Environmental Product Declaration

In accordance with ISO 14025 and EN 15804 for:

Concrete rooftiles and accessories

from

Benders Sverige AB

EPD Profile

	EPD Owner **Benders Sverige AB** Sofia Bender, QEHS Manager +46 108880006 Edsvära Lars Andersgården 1, 53593 Kvänum sofia.bender@benders.se
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Product category rules (PCR): The International EPD System PCR for Construction Products and Construction Services 2012:01, version 2.33 and PCR 2012:01-SUB-PCR-G
Independent third-party verification of the declaration and data, according to ISO 14025:2006: No verification

The EPD owner has the sole ownership, liability, and responsibility for the EPD. EPDs within the same product category but from different programmes may not be comparable. EPDs of construction products may not be comparable if they do not comply with EN 15804.

Company information

Description of the organization

Benders Sverige AB manufactures, sells, and delivers concrete rooftiles and accessories to professional customers and retailers on the European market. For over half a century, we have been developing and modifying the concrete rooftiles. We offer innovative, tight, fast to install, and easy roof safety concrete rooftiles. We are quality and environmental certified according to ISO 9001 and ISO 14001. Our headquarters are located at Edsvära, outside Kvänum in Västergötland. We produce rooftiles at Edsvära, Bålsta and Braås, we have warehouses in Åstorp south and Norberg north of Sweden. Out in Europe warehouses, sales companies and retailers are located in thirty locations. Our concrete rooftiles are available with three different profiles – Carisma, Palema and Exklusiv. All our concrete rooftiles and accessories are surface treated with paint manufactured by ourselves at our own production site Edsvära.

For more information regarding the products or the organization, see EPD owner's website: www.benders.se

Name and location of production sites

The concrete rooftiles and accessories covered in this EPD are produced at three different sites in Sweden, located in Edsvära (Edsvära Lars Andersgården 1, 53593 Kvänum), Bålsta (Hantverksvägen 11, 74640 Bålsta)) and Braås(Böksholmsvägen 5, 363 41 Braås).

EPD Product information

Product name: Concrete rooftiles and accessories.

Product identification:

This EPD covers Concrete rooftiles and accessories, all identified with product name in Appendix A.

Product description:

The concrete products are made of cement, gravel, and water. A small amount of sand and iron oxide is also included in the products. Lastly, it is painted with surface treatment paint for its final appearance. The three production sites in Edsvära, Bålsta and Braås use slightly different raw material compositions, and use different manufacturing fuels. The finished products are prefabricated concrete rooftiles and accessories. The final products are packed, and one fraction of the packaged products is distributed from the production site to the warehouse in Åstorp for storage. The other fraction is stored at each production site and then distributed directly to the user.

Figure 1 Illustration of the three concrete rooftiles Carisma, Palema and Exklusiv products assessed, all the three concrete rooftiles are valid for the functional unit.

After its lifetime, the effete product is assumed to be deconstructed and transported to a waste management centre, majority of the product

is made of concrete and pigments; both are assumed to be material recycled, and further used as filling materials for roads and other construction purposes.

This EPD is valid for all products listed in Appendix A. Specifications for each product can be found at www.benders.se

Average compilation:

Since the assessed product category is produced on three different sites, an average was compiled. This was done based on production volumes of the product category at the four sites, where the production volumes of the assessed product category were compared resulting in each site contributing with a corresponding ratio to the average.

UN CFC code: 3755

LCA Information

Functional unit: 1 metric tonne of the average Concrete rooftiles and accessories.

Reference service life: 50 years

Time representativeness: The data and information collected and modelled for refers to the production year of 2020. The general datasets from used databases are all representative and valid for the year of 2020.

Geographical scope: Sweden
The geographical coverage of this LCA is scenario adapted, i.e. set to Sweden for the manufacturing and to region specifics, when possible, for the raw material extraction and production. This means that the data used for raw material extraction and production is adapted to the geographical region it is extracted from and produced in. The geographical coverage for transports is set to Europe.

Database(s) and LCA software used:
The LCA software SimaPro 9.1.1.1 was used in the assessment, with data from specific raw material EPDs and the databases Ecoinvent 3.6, Environmental footprint (EF) database 2.0 and Industry data 2.0.

Description of system boundaries:
Cradle-to-grave, i.e. life cycle stages A1-C4

Excluded lifecycle stages: Life cycle stages A5, B2-B7 and D are neither considered nor declared.

Allocation methodology: The cut-off method has been applied within the product system. For allocations between product systems, the Polluter-pays allocation method has been used.

Cut-off: All raw materials according to the product formula, including their respective energy demands during extraction and production have been considered, as well as the main packaging materials used to prepare the final product for distribution. Some packaging materials & production solvents that constitute less than 1% of the product weight have been excluded. This cut-off rule does not apply for hazardous material and substances.

More information:
The differences between the environmental impact indicators deviate from the average results (i.e. results for the FU) with more than ±10%. Ranges are presented in Table 4 .

For more information about the EPD owner, visit www.benders.se

For more information about the EPD producer, visit www.dge.se.
For more information about the underlying LCA study, contact the LCA practitioner Sayali Bhalekar (Sayali.Bhalekar@dge.se).

Concrete in use goes through a carbonation process. Carbonation of concrete is a chemical reaction, a natural process by which CO_2 in the ambient air penetrates the concrete and reacts with hydration products in the concrete. Not only the $Ca(OH)_2$ component of the hardened cement paste is able to carbonate, but also other calcium rich hydrated oxides in the concrete have been shown to gradually transform into carbonate by first decompose to $Ca(OH)_2$ when pH is getting lower due to carbonation. For concrete carbonation this means that part of the carbon dioxide emitted during cement production is rebound to the concrete during use and end of life stages of a structure. The carbonation process for the products assessed is not considered, since carbonation is not included in the product category rules for construction products and construction services 2012:01, version 2.33 .

System diagram

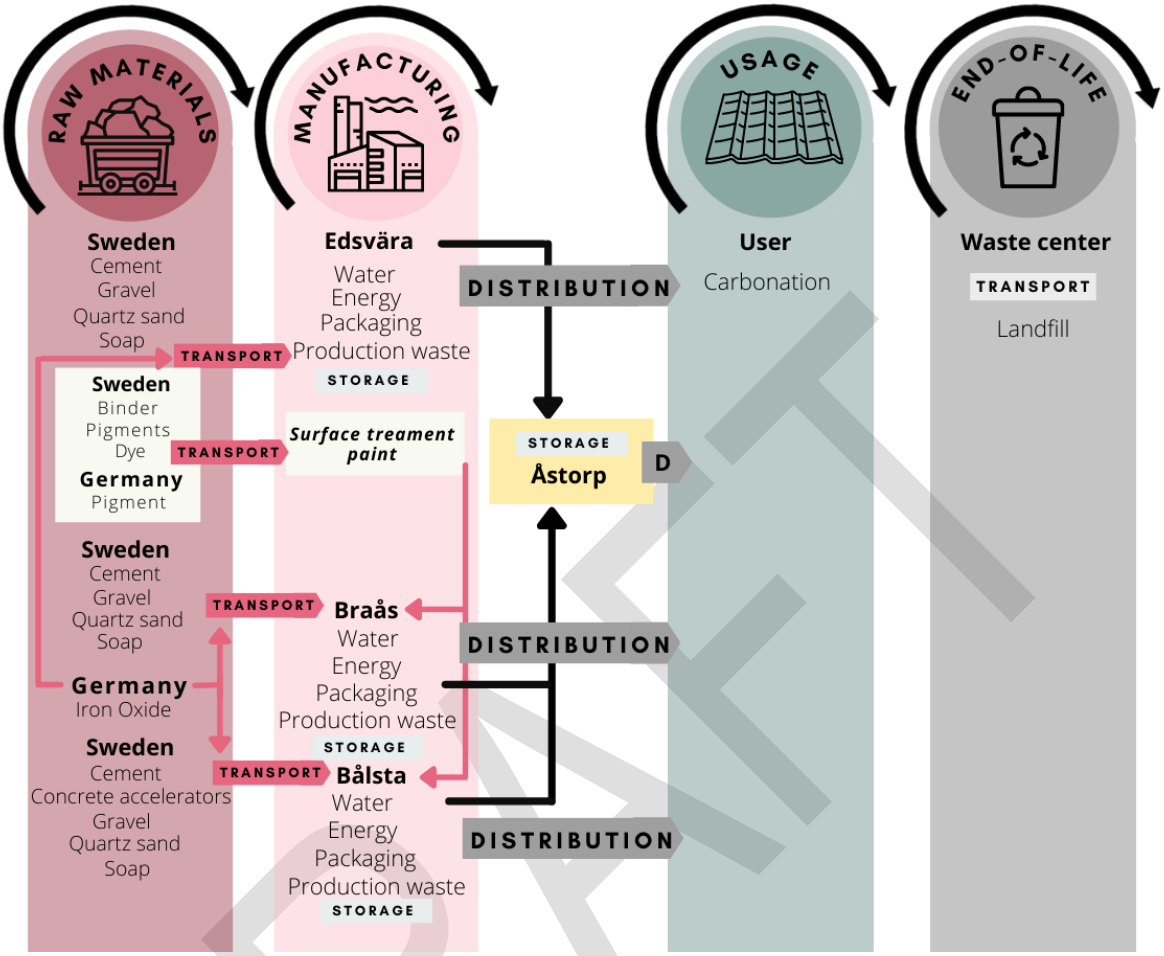

Figure 2 Flow diagram of the assessed life cycle phases of Benders concrete rooftiles, beginning with raw material extraction and production (A1), followed by transport from suppliers (A2) to the three manufacturing sites Edsvära, Bålsta and Braås. Manufacturing (A3) takes place at these sites and the finished product is transported (A4) from production sites to storage and a fraction is stored at all the production sites to be distributed (A4) to users. A further description of the life cycle phases included in the assessment is provided in Table 2.

Table 1 Table declaring the life cycle stages included in the LCA.
X = Included in the LCA, MND = Module Not Declared.

Product stage			Construction process stage		Use stage							End of life stage			
Raw materials	Transport	Manufacturing	Transport	Construction-Installation	Use stage	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction	Transport	Waste processing	Disposal
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4
X	X	X	X	MND	X	MND	MND	MND	MND	MND	MND	X	X	X	X

Description of life cycle stages A1-C4: Raw material extraction and production, transport from supplier, manufacturing on site, distribution, and end of life.

Table 2 The life cycle stages included in this EPD and a description of each stage.

Stage	Description
A1 Raw materials	Extraction and processing of all raw materials occurring upstream from the manufacturing process, including the waste generated for these processes. The energy generation needed for these processes (extraction, refining and transport of energy from primary energy sources) as well as the energy needed for the manufacturing process (A3).
A2 Transport	The external transportation of raw materials to each of the three manufacturing sites. The modelling includes transportation on road, water and/or rail, with processes for each raw material.
A3 Manufacturing	The manufacturing of the concrete products takes place at Benders' three sites in Edsvära, Bålsta and Braås. All raw materials are weighted in by a computer driven process. Gravels and cement are mixed, followed by dosing of water and addition of surface treatment paint and sand. The concrete mixture is then conveyed to be casted where the concrete mixture is poured into a cast oil coated cast. Electricity, fuel and water consumption, waste generation and packaging materials are all included in this stage.
A4 Distribution	When the rooftiles are produced and packaged, one fraction of the products is distributed from the production site to the warehouse in Åstorp for storage. The other fraction is stored at each production site and then distributed directly to the user.
C1-C4 End of life	The service life for concrete rooftiles is 50 years. After its lifetime, the effete product is assumed to be deconstructed and transported to a waste management centre. The majority of the product is made of concrete and pigments; both are assumed to be material recycled, and further used as filling materials for roads and other construction purposes

Content declaration per functional unit

1 metric tonne of the average concrete product for rooftiles and accessories

Table 3 Content declaration for the functional unit. None of the substances are regarded as SVHCs (Substances of very high concern) as defined in the REACH legislation.

Raw materials	Mass ratio
Cement	<17%
Gravel (all)	<74%
Surface treatment paint	<1%
Soap	<0,03%
Quartz sand	<0,07%
Iron Oxide	<1%
Concrete accelerator	<0,02%
Water*	<8%

**The water weight included in the products are the calculated amounts left after hardening, to sum up to the total weight.*

For construction product EPDs complaint with EN15804, the content declaration shall list substances contained in the products that are listed in the "Candidate List of Substances of Very High Concern for

Authorization” when their content exceeds the limits for registration with the European Chemicals Agency: i.e. >0.1 % of the weight of the product. **No such substances are used in the production of the products covered in this EPD.**

Packaging

The packaging process for the rooftiles is carried out in the same way at all three production sites.

Distribution packaging: It starts with stacking up five rooftiles on top of each other with some glue in between them to avoid damage. These five rooftiles are then secured with plastic band. A total of 50 such sets are then placed on a wooden stand. This batch is then secured with a plastic band. The whole batch is then protected with a stretch of plastic film around it. The material of the plastic film and the plastic band differs for different production sites.

Environmental performance

1 metric tonne of the average concrete rooftiles and accessories

Environmental impacts

Table 4 The results from the LCA showing the environmental impacts from 1 FU during the life cycle stages assessed.

1 metric tonne of the average **concrete rooftiles.**		A1 Raw material extraction and production	A2 Transport from supplier	A3 Manufacturing	A4 Distribution	C1-C4 End of life	TOTAL	Deviation range from average
Impact category	**Unit**							
Acidification	kg SO_2 eq.	0,37	0,06	0,04	0,06	0,10	**0,62**	**-2% to +4%**
Eutrophication	kg PO_4^{3-} eq.	0,14	0,02	0,01	0,01	0,02	**0,20**	**-6% to +4%**
Global warming	kg CO_2 eq.	180,3	13,8	7,8	16,5	12,3	**230,7**	**-2% to +2%**
Photochemical oxidation	kg C_2H_4 eq.	0,042	0,002	0,003	0,002	0,003	**0,052**	**-1% to +1%**
Abiotic depletion, elements	kg Sb eq.	7,92E-4	2,32E-4	1,44E-4	4,51E-4	1,25E-4	**1,74E-3**	**-7% to +9%**
Abiotic depletion, fossil fuels	MJ	793,6	200,4	168,1	246,2	245,7	**1653,9**	**-1% to +1%**
Ozone layer depletion	kg CFC-11 eq.	6,86E-6	2,35E-6	1,89E-6	3,02E-6	2,93E-6	**1,71E-5**	**-2% to +2%**

Use of resources

1 metric tonne of the average Concrete rooftiles and accessories

Resource use

Table 5 The results from the LCA showing the resource consumption from 1 FU during the life cycle stages assessed

1 metric tonne of the average **Concrete rooftiles**.			A1 Raw material extraction and production	A2 Transport from supplier	A3 Manufacturing	A4 Distribution	C1- C4 End of life	TOTAL
Parameter		**Unit**						
Primary energy resources - Renewable	Use as energy carrier	MJ, net calorific value	138	8	138	4	2	291
	Used as raw materials	MJ, net calorific value	0	0	0	0	0	0
	TOTAL	**MJ, net calorific value**	138	8	138	4	2	**291**
Primary energy resources - Non-renewable	Use as energy carrier	MJ, net calorific value	1004	219	263	251	249	1986
	Used as raw materials	MJ, net calorific value	0	0	40	0	0	0
	TOTAL	**MJ, net calorific value**	1004	219	303	251	249	**2026**
Secondary material		kg	9,8	0	0	0	0	**9,8**
Renewable secondary fuels		MJ, net calorific value	93,1	0	0	0	0	**93,1**
Non-renewable secondary fuels		MJ, net calorific value	141,7	0	0	0	0	**141,7**
Net use fresh water		m^3	2,74	0,05	0,14	0,04	0,18	**3,15**

Waste production and output flows

1 metric tonne of the average Concrete rooftiles and accessories

Waste production

Table 6 The results from the LCA showing the waste production from 1 FU during its different life cycle stages.

1 metric tonne of the average **concrete rooftiles**		A1 Raw material extraction and production	A2 Transport from supplier	A3 Manufacturing	A4 Distribution	C1-C4 End of life	TOTAL
Impact category	**Unit**						
Hazardous waste disposed	kg	0,005	0,006	8,4E-5	0	0	**0,011**
Non-hazardous waste disposed	kg	27,1	0	0	0	0	**27,1**
Radioactive waste disposed	kg	5,06E-4	0	0	0	0	**5,06E-4**

Output flows

Table 7 The results from the LCA showing the outflows from 1 FU during its different life cycle stages.

1 metric tonne of the average **concrete rooftiles**		A1 Raw material extraction and production	A2 Transport from supplier	A3 Manufacturing	A4 Distribution	C1-C4 End of life	TOTAL
Impact category	**Unit**						
Materials for reuse	kg	0	0	0	0	0	0
Materials for recycling	kg	2,45	0	4,73E-4	0	1000	1002,45
Materials for energy recovery	kg	1,62E-3	1,90E-04	9,67E-3	0	0	1,15E-2
Energy recovery	MJ	0	0	0	0	0	0

References

General programme Instructions of the International EPD® System. Version XX

PCR for Construction Products and Construction Services 2012:01, version 2.33.

Sub-PCR-G to PCR 2012:01, version 2.33

EN 15804:2012+A1:2013 *Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products*.

ISO 14040. (2006). *Environmental Management – Life cycle assessment – Principles and framework (SS-EN ISO 14040:2006).* Stockholm, Sweden.: Swedish Standards Institute (SIS förlag AB).

ISO 14044. *Environmental Management – Life cycle assessment – Requirements and guidelines (SS-EN ISO 14044:2006).* Stockholm, Sweden: Swedish Standards Institute (SIS förlag AB).

Cementa AB (2019). *EPD, Base cement (Portland fly ash cement CEMII/A V 52,5 N)*.

Cementa AB (2019). *EPD, Building cement (Portland cement CEM I 42,5 R)*.

Cementa AB (2019). *EPD, Quick setting cement (Portland cement CEM I 52,5 R)*.

Sika Sweden AB. (2015) *EPD, Hardening accelerator (Sika Rapid C-100).*

Fazio et. Al (2018) *EF database 2.0*

Stripple, H., Ljungkrantz, C., Gustafsson, T., & Andersson, R. (2018) *CO2 uptake in cement containing products.* Stockholm, Sweden: IVL Swedish Environmental Research Institute.

Werner et. Al. (2016). *Ecoinvent 3.6.*

Appendix A

The following table list all the products from Benders concrete rooftiles range for which this EPD is valid.

Table 8 The concrete products covered by this EPD

Product name
Exklusiv, all finishes
Palema, all finishes
Carisma, all finishes
All Concrete accessories, all finishes