Environmental Product Declaration

In accordance with ISO 14025 and EN 15804+A1 for:

Linear structural elements

from

Benders Byggsystem

Programme:	The International EPD® System, www.environdec.com
Programme operator:	EPD International AB
EPD owner:	Benders Byggsystem, Box 20, 535 21 Kvänum
EPD registration number:	S-P-01391
First date of publication:	2018-09-10
Revision date:	2021-03-05
Validity date:	2023-09-09
Geographical scope:	Nordic countries
PCR used	PCR 2012:01. Construction products and construction services. Version 2.2. of 2017-05-30
Sub-PCR used	PCR 2012:01-SUB-PCR-G. Concrete and concrete elements (EN 16757:2017)

General information

Information about the organization

Owner of the EPD:
Benders Byggsystem, +46 10-8884000, info@benders.se, Box 20, 53521 Kvänum

Product-related or management system-related certifications:
Benders Byggsystem is quality-, environmental- and work environment certified according to ISO 9001, ISO 14001 and OHSAS 18001. The product in this EPD is registered and assessed in the *Byggvarubedömningen*, *SundaHus* and *the Nordic Swan Ecolabel*. We have experience of projects to be certified for instance within *LEED*, *BREEAM*, *the Nordic Swan Ecolabel* and *Miljöbyggnad*.

Name and location of production site:
Benders Byggsystem, Mariefredsvägen 41, 645 41 Strängnäs.

About the company

Ever since starting in 1960, Benders' ambition has been to satisfy customer needs. Benders' operations are permeated by a local presence and a local responsiveness to the business climate. Together with receptiveness, this provides the foundations for long and strong relations with customers, suppliers and, not least, personnel. Positive development for almost 55 years has contributed to Benders now being active in five different business areas and establishing itself as one of the market-leading producers of roofing and landscaping products in the Nordic countries. Since 2016, Benders Byggsystem has been included in the Benders Group.

Benders Byggsystem offers complete solutions for prefabricated frame systems where we are responsible for design, project management, manufacturing and assembly. Benders Byggsystem has a factory in Strängnäs and headquarters in Stockholm. With manufacturing in our own factories we can offer both standardized and customer-unique solutions. We manufacture, among other things, facades in various designs and finishes, inner walls, pre-stressed flooring and pillars and beams. At our facility in Strängnäs, over 200 people work. At the office in Stockholm there are about 30 people in charge of project management and business. We have our own assembly organization consisting of about 60 people, who carry out their own assembly and lead hired assembly teams.

Product information

Product name[1]:
Linear structural elements (Balkar och pelare)

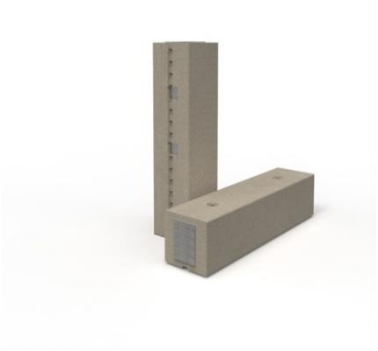
Product description:
Linear structural elements are foundations that carry up other parts of building constructions.
Application: Pillars and beams.

The technical standard followed is: SS-EN 13225.

The product number is: SS-EN 13225 P- pelare / B-balk.

Technical information:
Concrete:
Compressive strength - fck= 30-45N/mm2
Reinforcing steel:
Ultimate tensile strength - ftk = 500 N/mm2
Tensile yield strength - fyk= 540N/mm2
Prestressing steel:
Ultimate tensile strength - fpk = 1860 N/mm2
Tensile 0,1% proof-stress - fp0,1k = 1640 N/mm2

Picture of the product:



UN CPC code:
375 – Articles of concrete, cement and plaster.

Geographical scope:
Nordic countries

[1] Swedish original name within parenthesis

LCA information

PCR used:
The PCR (Product category rules) that has been used in this EPD is *PCR 2012:01. Construction products and construction services. Version 2.2. of 2017-05-30*.

The sub-PCR *PCR 2012:01-SUB-PCR-G. Concrete and concrete elements (EN 16757:2017)* has also been used.

Declared unit:
1 ton of Linear structural elements delivered to the customer.

Reference service life:
The life length of the product is at least 100 years (Svensk Betong, 2018) according to Benders Byggsystem.

Time representativeness:
The production data are from 2017 – 2018, the database data are from 2011 – 2017 i.e. no data is older than 10 years.

Database(s) and LCA software used:
Databases used are mainly Ecoinvent 3.4 and Thinkstep´s own database from 2017. The LCA software used is GaBi 8.

Data quality:
The quality of the data is judged to be good, since it is up to date data and it is collected directly from the production site.

System diagram:
A basic flowchart of the system is presented in the figure below.

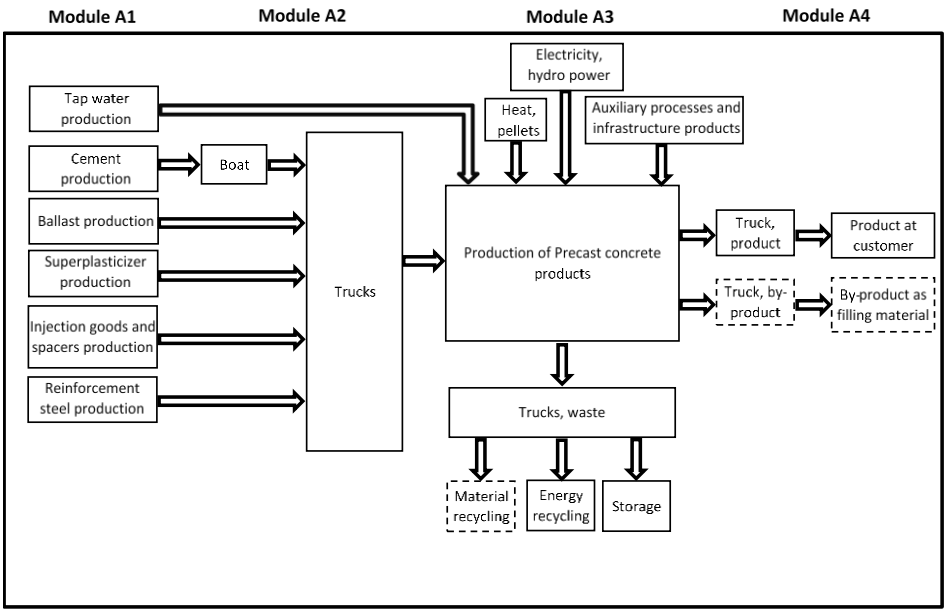


Figure 1 – Flow chart of the system

- Module A1: Several raw materials are produced, including packaging material.
- Module A2: Raw material and packaging are transported to the production site at Benders Byggsystem.

- Module A3: Production activities.
- Module A4: Transport of manufactured product to customer.

Description of system boundaries and delimitations:
This study is a so called *cradle-to-gate with options* according to the definition in the PCR used. All life cycle impacts until the transport to the customer are included, see flowchart above. According to the PCR followed the Polluter Pays Principle is applied in the system. For the waste management, this means that impacts occurring at the material recycling plant shall be allocated to the next life cycle. The life cycle starts by extracting raw materials used for the products, which is defining the boundary towards the nature.

The focus is on the overall significant processes and less accuracy for less significant processes in the model calculations.

According to the sub PCR used some infrastructure equipment shall be included if they are reusable for a limited number of times. They shall be taken into account at the product stage by dividing their total impact by the number of uses. The infrastructure product considered is wood molding for casting.

Carbonation is not taken into account in the calculations. Carbonation is a natural process which occurs during the life cycle of concrete. This means that part of carbon dioxide emitted during cement production is rebound to the concrete during use and end of life stages of a building.

The product is produced at the production site located in Strängnäs, Sweden.

Life cycle stages, included and excluded:
The life cycle stages included are A1-A4.

The life cycle stages excluded are A5, B1-B7, C1-C4 and D.

See table in the section presenting the *Product system*.

Allocations made:
Waste materials are generated in the production which is used as filling material for example in roads within the surroundings of Strängnäs. A conservative assumption is made that all environmental impact is allocated to the products and not to the co-product (i.e. the filling material). The total amount of filling material is 0.041 ton per declared unit.

Scenarios:
One scenario has been modelled and is assumed to be the most probable scenario for the product regarding for example, energy use, raw material use and waste.

Data used:
Site-specific production data have been retrieved for 2017 and 2018 from the production site. Some of the data are modelled by using EPDs in the model calculations (for instance for concrete and reinforcement steel). In some cases generic data has been used from databases such as Ecoinvent 3.4 and Thinksteps database from 2017.

About 99.9 % of the material used has been covered in the analysis. Form oil used in the concrete production is not covered in the analysis (i.e. a 0.1% cut-off), due to uncertainties in data sets. No other omissions are made and it does not affect the result.

Main raw materials:
The main raw materials used in the product can be seen in the flowchart in Figure 1.

Packaging:
Packaging materials are used for protecting the raw materials. The main packaging materials are polyethylene and corrugated board. The products to the customers are transported on scaffolding which is part of the truck, i.e. no use of packaging material.

Transportation:
The transportation included in this study are transport of raw materials and its packaging, products to customers and waste materials from the production site. The transport is mainly carried out by truck and in some cases by boat. Weighted averages for all transport distances and modes for the raw materials were calculated per declared unit.

Energy utilities:
Both electricity and heat are used at the production site. The specific mix used at the production has been collected from Benders Byggsystem. The electricity is based on 100% hydropower production from Vattenfall. Vattenfall´s EPD[2] for hydropower has been used in the model calculations, the global warming potential of 1 kWh electricity is 10.5 g CO_{2e}. Regarding the heat, wood pellets are used at the production which has been modelled by an Ecoinvent dataset.

Recycled materials:
Secondary material used in the product is mainly reinforcement steel.

Secondary energy:
Secondary energy comes from wood pellets which are used to generate heat for the cement production.

Direct emissions from production site:
The emissions from the production site are water emissions via sludge: lead, cadmium, copper, chromium, nickel and zinc. Water samples are taken on a regular basis, several times each year, at the site. For the past years the measurements have been below the regulatory limits for these substances.

Waste:
Wastes are generated from the packaging used for the raw materials as well as from the production. Packaging material for raw materials are mainly polyethylene and corrugated board. This is sent to the material recycling. Production waste could consist of for example mixed fractions of waste, electronic scrap, wood, paint, batteries. The non-hazardous waste is sent to energy recycling with energy recovery and material recycling. The hazardous wastes are sent to handling and storage.

Modifications made with update:
The following modifications have been applied for this version of the EPD:

- Use of product-specific data that has become available (A1)
- Adjustments to biogenic carbon balance (A3)

More information:
This Environmental Product Declaration (EPD) has been carried out by IVL Swedish Environmental Research Institute. This EPD is in accordance with ISO 14025 and EN 15804. It is a third party

[2] www.environdec.com/Detail/?Epd=7468

externally verified document that reports environmental data of products based on Life Cycle Assessment (LCA) and other relevant information.

Guidance on safe and effective installation, use and disposal of the product can be supplied by Benders Byggsystem. For more information about Benders Byggsystem see www.bendersbyggsystem.se

Product system

The life cycle stages included in the analysis is illustrated in the table below, according to EN15804. If a stage is included, it is indicated with an ”X” and if it is not included ”MND” (Module Not Declared) is noted.

Product stage			**Construction process stage**		**Use stage**							**End of life stage**					**Resource recovery stage**
Raw material	Transport	Manufacturing	Transport	Construction installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Deconstruction, demolition	Transport	Waste processing	Disposal		Reuse, recycling or energy recovery potentials
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4		D
X	X	X	X	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND		MND

Inventory and Impact categories

In accordance with the International EPD system programme instructions and the specific PCR used, the following characterization factors are used:

PARAMETER	UNIT	Characterization factors
Global warming potential (GWP)	kg CO_2 eq.	CML2001 – Jan. 2016, baseline method.
Acidification potential (AP)	kg SO_2 eq.	
Eutrophication potential (EP)	kg PO_4^{3-} eq.	
Formation potential of tropospheric ozone (POCP)	kg C_2H_4 eq.	
Ozone layer depletion potential (ODP)	kg R11-e	
Abiotic depletion potential – Elements	kg Sb eq.	
Abiotic depletion potential – Fossil resources	MJ, net calorific value	

PARAMETER		UNIT
Primary energy resources – Renewable	Use as energy carrier	MJ, net calorific value
	Used as raw materials	MJ, net calorific value
	TOTAL	MJ, net calorific value
Primary energy resources – Non-renewable	Use as energy carrier	MJ, net calorific value
	Used as raw materials	MJ, net calorific value
	TOTAL	MJ, net calorific value
Secondary material		kg
Renewable secondary fuels		MJ, net calorific value
Non-renewable secondary fuels		MJ, net calorific value
Net use of fresh water		m^3

PARAMETER	UNIT
Hazardous waste disposed	kg
Non-hazardous waste disposed	kg
Radioactive waste disposed	kg

PARAMETER	UNIT
Components for reuse	kg

Environmental performance

Potential environmental impact

PARAMETER	UNIT	A1	A2	A3	A1-A3	A4	A1-A4*
Global warming potential (GWP)	kg CO_2 eq.	2.07E+02	9.66E+00	5.27E+00	2.22E+02	4.62E+00	2.26E+02
Acidification potential (AP)	kg SO_2 eq.	2.23E-06	1.56E-15	9.02E-08	2.32E-06	7.54E-16	2.32E-06
Eutrophication potential (EP)	kg PO_4^{3-} eq.	3.70E-01	2.75E-02	2.24E-02	4.20E-01	1.03E-02	4.30E-01
Formation potential of tropospheric ozone (POCP)	kg C_2H_4 eq.	8.16E-02	6.55E-03	9.35E-03	9.75E-02	2.44E-03	9.99E-02
Ozone layer depletion potential (ODP)	kg R11-e	4.93E-02	-6.49E-03	2.25E-03	4.50E-02	-3.54E-03	4.15E-02
Abiotic depletion potential – Elements	kg Sb eq.	9.55E-05	6.83E-07	3.33E-06	9.95E-05	3.38E-07	9.98E-05
Abiotic depletion potential – Fossil resources	MJ, net calorific value	1.19E+03	1.31E+02	3.93E+01	1.36E+03	6.25E+01	1.42E+03

Use of resources

PARAMETER		UNIT	A1	A2	A3	A1-A3	A4	A1-A4*
Primary energy resources – Renewable	Use as energy carrier	MJ, net calorific value	3.34E+02	6.98E+00	4.75E+02	8.16E+02	3.52E+00	8.19E+02
	Used as raw materials	MJ, net calorific value	2.05E-01	0.00E+00	0.00E+00	2.05E-01	0.00E+00	2.05E-01
	TOTAL	MJ, net calorific value	3.34E+02	6.98E+00	4.75E+02	8.16E+02	3.52E+00	8.19E+02
Primary energy resources – Non-renewable	Use as energy carrier	MJ, net calorific value	1.35E+03	1.31E+02	4.67E+01	1.53E+03	6.27E+01	1.59E+03
	Used as raw materials	MJ, net calorific value	4.56E+00	0.00E+00	0.00E+00	4.56E+00	0.00E+00	4.56E+00
	TOTAL	MJ, net calorific value	1.35E+03	1.31E+02	4.67E+01	1.53E+03	6.27E+01	1.59E+03
Secondary material		kg	9.58E+01	0.00E+00	5.98E-03	9.58E+01	0.00E+00	9.58E+01
Renewable secondary fuels		MJ, net calorific value	1.56E+02	0.00E+00	1.49E-02	1.56E+02	0.00E+00	1.56E+02
Non-renewable secondary fuels		MJ, net calorific value	2.55E+02	0.00E+00	0.00E+00	2.55E+02	0.00E+00	2.55E+02
Net use of fresh water		m^3	3.51E+03	8.10E-03	6.30E+01	3.57E+03	4.08E-03	3.57E+03

Waste production and output flows

Waste production

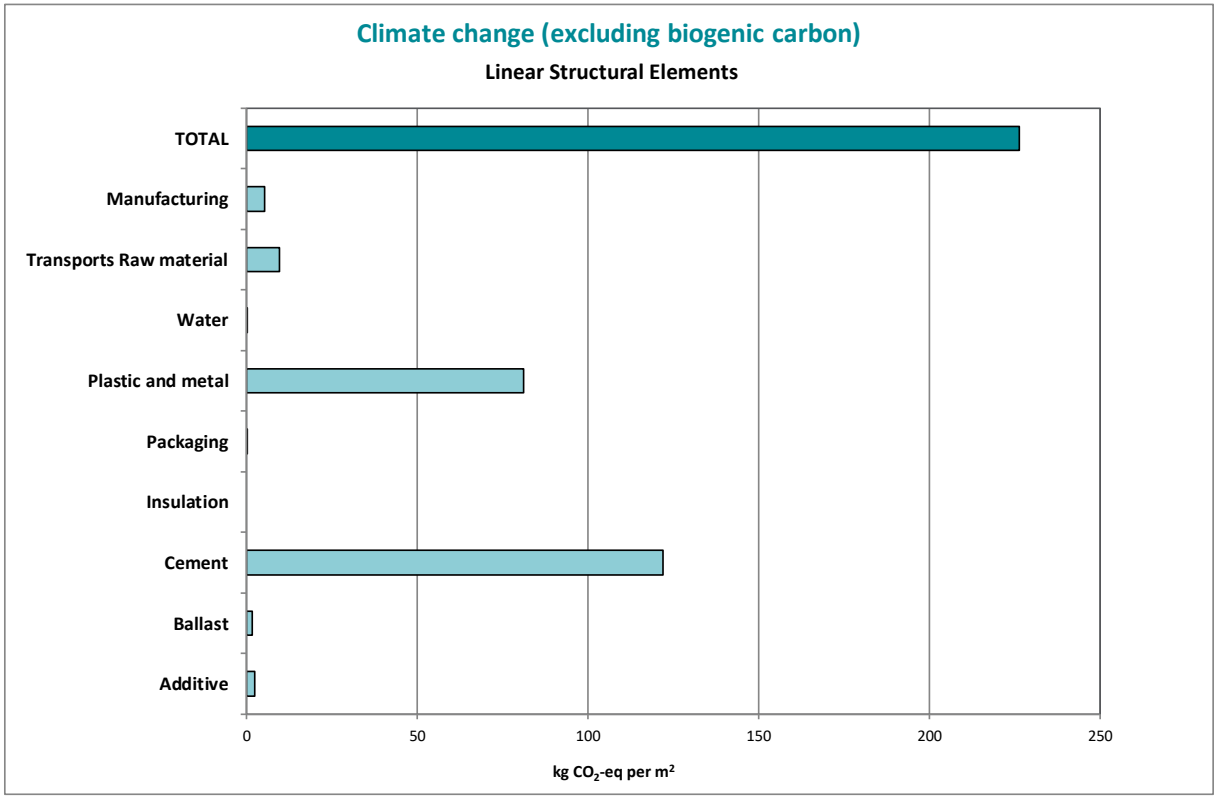
PARAMETER	UNIT	A1	A2	A3	A1-A3	A4	A1-A4*
Hazardous waste disposed	kg	8.01E-03	5.76E-06	2.69E-02	3.49E-02	2.92E-06	3.49E-02
Non-hazardous waste disposed	kg	1.25E+02	1.97E-02	1.17E+00	1.26E+02	9.60E-03	1.26E+02
Radioactive waste disposed	kg	8.82E-03	1.61E-04	1.99E-03	1.10E-02	7.76E-05	1.10E-02

Output flows

PARAMETER	UNIT	A1	A2	A3	A1-A3	A4	A1-A4*
Components for re-use	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for recycling	kg	4.80E-02	0.00E+00	0.00E+00	4.80E-02	0.00E+00	4.80E-02
Material for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported electrical energy	MJ, net calorific value	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported thermal energy	MJ, net calorific value	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Contribution analysis

The raw materials (module A1) were identified as hotspot for the product for several environmental impact categories. To exemplify this, the Global warming potential for the product is presented in the chart below. All raw materials belonging to module A1 are separately presented and modules A2 – A4 are presented aggregated.



Content declaration

For construction product EPDs compliant with EN 15804, the content declaration shall list, as a minimum, substances contained in the products that are listed in the “Candidate List of Substances of Very High Concern for Authorisation” when their content exceeds the limits for registration with the European Chemicals Agency. No substances occur on the REACH candidate list of SVHC (Candidate List of Substances of Very High Concern) in the product of the EPD.

Programme-related information and verification

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

Programme:	The International EPD® System EPD International AB Box 210 60 SE-100 31 Stockholm Sweden www.environdec.com info@environdec.com
EPD registration number:	S-P-01391
Published:	2018-09-10
Valid until:	2023-09-09
New version:	2021-03-05
Product Category Rules:	PCR 2012:01. Construction products and construction services. Version 2.2. of 2017-05-30
Sub-PCR used:	PCR 2012:01-SUB-PCR-G. Concrete and concrete elements (EN 16757:2017)
Product group classification:	UN CPC 375 – Articles of concrete, cement and plaster.
Reference year for data:	2017
Geographical scope:	Nordic countries

CEN standard EN 15804 serves as the Core Product Category Rules (PCR)
Product category rules (PCR): PCR 2012:01. Construction products and construction services. Version 2.2 of 2017-05-30. UN CPC code 375 – Articles of concrete, cement and plaster.
PCR review was conducted by: The Technical Committee of the International EPD® System. Chair: Massimo Marino. Contact via info@environdec.com
Independent third-party verification of the declaration and data, according to ISO 14025:2006: ☐ EPD process certification ☒ EPD verification
Third party verifier: Carl-Otto Nevén, NEVÉN Miljökonsult, carlotto.neven@bredband.net Approved by: The International EPD® System

Procedure for follow-up of data during EPD validity involves third party verifier:

☒ Yes ☐ No

References

- Benders Byggsystem (2018) www.bendersbyggsystem.se.
- General Programme Instructions of the International EPD® System. Version 3.0 of 11/12/2017.
- Ecoinvent (2017). Ecoinvent 3.4. https://www.ecoinvent.org/database/ecoinvent-34/ecoinvent-34.html.
- EN 15804:2012+A1:2013, Sustainability of construction works – Environmental product declarations – Core rules for the product category of construction products.
- LCA Methodology Report for 5 EPDs – Precast concrete products from Benders Byggsystem.
- PCR 2012:01. Construction products and construction services. Version 2.2 of 2017-05-30.
- Svensk Betong (2018) Livslängd för byggnader. https://www.svenskbetong.se/bygga-med-betong/bygga-med-prefab/miljo-och-hallbarhet/livslangd-for-byggnader.
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- Thinkstep (2017). GaBi Databases. http://www.gabi-software.com/international/databases/gabi-databases/.
- ThinkStep (2018) Gabi 8 (LCA software).

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