

ENVIRONMENTAL PRODUCT DECLARATION

as per /ISO 14025/ and /EN 15804/

Owner of the Declaration	bauforumstahl e.V.
Programme holder	Institut Bauen und Umwelt e.V. (IBU)
Publisher	Institut Bauen und Umwelt e.V. (IBU)
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Structural Steel: Sections and Plates bauforumstahl e.V.

www.ibu-epd.com / <https://epd-online.com>



Picture: Residential buildings at Saselberg, Hamburg, Schulitz Architekten

1. General Information

bauforumstahl e.V.

Programme holder

IBU - Institut Bauen und Umwelt e.V.
Panoramastr. 1
10178 Berlin
Germany

Declaration number

EPD-BFS-20180116-IBG2-EN

This declaration is based on the product category rules:

Structural steels, 07.2014
(PCR checked and approved by the SVR)

Issue date

25.10.2018

Valid to

24.10.2023

Structural Steel: Sections and Plates

Owner of the declaration

bauforumstahl e.V.
Sohnstraße 65
D-40237 Düsseldorf

Declared product / declared unit

The declared unit is 1 t of structural steel (sections and plates)

Scope:

This environmental product declaration covers steel products rolled out to structural sections, merchant bars and heavy plates, intended for bolted, welded or otherwise connected constructions of buildings, bridges and other structures.

This environmental product declaration is valid for the following products:

Heavy Plates produced by:

- Dillinger with the sites in Dillingen (Germany) and Dunkirk (France)

Hot rolled sections produced by:

- ArcelorMittal on the sites Differdange (Luxembourg), Dabrowa (Poland), Esch-Belval (Luxembourg), Bergara (Spain), Hunedoara (Romania), Olaberria (Spain), Warszawa (Poland) and Rodange (Luxembourg)

- Peiner Träger (Germany)

- Stahlwerk Thüringen (Germany)

The production shares in this EPD are 24% Basic Oxygen Furnace route (primary steel production) and 74% Electric Arc Furnace route (secondary steel production) based on the total yearly production volume. The data used represent >95% of the annual production of sections and plates from all BauforumStahl member companies.

The owner of the declaration shall be liable for the underlying information and evidence; the IBU shall not be liable with respect to manufacturer information, life cycle assessment data and evidences.

Verification

The standard /EN 15804/ serves as the core PCR

Independent verification of the declaration and data according to /ISO 14025:2010/

internally externally



Prof. Dr.-Ing. Horst J. Bossenmayer
(President of Institut Bauen und Umwelt e.V.)



Dipl. Ing. Hans Peters
(Head of Board IBU)



Dr.-Ing. Wolfram Trinius
(Independent verifier appointed by SVR)

2. Product

2.1 Product description / Product definition

This EPD applies to 1 t of structural steel (sections and plates). It covers steel products of the grades S235 to S960 rolled out to structural sections, merchant bars and heavy plates.

For the placing on the market of the product in the EU/EFTA (with the exception of Switzerland) Regulation (EU) No. 305/2011 (CPR) applies. The product needs a declaration of performance taking

into consideration /EN 10025-1:2004 Hot rolled products of structural steels – Part 1: General technical delivery conditions/ and the CE-marking.

For the application and use the respective national provisions apply.

2.2 Application

Structural steels are intended for bolted, welded or otherwise connected constructions of buildings, bridges and other structures, or in composite steel and concrete structures. Examples are:

- single storey buildings (industrial and storage halls, etc.)
- multi-storey buildings (offices, residential buildings, shops, car parks, high rise, etc.)
- bridges (railway bridge, road bridge, pedestrian bridge, etc.)
- other structures (power plants, stadiums, convention centers, airports, stations, etc.)

2.3 Technical Data

This EPD is valid for plates and sections of varied grades and different forms of delivery. Specific information on dimension tolerances, constructional data as well as mechanical and chemical properties can be found in the relevant literature and/or the standards.

Constructional data

Name	Value	Unit
Density	7850	kg/m ³
Modulus of elasticity	210000	N/mm ²
Coefficient of thermal expansion	12	10 ⁻⁶ K ⁻¹
Thermal conductivity at 20°C λ	48	W/(mK)
Melting point depending on the alloy proportions up to	1536	°C
Shear modulus	81000	N/mm ²

Performance data of the product in accordance with the declaration of performance with respect to its essential characteristics according to /EN 10025/, Hot rolled products of structural steels. Further product standards: /ASTM A36/, /A572/, /A992/, /A913/, /A283/, /A514/, /A573/, /A588/, /A633/, /A709/ and /A1066/.

2.4 Delivery status

The dimensions of the declared products may vary according to the intended application.

2.5 Base materials / Ancillary materials

Structural steels are non-or low-alloy steel products whose carbon content is between 0 and 0.6%. Iron is the main component of steel sections and plates. The content of other elements is significantly less. The exact chemical composition varies depending on the steel grade.

Auxiliary materials:

A. For the production route “blast furnace with basic oxygen furnace”: coking coal, coal, lime
 B. For the production route “electric arc furnace”: lime
 For both production routes:
 aluminum, ferro alloys (ferro silicon, ferro manganese, ferro-nickel, ferro niobium, ferro vanadium, ferro titanium)

The rates of these additives depend on the steel grade.

2.6 Manufacture

In the integrated steel production route iron ore, (typical mix based on ferro-oxides Fe₂O₃) coke breeze, circulating components and other additives are mixed and sintered in preparation for being fed into the blast furnace together with coking coke, which is the reducing agent. Also pellets and /or lump may be used. The pig iron produced in the blast furnace is transferred into the basic oxygen furnace. In this vessel, the iron is converted into steel by lowering the carbon content of the iron by blowing oxygen into the melt (exothermic reaction). For temperature control, scrap (up to 35%) is added to the melt.

In the electric steel production route scrap is molten in an electric arc furnace to obtain liquid steel.

Refining (lowering of sulphur, phosphorous and other tramp elements) and alloying (e.g. about 1% Mn, 0.2% Si) and / or micro-alloying (e.g. about 0.01% V) is applied to give the requested characteristics to the steel.

At the end of the steelmaking process, the liquid steel is transformed into a semi-finished product in a continuous casting machine, or in special cases, poured into ingot molds to form blocks.

The semi-product (slab, beam-blank, bloom or billet) is hot-rolled into the final product dimensions (heavy plate, wide flats, H-shape, I-shape, U-shape, L- shape and other merchant bars).

Quality control: /ISO 9001/ Monitoring according to the product standards, e.g. /EN 10025, Part 1/.

2.7 Environment and health during manufacturing

No measures relating to safety, health and environment protecting during the manufacturing process extending beyond national guidelines are required.

2.8 Product processing/Installation

Processing recommendations:

Planning, processing, implementation and intended use of section and plate constructions have to be carried out depending on the respective applications according to the generally recognized rules of engineering and manufacturer’s recommendations. The standards of /EN 1993/ and /EN 1994/ (/EUROCODE EC3/ and /EC4/) apply to the design of steel structures and composite steel and concrete structures. They include the requirements regarding serviceability, bearing capacity, durability and fire resistance of steel structures /EC3/ and composite steel and concrete structures /EC4/.

The Standard Parts 1+2 of /EN 1090/ apply to the execution of steel structures and include the requirements for factory production control. In addition, the /European Standards/ will work in connection with national amendments, national instructions, guidelines and publications, as well as legal provisions.

Regarding transport and storage of sections and plates, the generally accepted requirements for securing loads have to be observed.

Instruction details of the manufacturer based on verified standards and guidelines regarding welding,

galvanizing as well as hot and cold forming are to be observed in every case.

Occupational safety / Environmental protection:

When processing/using steel sections and plates pursuant to the generally recognized rules of engineering there are no measures to be taken which are going beyond the public occupational health and safety.

The processing/using of steel sections and plates pursuant to the generally recognized rules of engineering does not release substantial environmental pollutants. Particular measures to protect the environment are not required.

Residual material:

During processing residual pieces as well as turnings are to be separately collected. This scrap steel is entirely recycled by melting and producing new steel products.

2.9 Packaging

Structural steels are delivered unpacked.

2.10 Condition of use

Structural steels are non- /low-alloyed steel products generated by alloying iron with other metals and non-metals (esp. carbon). Iron is the main component of steel sections and plates. The components are listed under chapter 2.5 "Base materials". During usage no changes in material composition shall occur.

2.11 Environment and health during use

The intended use of sections and plates does not hazard health or environment in any known way.

2.12 Reference service life

The reference service life is not relevant for consideration of the LCA. As construction products with many different applications, a reference service life for structural steel as sections and plates is not declared here.

The purpose, possible corrosion protection and adequate maintenance are decisive for service life.

2.13 Extraordinary effects

Fire

The material is class A1, i.e. not flammable per /EN 13501/.

The material does not emit fumes or fire-gases.

Fire safety

Name	Value
Building material class acc. /EN 13501-1/	A1

Water

Steel is stable to water, insoluble and does not emit substances in water. In case of flooding no impacts are to be expected.

Steel can corrode in the presence of oxygen in the water (= slow oxidation).

Mechanical destruction

Due to the ductility of steel, steel-structures react resilient in the event of unforeseeable mechanical destruction: In case of tensile load necking will occur before cracking. In case of lasting high compression load, components of steel may buckle or bulge. No splintering or breaking edges shall result.

2.14 Re-use phase

General:

Sections and plates of steel are recyclable by 100%. Due to the magnetic properties of steel, 99% of the used steel is regained after dismantling /European Commission Technical Steel Research/.

Re-use:

Sections and plates can be re-used. Currently, around 11% of the products are re-used after dismantling.

Recycling:

Sections and plates can be recycled without any problems after dismantling. Currently, around 88% of the products are used for closed-loop recycling. Data from industry estimates based on the following sources: /European Commission Technical Steel Research/ and /Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit/

2.15 Disposal

Due to its high value as a resource, steel scrap is not disposed, but instead fed into a well-established cycle of reuse or recycling. However, in case of dumping due to collection loss no environmental impacts are expected.

Waste code according to European Waste Catalogue /EWC/:

17 04 05 - iron and steel

2.16 Further information

Additional information on constructing with steel can be obtained from bauforumstahl.de.

3. LCA: Calculation rules

3.1 Declared Unit

The declaration refers to the functional unit of 1 ton of Structural Steel: Sections and plates.

The LCA is calculated based on averaged volume production data of the contributing plants.

Declared unit

Name	Value	Unit
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Declared unit	1	t
Conversion factor to 1 kg	0.001	-

3.2 System boundary

Type of the EPD: cradle-to-gate - with options.

Module A1-A3, Module C3 and module D were considered.

Modules A1-A3 of the structural steel production include the following:

- The provision of resources, additives, and energy
- Transport of resources and additives to the production site
- Production processes on-site including energy, production of additives, disposal of production residues, and consideration of related emissions
- Recycling of production/manufacturing scrap. Steel scrap is assumed to reach the end-of-waste status once it is shredded and sorted, thus becomes input to the product system in the inventory.

Module C3 takes into account the sorting and shredding of after-use steel that is recycled, as well as the non-recovered scrap due to sorting efficiency which is landfilled. A conservative value of 1% landfill is considered.

Module D refers to the end of life of the structural steel sections and merchant bars, including reuse and recycling.

3.3 Estimates and assumptions

For all Input- and Output materials the actual transport distances were applied or assumptions were taken.

3.4 Cut-off criteria

All information from the data collection process has been considered, covering all used and registered materials, thermal energy, electrical energy and diesel consumption. Measurement of on-site emissions took place and those emissions were considered. Data for different sites were cross-checked with one another to identify potential data gaps. No processes, materials or emissions that are known to make a significant contribution to the environmental impact of the products studied have been omitted. On this basis, there is no evidence to suggest that input or outputs contributing more than 1% to the overall mass or energy of the system or that are environmentally significant have been omitted.

It can be assumed, that all excluded flows contribute less than 5% to the impact assessment categories. The manufacturing of required machinery and other infrastructure is not considered in the LCA.

3.5 Background data

As a general rule, specific data derived from specific production processes or average data derived from specific production processes shall be the first choice

as a basis for calculating an EPD.

For life cycle modeling of the considered products, the GaBi 8 Software System for Life Cycle Engineering is used /GaBi ts Software/. The GaBi-database contains consistent and documented datasets which can viewed in the online GaBi-documentation /GaBi ts Documentation /.

To ensure comparability of results in the LCA, the basic data of GaBi database were used for energy, transportation and auxiliary materials.

3.6 Data quality

All relevant background datasets are taken from the GaBi 8 software database. The study is based on high quality data.

This EPD is representative for the production of sections and plates. The two main production routes for steel, BOF and EAF oven, are covered in this EPD. The data used represent >95% of the annual production of sections and plates from all BauforumStahl member companies.

3.7 Period under review

The foreground data collected by the manufacturer are based on yearly production amounts and extrapolations of measurements on specific machines and plants. The production data refers to the years 2014-2017. Most of the necessary life cycle inventories for the basic materials are available in the GaBi database. The last update of the database was 2018.

3.8 Allocation

The used allocation methodology for the coking processes and the crude iron production was developed by the *Worldsteel* Association and *EUROFER* in accordance with the /EN 15804/ /World Steel EUROFER/. Unless justified the methodology is based on physical allocation and considers the changes in the input and output quantities that influence the production of by-products in steelmaking. The aim of the methodology is to separate the involved processes, functional or causal. Economic allocation was considered, as slag is considered a low-value co-product under /EN 15804/, however, as neither hot metal nor slag are tradable products upon leaving the blast furnace (BF), economic allocation would most likely be based on estimates. Similarly slag from the basic oxygen furnace (BOF) must undergo processing before being used as a clinker or cement substitute. *Worldsteel* and *EUROFER* also highlights that companies purchasing and processing slag work on long-term contracts which do not follow regular market dynamics of supply and demand.

3.9 Comparability

Basically, a comparison or an evaluation of EPD data is only possible if all the data sets to be compared were created according to /EN 15804/ and the building context, respectively the product-specific characteristics of performance, are taken into account.

4. LCA: Scenarios and additional technical information

The end of life for average structural steel sections and plate products consists of 11% re-use, 88% recycling and 1% landfill, with the corresponding benefits and burdens.

The reused material receives a credit as avoided manufacturing of Sections and Plates.

Module D is based on the value of scrap methodology from worldsteel. The credits and burdens in that study represent a global steel scrap average and not

necessarily the specific scrap value of the manufactured Sections and Plates.

End of life (C3)

Name	Value	Unit
Landfilling	1	%

Re-use, recovery- and recycling potential (D)

Name	Value	Unit
Recycling	88	%
Re-use	11	%

5. LCA: Results

DESCRIPTION OF THE SYSTEM BOUNDARY (X = INCLUDED IN LCA; MND = MODULE NOT DECLARED)

PRODUCT STAGE			CONSTRUCTION PROCESS STAGE		USE STAGE							END OF LIFE STAGE				BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARIES
Raw material supply	Transport	Manufacturing	Transport from the gate to the site	Assembly	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal	Reuse-Recovery-Recycling-potential
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
X	X	X	MND	MND	MND	MND	MNR	MNR	MNR	MND	MND	MND	MND	X	MND	X

RESULTS OF THE LCA - ENVIRONMENTAL IMPACT: 1 ton structural steel

Parameter	Unit	A1-A3	C3	D
Global warming potential	[kg CO ₂ -Eq.]	1.13E+3	1.84E+0	-4.13E+2
Depletion potential of the stratospheric ozone layer	[kg CFC11-Eq.]	1.96E-9	6.85E-12	1.62E-6
Acidification potential of land and water	[kg SO ₂ -Eq.]	2.16E+0	5.84E-3	-8.07E-1
Eutrophication potential	[kg (PO ₄) ³ -Eq.]	2.19E-1	6.69E-4	-6.66E-2
Formation potential of tropospheric ozone photochemical oxidants	[kg ethene-Eq.]	4.02E-1	4.01E-4	-1.78E-1
Abiotic depletion potential for non-fossil resources	[kg Sb-Eq.]	4.92E-4	8.92E-7	-8.92E-4
Abiotic depletion potential for fossil resources	[MJ]	1.02E+4	2.04E+1	-3.94E+3

RESULTS OF THE LCA - RESOURCE USE: 1 ton structural steel

Parameter	Unit	A1-A3	C3	D
Renewable primary energy as energy carrier	[MJ]	1.52E+3	1.09E+1	1.98E+1
Renewable primary energy resources as material utilization	[MJ]	0.00E+0	0.00E+0	0.00E+0
Total use of renewable primary energy resources	[MJ]	1.52E+3	1.09E+1	1.98E+1
Non-renewable primary energy as energy carrier	[MJ]	1.15E+4	3.22E+1	-3.97E+3
Non-renewable primary energy as material utilization	[MJ]	0.00E+0	0.00E+0	0.00E+0
Total use of non-renewable primary energy resources	[MJ]	1.15E+4	3.22E+1	-3.97E+3
Use of secondary material	[kg]	7.86E+2	0.00E+0	0.00E+0
Use of renewable secondary fuels	[MJ]	0.00E+0	0.00E+0	0.00E+0
Use of non-renewable secondary fuels	[MJ]	0.00E+0	0.00E+0	0.00E+0
Use of net fresh water	[m ³]	4.19E+0	1.49E-2	-7.15E-2

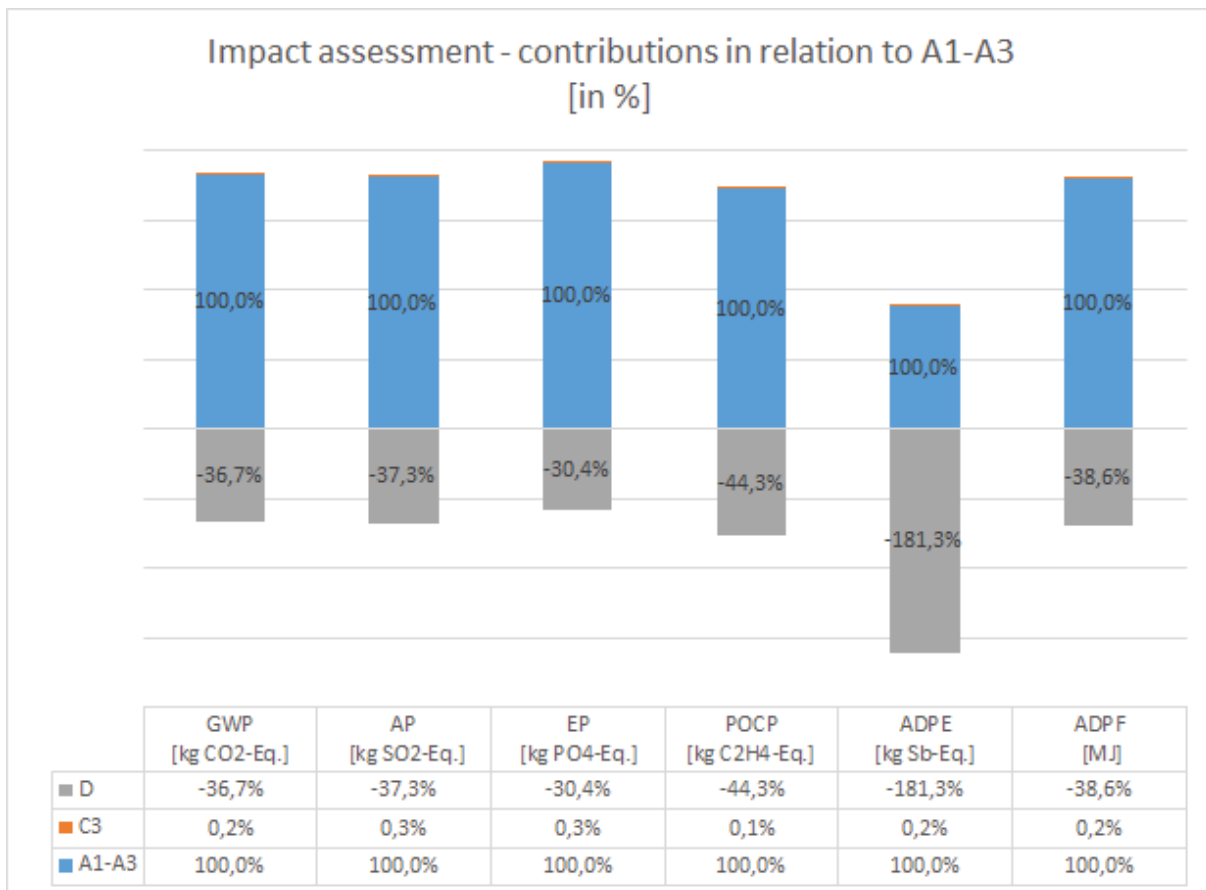
RESULTS OF THE LCA – OUTPUT FLOWS AND WASTE CATEGORIES: 1 ton structural steel

Parameter	Unit	A1-A3	C3	D
Hazardous waste disposed	[kg]	1.06E-5	1.81E-7	-1.91E-4
Non-hazardous waste disposed	[kg]	8.11E+0	1.00E+1	3.03E+1
Radioactive waste disposed	[kg]	5.01E-1	4.67E-3	-5.51E-2
Components for re-use	[kg]	0.00E+0	1.10E+2	0.00E+0
Materials for recycling	[kg]	0.00E+0	8.80E+2	0.00E+0
Materials for energy recovery	[kg]	0.00E+0	0.00E+0	0.00E+0
Exported electrical energy	[MJ]	0.00E+0	0.00E+0	0.00E+0
Exported thermal energy	[MJ]	0.00E+0	0.00E+0	0.00E+0

6. LCA: Interpretation

This chapter contains an interpretation of the Life Cycle Impact Assessment categories with regard to the functional unit. It focuses on the dominant contributions during the production process. The following graph shows the relative contribution of the production stages

(Module A1-A3), waste treatment (Module C3) and the benefits and loads beyond the product system boundary (Module D).



For most categories, the results for product stage (A1-3) contributes with the highest shares. Overall, C3 has a minimized contribution. The credits in Module D have a considerable share, due to the recycling and reuse rate.

The most relevant and significant emissions on steel production:

for **GWP** are CO₂, CH₄

for **AP** are SO₂ and NO_x;

for **EP** are NO_x

for **POCP** are CO, SO₂, NO_x, and NMVOC.

The results per site for the production (A1-A3) range between factor 2 for the BOF route and factor 0,5 for EAF route compared to the declared average.

Global Warming Potential (**GWP**), Acidification Potential (**AP**), Eutrophication Potential (**EP**) and Photochemical Ozone Creation Potential (**POCP**) are mostly caused by onsite emissions and the generation of electricity, as the steel production is an energy intensive process (A1-A3), followed by the extraction and processing of raw materials and the generation steam and heat. The benefits of Module D are related to the replacement of primary steel by secondary steel produced through Electric Arc Furnace (EAF).

Abiotic Depletion (elements) relates to the use of non-renewable elements in the production of ancillary materials/pre-products e.g. copper and molybdenum (A1-A3). In this EPD, **ADPE** benefits from a dominant credit for module D, which is based on a worldwide average steel production. In contrast, for module A1-A3, country and site-specific data is used. Abiotic Depletion Potential (fossil) is strongly dominated by the extraction and processing of raw materials and the generation of electricity, steam and heat from primary energy resources, including extraction, refining and transport (A1).

Total use of renewable primary energy carrier (**PERT**) and total use of non-renewable primary energy (**PENRT**) are dominated by the extraction and processing of raw materials and the generation of electricity, steam and heat from primary energy resources, including extraction, refining and transport.

Radioactive waste comes from the provision of electrical energy, especially from the share of nuclear power in the grid mix. Non-hazardous wastes include overburden and tailings. Hazardous waste for deposition is produced in small amounts during production.

7. Requisite evidence

This EPD covers semi-finished structural steel of hot-rolled construction products. Further processing and fabrication depend on the intended application. Therefore, further documentation is not applicable.

7.1 Weathering performance

The rusting rate of unalloyed steel depends on the

position of the component and the conditions of the surrounding atmosphere (corrosivity categories according to /EN ISO 12944-2/.

If required, the surfaces of fabricated structural components are usually protected with anticorrosion material in order to prevent any direct contact with the

atmosphere. The weathering of this protection depends on the applied protection system.

8. References

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<http://documentation.gabi-software.com>

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ISO 14001:2015, Environmental management systems - Requirements with guidance for use
ISO 9001:2015, Quality management systems - Requirements

EN 10025:2005-2, Hot rolled products of structural steels

EN 1090:2018, Execution of steel structures and aluminium structures

EN 13501:2010-1, Fire classification of construction products and building elements

ASTM A 36-14, Standard specification for carbon structural steel

ASTM A283-18, Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates

ASTM A514-14, Standard Specification for High-Yield-Strength, Quenched and Tempered Alloy Steel Plate, Suitable for Welding

ASTM A572-15, Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel

ASTM A573-13, Standard Specification for Structural Carbon Steel Plates of Improved Toughness

ASTM A588-15, Standard Specification for High-Strength Low-Alloy Structural Steel, up to 50 ksi [345 MPa] Minimum Yield Point, with Atmospheric Corrosion Resistance

ASTM A633-18, Standard Specification for Normalized High-Strength Low-Alloy Structural Steel Plates

ASTM A709-13, Standard Specification for Structural Steel for Bridges

ASTM A913-15, Standard specification for high-strength low-alloy steel shapes of structural quality, produced by quenching and self-tempering process (QST)

ASTM A992-11(15), Standard specification for structural steel shapes

ASTM A1066-11(15), Standard Specification for High-Strength Low-Alloy Structural Steel Plate Produced by Thermo-Mechanical Controlled Process (TMCP)

AWS D1.1/D1.1M-15, Structural Welding Code – Steel

AISC 303-10, Code of Standard Practice for Steel Buildings and Bridges

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EN 1993:2010-12/ Eurocode 3, Design of steel structures

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ANSI/AISC 360-16, Specification for Structural Steel Buildings

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General Information

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Published by

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Sohnstraße 65
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Declaration number

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This Annex is based on an Environmental Product Declaration:

Structural Steel: Sections and Plates, 10-2018
(EPD verified independently)

Issue date

2018

Valid to

2023

Structural Steel: Sections and Plates

Owner of the Annex

bauforumstahl e.V.
Sohnstraße 65
40237 Düsseldorf
Germany

Scope:

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- ArcelorMittal on the sites Ostrava (Czech Republic), Differdange (Luxembourg), Dabrowa (Poland), Esch-Belval (Luxembourg), Bergara (Spain), Hunedoara (Romania), Olaberria (Spain), Warszawa (Poland) and Rodange (Luxembourg)

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- Stahlwerk Thüringen (Germany)

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LEED rating system and Version

LEED v4

Product

Product description

1 t of structural steel (sections and plates). It covers steel products of the grades S235 to S960 rolled out to structural sections, merchant bars and heavy plates.

Application

Structural steels are intended for bolted, welded or otherwise connected constructions of buildings, bridges and other structures, or in composite steel and concrete structures.

Examples:

- single storey buildings (industrial and storage halls, etc.)
- multistorey buildings (offices, residential buildings, shops, car parks, high rise, etc.)
- bridges (railway bridge, road bridge, pedestrian bridge, etc.)
- other structures (power plants, stadiums, convention centers, airports, stations, etc.)

LEED - Materials and Resources (MR)

MR Credit 4: Recycled Content
List of waste materials during construction

Name	Value	Unit
Total weight of the product	1000	kg
Postconsumer recycled content	72	%
Pre-consumer recycled content	12,4	%

MR Credit 4: Recycled Content

Relevant for:
Every product.

Requirements:

Certified Report encouraged but not yet required: Indication of the recycled content distinct to Post- and Pre-consumer recycled content.

Target on building level:

10-20% recycled content based on total costs of the building.

Info:

MR Credit 4: 1-2 points



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