Environmental Product Declaration

of multiple products based on the average result of the product group.

In accordance with ISO 14025:2006 and EN 15804:2012+A2:2019/AC:2021 for:

High-tensile chain-link mesh

from

BRUGG Geobrugg

Programme:	The International EPD® System, www.environdec.com
Programme operator:	EPD International AB
EPD registration number:	S-P-06298
Publication date:	2024-04-02
Valid until:	2029-04-02

An EPD should provide current information and may be updated if conditions change. The stated validity is therefore subject to the continued registration and publication at www.environdec.com

Products included in average results:

TECCO G45/2
TECCO G65/3
TECCO G65/4
DELTAX 80/2
DELTAX 80/3
MINAX G80/4

General information

Programme information

Programme:	The International EPD® System
Address:	EPD International AB Box 210 60 SE-100 31 Stockholm Sweden
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Accountabilities for PCR, LCA and independent, third-party verification
Product Category Rules (PCR)
CEN standard EN 15804 serves as the Core Product Category Rules (PCR)
Product Category Rules (PCR): PCR 2019:14 Construction products version 1.3.2
PCR review was conducted by: The Technical Committee of the International EPD® System. A full list of members available on www.environdec.com. Chair of the PCR review: Claudia A. Peña, University of Concepción, Chile. The review panel may be contacted via info@environdec.com.
Life Cycle Assessment (LCA)
LCA consultant: DEKRA Assurance Services GmbH, Handwerkstraße 15, 70565 Stuttgart, Germany
Third-party verification
Independent third-party verification of the declaration and data, according to ISO 14025:2006, via: ☒ EPD verification by individual verifier Third-party verifier: Jonas Bengtsson, edge impact, jonas.bengtsson@edgeimpact.global Approved by: The International EPD® System
Procedure for follow-up of data during EPD validity involves third party verifier: ☐ Yes ☒ No

The EPD owner has the sole ownership, liability, and responsibility for the EPD.

EPDs within the same product category but registered in different EPD programmes, or not compliant with EN 15804, may not be comparable. For two EPDs to be comparable, they must be based on the same PCR (including the same version number) or be based on fully-aligned PCRs or versions of PCRs; cover products with identical functions, technical performances and use (e.g. identical declared/functional units); have equivalent system boundaries and descriptions of data; apply equivalent data quality requirements, methods of data collection, and allocation methods; apply identical cut-off rules and impact assessment methods (including the same version of characterisation factors); have equivalent content declarations; and be valid at the time of comparison. For further information about comparability, see EN 15804 and ISO 14025.

Company information

Owner of the EPD:
Geobrugg AG

Contact:
- Contact: Mario Brunn
- Mail: mario.brunn@geobrugg.com
- Address: Aachstrasse 11, CH-8590 Romanshorn, Switzerland

Description of the organisation:
Geobrugg has been developing and manufacturing protection solutions since 1951. High-tensile steel wire mesh and matching services monitor and protect against natural hazards such as rockfall, landslides, debris flows, avalanches or coastal erosion. They ensure safety in mining and tunnelling as well as on motorsports tracks, in industry and in test facilities. More than 400 specialists work for Geobrugg worldwide. Geobrugg has production facilities on all continents as well as a presence in over 50 countries. This global reach allows Geobrugg to always be in close proximity to its customer for rapid project implementation - from requirements analysis to acceptance. Geobrugg, headquartered in Romanshorn, Switzerland, is an independent company within the BRUGG GROUP. For more information see https://www.geobrugg.com/.

Product-related or management system-related certifications:
Geobrugg AG is ISO 9001-certified for management of the group of companies as well as development, manufacturing, sales and service in the field of wire ropes, protective netting systems and industrial cables. For more information see Documents for download (geobrugg.com).

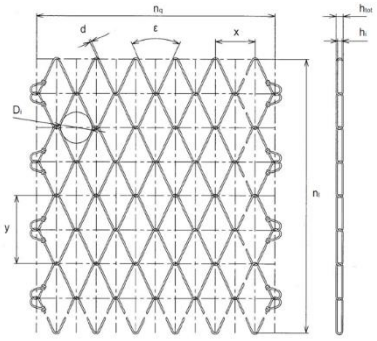
Name and location of production site:
Aachstrasse 11, CH-8590 Romanshorn, Switzerland

Product information

Product name:
High-tensile chain-link mesh

Product identification:
The results in this EPD are an average representation of different high tensile chain-link meshes manufactured by Geobrugg AG. The products covered by this EPD are:

- TECCO G45/2
- TECCO G65/3
- TECCO G65/4
- DELTAX G80/2
- DELTAX G80/3
- MINAX G80/4



The average was calculated considering the total consumption of raw materials, auxiliary materials, wastes and the production volume related to the product group.

The products are certified as 'Flexible facing systems for slope stabilization and rock protection' according to EAD (European Assessment Document) 230023-00-0106.

Product description:

The high-tensile chain-link mesh can be used to stabilize virtually any kind of slope, whether it consists of rock or loose soil. The mesh is manufactured starting from a high-tensile steel wire that is externally purchased. The steel wire has a diameter of 2 to 4.6 mm and corrosion protection consisting of zinc (95%) and aluminum (5%). The steel wire is further processed into a mesh by bending.
High-tensile chain link meshes are distributed under various brand names (TECCO®, DELTAX® and MINAX®). The differences between the products within the product group are due to the wire diameter (2 mm to 4.6 mm) and mesh size (D = 45 mm, 65 mm or 80 mm) and can be used for purposes with their technical specification. The technical service life of the wire depends on where it is installed. In areas with average corrosion the service life of a mesh made of 3 mm thick wire is 60 years on average.
Detailed information on the product's technical specifications is shown below and can be found in the data sheets available at Geobrugg's website (https://www.geobrugg.com/en/Documents-for-download-111519,7849.html).

Products included in this EPD	*TECCO G45/2*	*TECCO G65/3*	*TECCO G65/4*	*DELTAX G80/2*	DELTAX *G80/3*	*MINAX G80/4*
Mesh size [mm]	48	65	65	80	80	80
Wire thickness [mm]	2	3	4	2	3	4
Tensile Strength [N/mm²]	1,770	1,770	1,770	1,770	1,770	1,770
Tensile resistance of a wire [kN]	5.5	12.5	22	5.5	12.5	22
Tensile strength of mesh [kN/m]	≥85	≥150	≥250	≥53	≥120	≥190
Corrosion protection	Geobrugg SUPERCOATING 95% Zn / 5% Al					
Coating [g/m²]	125	150	150	125	150	150
Bearing Resistance against Puncturing	D_R ≥ 80 kN / 110 kN *)	D_R ≥180 kN / 240 kN **)	D_R ≥280 kN / 370 kN **)	N/A	N/A	N/A
Bearing resistance against shearing-off	P_R ≥ 40 kN / 55 kN *)	P_R ≥90 kN / 120 kN **)	P_R ≥140 kN / 185 kN **)	N/A	N/A	N/A
Bearing Resistance against slope-parallel tensile stress	Z_R ≥ 10 kN / 10 kN *)	Z_R ≥ 30 kN / 45 kN **)	Z_R ≥ 50 kN / 75 kN **)	N/A	N/A	N/A
Elongation in longitudinal tensile strength test:	δ < 6.0 %	δ < 6.0 %	δ < 6.0 %	N/A	δ < 6.0 %	δ < 6.0 %
Classification according to EAD 230025-00-0106	Group 4, class A (P25 and P33)	Group 2, class A (P33 and P66)	Group 1, class A (P33 and P66)	N/A	N/A	N/A

*) As in EAD 230025-00-0106 and referring to TSUS test report 11/2016 using spike plate P25 / P33
**) As in EAD 230025-00-0106 and referring to TÜV Rheinland LGA test report 01/2014 using spike plate P33 / P66

Manufacturing Process:

The manufacturing process begins with the receipt of the coated steel wire, which is then fed into a bending machine. The bending machine produces a mesh using a special bending technique. The finished mesh is stacked and stored unpacked outdoors before being transported to the customer.

UN CPC code:

412 – Products of iron or steel

Geographical scope:

The geographical scope is Europe.

Variability for GWP-GHG:

The variability for GWP-GHG results of the high-tensile chain-link mesh is <10%.

LCA information

Functional unit / declared unit:
The declared unit is 1 kg of an average high-tensile chain-link mesh.

Reference service life:
n/a

Time representativeness:
The reference year of the study is 2022.

Database(s) and LCA software used:
The database used is ecoinvent v3.9.1 (Wernet et al., 2016) with the EN15804 reference package based on Environmental Footprint (EF) 3.0. The LCA software used is Umberto 11.

Description of system boundaries:
The system boundary is cradle to gate (A1-A3) with modules C1-C4 and module D.
The construction process stage (A4-A5) and use stage (B1-B7) are not included because it is highly dependent on the application. The high-tensile chain-link mesh is directly loaded into trucks, therefore no packaging of the final product is considered. In addition, the environmental impact of the use phase is considered negligible because it is a passive product that is not removed over a long period (>50 years).

Modul A1 includes the extraction and processing of raw materials (steel, coating) and the manufacturing of the pre-product (steel wire, drawn and galvanized) that serves as input for the manufacturing process taking place at Geobrugg's site in Romanshorn. The steel wire is coiled around a cardboard core and put on flat pallets for transport.
Modul A2 includes the transport via truck from the suppliers of wire to the production site.
Modul A3 includes the production of the mesh (core process) i.e., bending the wire and the thermal waste treatment of the packaging of the steel wire
Modul C includes the demolition and transport of the mesh to a recycling facility and waste disposal.
Modul D includes the benefits/loads outside the system boundary that are related to the recovery of steel and has been calculated according to EN15804

Cut-off:
The cut-off criteria follow EN15804:2012+A2:2019 and the applicable PCR. Cut-off rules were applied for capital equipment, heating of the production facility and office and administration.

Estimations and assumptions:
Module A: Steel scrap was modelled as burden-free when entering the product system in accordance with the world steel data. The recycled content is 52% based on world steel data which is a conservative assumption.
Modul C: A recovery rate of 95% is assumed. I.e., 95% of the steel mesh is considered for recovery in module D, 5% of the steel mesh goes to landfill (prEN17662). The assumed transport distance to the recycling facility is 100 km, the transport distance to the landfill is 30 km. Both transports are assumed to be done by truck (prEN17662).
Modul D: A process efficiency of 95% is assumed (prEN17662). Disposal is assumed to be a mix of landfill and municipal incineration according to generic data from ecoinvent.

Electricity mix:
For the generation of electricity, a specific electricity mix is used in the manufacturing. Geobrugg has two sources for its electricity supply: Self-production through Photovoltaic (PV) modules and purchased electricity from a local supplier. For the purchased electricity labelling was provided. Both are modelled using the ecoinvent database v3.9.1.
The emission factor for the GWP-GHG indicator is 9 g CO_2 eq./kWh for the purchased electricity mix and 81 g CO_2 eq./kWh for the self-generated electricity The emission factor for both electricity sources combined is 29 g CO_2 eq./kWh.

Allocation:
Background data on steel wire production is based on data from the World Steel Association which has a high geographical and temporal representativeness. Pre-consumer scrap was treated like post-consumer scrap. Hence, all scrap inputs enter the product system burden free (0.00 CO_2 eq./kg scrap).
Module D has been calculated using the net flow of secondary material.
For the core process economic allocation has been applied to production scrap. However, the amount of scrap and its monetary value is very low and can be regarded as negligible.

Data quality:
Data for the core process which takes place at Romanshorn, Switzerland was collected by Geobrugg for the year 2022 and represents the current technology. Data for steel production is taken from World Steel Association (2023, 2021) which represents the current technology mix. Data for the other processes is taken from recognized databases (latest version) where the most appropriate datasets regarding their geographical and technical scope were chosen.

Compliance with standards
The LCA and EPD have been developed to comply with:

- ISO 14040:2006 and ISO14044:2006+A1:2018 which describe the principles, framework, requirements and provides guidelines for life cycle assessment (LCA) (ISO 14040, 2006) (ISO 14044, 2006).
- ISO 14025:2006 Environmental labels and declarations – Type III environmental declarations -- Principles and procedures, which establishes the principles and specifies the procedures for developing Type III environmental declaration programmes and Type III environmental declarations (ISO 14025, 2006).
- ISO 14020:2000 Environmental labels and declarations — General principles, which describes the guiding principles for the development and use of environmental labels and declarations (ISO 14020, 2000).
- EN 15804+A2:2019: Sustainability of construction works – Environmental product declarations - Core rules for the product category of construction products- hereafter referred to as EN15804+A2 (BS EN 15804+A2, 2020).
- Product Category Rules (PCR) 2019:14, v1.3.2 – Construction products – hereafter referred to as PCR 2019:14 (PCR 2019:14, 2022).
- General Programme Instructions (GPI) for the International EPD System V4.0 – containing instructions regarding methodology and the content that must be included in EPDs registered under the International EPD System (Environdec, 2021).

LCA Practitioner:
DEKRA Assurance Services GmbH
Handwerkstr. 15
70565 Stuttgart, Germany
https://www.dekra.de/de/produktnachhaltigkeit/

Modules declared, geographical scope, share of specific data (in GWP-GHG indicator) and data variation:

	Product stage			Construction process stage		Use stage							End of life stage				Resource recovery stage
	Raw material supply	Transport	Manufacturing	Transport	Construction installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal	Reuse-Recovery-Recycling-potential
Module	**A1**	**A2**	**A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
Modules declared	X	X	X	ND	ND	ND	ND	ND	ND	ND	ND	ND	X	X	X	X	X
Geography	EU	EU	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	EU
Specific data used	<10%			-	-	-	-	-	-	-	-	-	-	-	-	-	--
Variation – products	<10%			-	-	-	-	-	-	-	-	-	-	-	-	-	-
Variation – sites	N/A			-	-	-	-	-	-	-	-	-	-	-	-	-	-

Content information

Product components	Weight, kg	Post-consumer material recycled, weight-%	Biogenic material, weight-% and kg C/kg
Steel	0.975	52	0 resp. 0
Coating	0.025	0	0 resp. 0
Sum	1.00	0	0 resp. 0

Results of the environmental performance indicators

The estimated impact results are only relative statements, which do not indicate the endpoints of the impact categories, exceeding threshold values, safety margins and/or risks.

Mandatory impact category indicators according to EN 15804*

Results per functional or declared unit							
Indicator	**Unit**	**A1-A3**	**C1**	**C2**	**C3**	**C4**	**D**
GWP-fossil	kg CO_2 eq.	2.35E+00	6.36E-02	1.93E-02	1.41E-02	3.19E-04	-8.77E-01
GWP-biogenic	kg CO_2 eq.	3.97E-03	9.77E-06	6.80E-06	7.71E-06	1.57E-07	-7.48E-05
GWP-luluc	kg CO_2 eq.	9.30E-03	7.02E-06	9.22E-06	8.31E-06	1.87E-07	-1.73E-04
GWP-total	kg CO_2 eq.	2.36E+00	6.36E-02	1.94E-02	1.42E-02	3.19E-04	-8.75E-01
ODP	kg CFC 11 eq.	1.99E-08	9.88E-10	4.10E-10	2.91E-10	8.82E-12	-1.79E-08
AP	mol H^+ eq.	1.98E-02	5.76E-04	6.14E-05	5.25E-05	2.29E-06	-3.49E-03
EP-freshwater	kg P eq.	3.25E-04	1.90E-06	1.32E-06	1.43E-06	2.90E-08	-3.80E-04
EP-marine	kg N eq.	1.77E-03	2.67E-04	2.11E-05	1.85E-05	8.80E-07	-7.87E-04
EP-terrestrial	mol N eq.	6.76E-02	2.90E-03	2.23E-04	1.96E-04	9.43E-06	-8.49E-03
POCP	kg NMVOC eq.	5.04E-03	8.59E-04	9.17E-05	7.46E-05	3.28E-06	-4.44E-03
ADP-minerals&metals**	kg Sb eq.	3.66E-05	2.17E-08	6.18E-08	4.46E-08	4.35E-10	-7.23E-06
ADP-fossil**	MJ	2.71E+01	8.19E-01	2.69E-01	1.98E-01	7.64E-03	-7.84E+00
WDP	m^3	1.38E+00	2.02E-03	1.32E-03	1.30E-03	3.55E-05	-1.46E-01
Acronyms	GWP-fossil = Global Warming Potential fossil fuels; GWP-biogenic = Global Warming Potential biogenic; GWP-luluc = Global Warming Potential land use and land use change; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential, Accumulated Exceedance; EP-freshwater = Eutrophication potential, fraction of nutrients reaching freshwater end compartment; EP-marine = Eutrophication potential, fraction of nutrients reaching marine end compartment; EP-terrestrial = Eutrophication potential, Accumulated Exceedance; POCP = Formation potential of tropospheric ozone; ADP-minerals&metals = Abiotic depletion potential for non-fossil resources; ADP-fossil = Abiotic depletion for fossil resources potential; WDP = Water (user) deprivation potential, deprivation-weighted water consumption						

** Disclaimer: The results generated by module A1-A3 should not be used in isolation. It is strongly advised that the outcomes produced by modules A1-A3 are considered alongside the results derived from module C to ensure comprehensiveness and accurate analysis.*

*** Disclaimer: The results of this environmental impact indicator shall be used with care as the uncertainties of these results are high or as there is limited experience with the indicator.*

Additional mandatory and voluntary impact category indicators

Results per functional or declared unit							
Indicator	**Unit**	**A1-A3**	**C1**	**C2**	**C3**	**C4**	**D**
GWP-GHG[1]	kg CO_2 eq.	2.36E+00	6.36E-02	1.93E-02	1.41E-02	3.19E-04	-8.77E-01

Resource use indicators

Results per functional or declared unit							
Indicator	**Unit**	**A1-A3**	**C1**	**C2**	**C3**	**C4**	**D**
PERE	MJ	4.08E+00	4.61E-03	4.14E-03	5.32E-03	6.49E-05	-5.59E-01
PERM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0,00E+00
PERT	MJ	4.08E+00	4.61E-03	4.14E-03	5.32E-03	6.49E-05	-5.59E-01
PENRE	MJ	2.71E+01	8.19E-01	2.69E-01	1.98E-01	7.64E-03	-7.84E+00
PENRM	MJ.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	2.71E+01	8.19E-01	2.69E-01	1.98E-01	7.64E-03	-7.84E+00
SM	kg	5.18E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m^3	4.55E+00	4.38E-05	3.21E-05	3.23E-05	7.74E-06	-1.76E-03
Acronyms	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 re-sources; SM = Use of secondary material; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels; FW = Use of net fresh water						

Waste indicators

Results per functional or declared unit							
Indicator	**Unit**	**A1-A3**	**C1**	**C2**	**C3**	**C4**	**D**
Hazardous waste disposed	kg	4.35E-02	3.77E-04	1.80E-04	1.75E-04	3.76E-06	-1.24E-01
Non-hazardous waste disposed	kg	7.93E-01	7.51E-03	5.48E-03	6.23E-03	6.23E-04	-1.49E+00
Radioactive waste disposed	kg	1.86E-05	8.90E-08	8.67E-08	1.30E-07	1.13E-09	6.16E-06

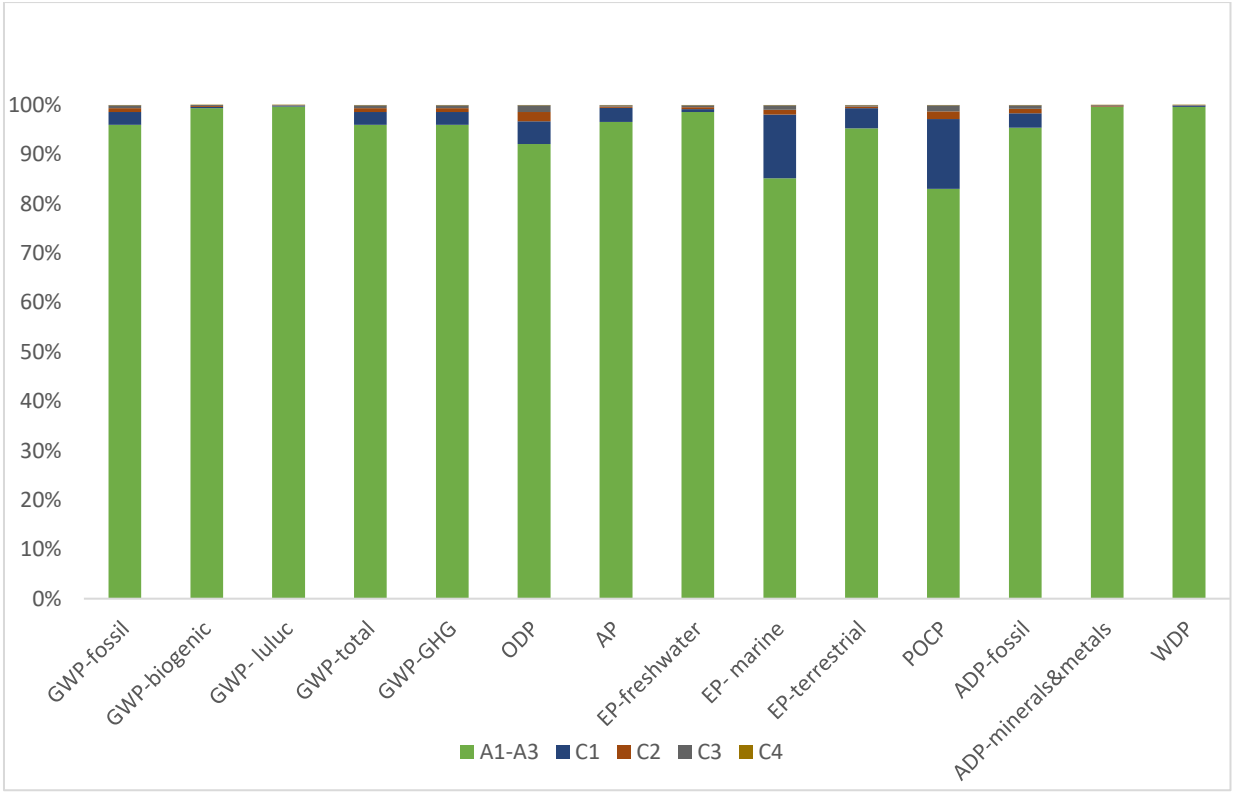
[1] The GWP-GHG indicator is identical to GWP-total except that the characterisation factor (CF) for biogenic CO2 is set to zero. This means that the uptake and emissions of biogenic CO2 are "balanced out" already in modules A1-A3, instead of in modules A1-A5 (for packaging) or modules A-C (for product). The results over the entire product life cycle, from module A to C, are thus identical for GWP-GHG and GWP-total unless some of the uptake of biogenic CO2 is released as another greenhouse gas (e.g., CH4).

Output flow indicators

Results per functional or declared unit							
Indicator	**Unit**	**A1-A3**	**C1**	**C2**	**C3**	**C4**	**D**
Components for re-use	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	0.00E+00	0.00E+00	0.00E+00	9.50E-01	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, electricity	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, thermal	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Interpretation of LCA Results

The following figure shows the contribution of the individual modules to the main environmental impact categories for 1 kg of high-tensile chain link mesh. Module D is excluded in the interpretation of share because it's outside the system boundary.



The dominating contributors to all environmental impacts are modules A1-A3. This is due to the use of steel as principal raw material which causes the main impact in all impact categories considered.

References

GPI (2021) General Programme Instructions for the International EPD® System, Version 4.0

PCR (2019) Product Category Rules Construction Products PCR 2019:14, Version 1.3.2

prEN 17662 Product category rules complementary to EN 15804 + A2 for Steel, Iron and Aluminium structural products for use in construction works

Wernet, G., Bauer, C., Steubing, B., Reinhard, J., Moreno-Ruiz, E., and Weidema, B., 2016. The ecoinvent database version 3 (part I): overview and methodology. The International Journal of Life Cycle Assessment, [online] 21(9), pp.1218–1230.

World Steel Association 2023 – LCI Data for Steel products (on request)

World Steel Association 2021 – Life cycle inventory (LCI) study, 2020 data release

World Steel Association 2021 – LCA eco-profiles 2021

European Commission, Joint Research Centre, Damiani, M., Ferrara, N., Ardente, F., Understanding Product Environmental Footprint and Organisation Environmental Footprint methods, Publications Office of the European Union, 2022, https://data.europa.eu/doi/10.2760/11564

Norms

ISO 14025 DIN EN ISO 14025:2011: Environmental labels and declarations – Type III environmental declarations – Principles and procedures

ISO 14040 DIN EN ISO 14040:2006: Environmental management – Life cycle assessment – Principles and framework

ISO 14044 DIN EN ISO 14044:2006: Environmental management – Life cycle assessment – Requirements and guidelines

EN 15804 + A2 EN15804:2012+A2:2019+AC:2021: Sustainability of construction works – Environmental Product Declarations – Core rules for the product category of construction products

ISO 9001:2015 DIN EN ISO 9001:2015: Quality management systems – Requirements

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