product as mentioned previously.
The proportion between the take back program, and the base scenario is assumed to be:

- 40% of the product recovered by the take back program
- 55% of the product recycled
- 5% of the product landfilled

Concerning the recycling, blocks and mortar are crushed together and can then replace inert materials.
C1: Demolition
The demolition of blocks is associated with the demolition of the wall. This module takes into account the diesel consumption of the machines for the demolition (0.044 MJ/kg).
This step is applied on 60% of the product. The product entering the take back program is obtained directly.
C2: Transport to waste processing

Concerning the transport of waste, the generic transport distances have been used:

- From construction/demolition site to sorting plant/crusher/collection point: 30 km
- From sorting plant to landfill: 50 km

For the product recovered by the take back program, the product is sent back to BC materials site. The average transportation is then used with 72.5 km. Concerning the range EURO, suppliers have confirmed their EURO6 certification for trucks and the Brussels region only allows EURO6 trucks on its territory starting from 1/1/2025. The transporting mode is a lorry 16-32 tonnes, EURO 6.
For the remaining waste going to the sorting plant, and to the landfill, the default transporting mode is used with a lorry 16-32 tonnes, EURO 5.
C3: Waste processing for reuse, recovery and/or recycling
The amount of waste going to the sorting plant is about 60% of the global waste which represent the product recycled and the product landfilled.
Concerning the sorting plant, it has a crusher and then a consumption of 0,0037 kWh of Belgian electricity per kg of crushed product has been used.
To charge and discharge waste, a diesel consumption of 5,9 MJ burned in building machine is assumed for 1 cubic meter of bulk waste (density of 1400 kg/m^3 and the bulk density of waste can be calculated as 0.9 x material density).
To take the infrastructure of sorting plant into account, a factor of 10^{-10} plant per kg of waste has been used.
C4: Waste processing for reuse, recovery and/or recycling
Concerning the disposal, waste is assumed to be put in a landfill for inert waste.
Parameters of used scenarios are presented in Table below.

End of life modules – C3 and C4	Unit	Value
Wastes collected separately	kg	98.1
Waste collected as mixed construction waste	kg	147.2
Waste for re-use	kg	98.1
Waste for recycling	kg	134.9
Waste for energy recovery	kg	0
Waste for final disposal	kg	12.3

10.8 D – Benefits and loads beyond the system boundaries

Module D is calculated in accordance with EN 15804:2012+A2:2019. All declared net profits and expenses resulting from net flows leaving the system of products that have not been assigned as co-products and have reached end-of-waste status, are included in this end-of-waste status, are included in this module D (reuse, recycling, energy recovery).
The benefits come from the reuse, recycling and energy valorisation of packaging waste (see A5 for more details) but also from the reuse and recycling of of Earth Compressed blocks and associated mortar.
The BE-PCR default values are applied.
The benefits out of boundaries are the following:

- Reuse
  - Earth Compressed block (C4): 95.4 kg/FU which are substituted new product. The benefits are calculated as the environmental impacts of the production of Leem Earth compressed block (from A1 to A3) without packaging
  - Earth Adhesive mortar (C4): 2.7 kg/FU which is substituted new product. The benefits are calculated as the environmental impacts of the production Earth Adhesive mortar (from A1 to A3) without packaging
  - Pallets (A5): 4.35E-2 kg/FU which substitutes new pallet
- Recycling
  - Earth Compressed block and associated mortar (C4): 134.9 kg/FU. To avoid double benefits of the use of secondary resources, only the percentage of the primary raw materials will be taken into account. They represent 22.5% of the weight of the product.
  - Pallets (A5): 8.70E-02 kg/FU which substitutes wood chips.
  - Big bag - Film (A5): 4.82E-02 kg/FU which substitutes polypropylene plastic.
- Energy recovery

- Pallet (A5): 8.70E-02 kg/FU. The lower heating value of a pallet of 30% of humidity is about 12.24 MJ/kg. A specific cogeneration plant is modelled (Valbiom) with an electric yield of 22% and a thermal efficiency of 50%.
- Big bag – Film (A5): 8.27E-02 kg/FU. The incinerated fraction leads to a cogeneration with default efficiency of 10% for electricity and 20% for the thermal energy. The LHV of the polypropylene is equal to 44 MJ/kg.

Total electricity substitution is equal to 5.98-01 MJ/FU or 1.66E-01 kWh/FU. Thermal substitution is about 1.26 MJ/FU.

The loads out of boundaries are the following:

- Shredding of pallet (A5): 8.70E-02 kg/FU related to the wood chips substitution.
- Plastic sorting and recycling.
- Transportation to the recycling plant for plastics: 138 km
- Transportation to the shredding plant of pallet: 64 km

11 RELEASE OF DANGEROUS SUBSTANCES TO INDOOR AIR, SOIL AND WATER DURING THE USE STAGE

11.1 Indoor air

VOC emissions have been assessed in accordance with EN16516 and are below the minimum threshold. This means no indoor air problems.

11.2 Soil and water

The contact with water is reduced by the application and then the emissions of substances potentially problematic is not relevant.

12 DEMONSTRATION OF VERIFICATION

EN 15804+A1 serves as the core PCR

Independent verification of the environmental declaration and data according to standard EN ISO 14025:2010
Internal ☐ External ☒

Third party verifier: Agnes Schuurmans & Bob Roijen, SGS INTRON B.V., Dr. Nolenslaan 126, 6136 GV Sittard, the Netherlands, bob.roijen@sgs.com

13 LCA INTERPRETATION

This study has shown the low environmental impact of product coming from earth as a resource, especially when using secondary resources such as Loess loam coming from excavations of construction sites as well as recycled washed concrete.
This study has shown the importance of the take back program that implies a reuse of the components and then savings of resources and energy. The take back program is already in place but this type of element is quite new on the market and there are few experiences about demolition of buildings including this product. Indeed, the starting point of the use of this component is less old than the lifetime of the buildings where they are involved. However, a take back program as a defining principle of earth building materials is also mentioned in the German PCR for Clay Plaster (see German PKR for Earth Blocks and Earth Masonry Mortar chapter 8 Nachnutzungsphase).
The take back program is possible thanks to the easy separating qualities of clay-based building materials. The blocks and mortar can be easily separated by hand after wetting by a high-pressure water hose. There is no particulate matter during this dismantling. Blocks can be stored for reuse.
In this case of installation, using Leem Adhesive Mortar and because of the reversible binding qualities of clay, this product has the exact same composition and unaltered chemistry as the initial product and can be reused without further processing in the C stage (See German PKR for Earth Masonry Mortar chapter 8.1).

14 TECHNICAL INFORMATION FOR SCENARIO DEVELOPMENT

This B-EPD is relative to a Compressed Earth Block of 140 mm width installed with Earth Adhesive Mortar. Other dimensions are available with 90 m or 190 mm of width.
For the 190 mm, a proportional rule can be applied due to the same density of the product.
For the 90 mm, the rule of weight is not direct. Indeed, the density of the block 90 mm is 1970 kg/m^3 while for the 140 and 190 mm, the density is 1760 kg/m^3. That means that block of 90 mm requires proportionally more matter than other width.
Calculations from A1 to A4 are directly proportional to the mass of the blocks. Based on this, and the ratio between the density of the blocks (90 and 140/190), the proportional rule must be multiplied by 1.12 to obtain the results for modules A1 to A4.
Module A5 is directly proportional to the width of the blocks.
That means:
Impact of CEB 90 (A1 to A4) = Impacts of CEB 140 (A1 to A4) *90/140*1.12
Impact of CEB 190 = Impacts of CEB 140 * 190/140
Concerning modules B1 to D, results are extrapolated from block 140 to block 190. For the block of 90mm, only results from A1 to A5 can be obtained directly by following the previous rules.

15 APPLICATION UNIT

The functional unit is defined as "To build 1 m² of wall with 140 mm width compressed earth blocks installed with Earth adhesive mortar and with a lifetime of 60 years, in Belgium". To fulfil this, 238.5 kg of product is needed. This study is performed for the Compressed Earth Block "as installed" with Earth adhesive mortar (6.7 kg per FU). This functional unit is in accordance with the TOTEM program.

Other width of 90 mm and 190 mm can be extrapolated from the table of results from 140 mm. Environmental impacts are directly proportional with the width for the 190 mm and with a factor of 1.12 for the 90 mm (see paragraph 14 for more explanation).

16 ADDITIONAL INFORMATION ON REVERSIBILITY

Description	Type of fixing	Level of reversibility	Simplicity of disassembly	Speed of disassembly	Ease of handling (size and weight)	Robustness of material (material resistance to disassembly)	Comment
Blocks joint together to form an interior wall	Earth Adhesive mortar	Reversible connection (See German PKR for Earth Blocks and Earth Masonry Mortar, Chapter 8)	simple – use of trowels and water if needed.	Speedy disassembly	easy to handle manually, one worker is usually sufficient	The material resists well during disassembly, there is no loss of quality.	

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External independent verification of the declaration and data according to EN ISO 14025 and relevant PCR documents

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