ENVIRONMENTAL PRODUCT DECLARATION

as per *ISO 14025* and *EN 15804+A2*

Owner of the Declaration	DSI Underground Merol Sp. z o.o.
Publisher	Institut Bauen und Umwelt e.V. (IBU)
Programme holder	Institut Bauen und Umwelt e.V. (IBU)
Declaration number	EPD-DSI-20240252-IBA1-EN
Issue date	11.09.2024
Valid to	10.09.2029

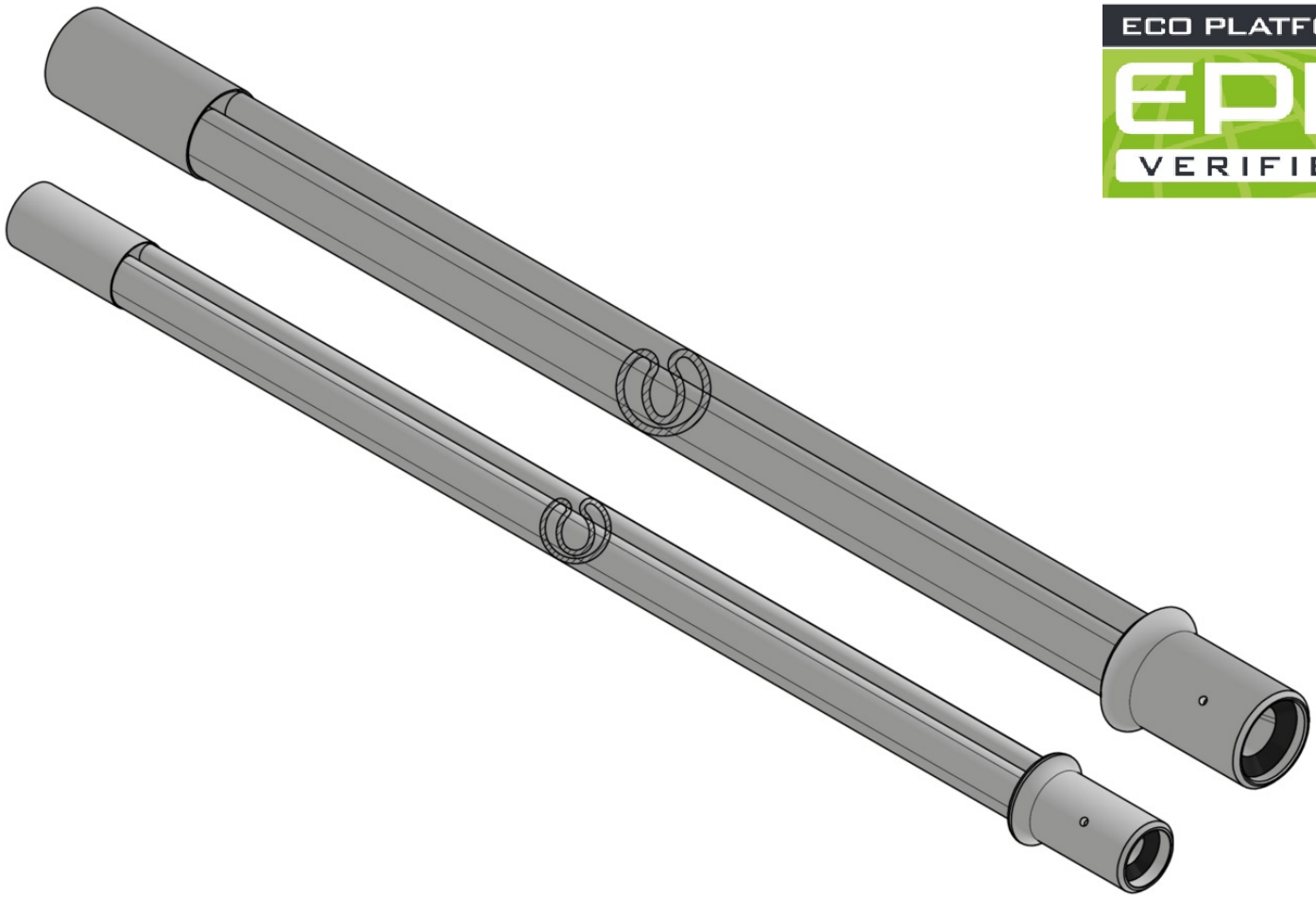
DSI OMEGA-BOLT®

DSI Underground Merol Sp. z o.o.

Institut Bauen und Umwelt e.V.

www.ibu-epd.com | https://epd-online.com

ECO PLATFORM EPD VERIFIED



1. General Information

DSI Underground Merol Sp. z o.o.

Programme holder

IBU – Institut Bauen und Umwelt e.V.
Hegelplatz 1
10117 Berlin
Germany

Declaration number

EPD-DSI-20240252-IBA1-EN

This declaration is based on the product category rules:

Structural steels, 01.08.2021
(PCR checked and approved by the SVR)

Issue date

11.09.2024

Valid to

10.09.2029



Dipl.-Ing. Hans Peters
(Chairman of Institut Bauen und Umwelt e.V.)



Florian Pronold
(Managing Director Institut Bauen und Umwelt e.V.)

DSI OMEGA-BOLT®

Owner of the declaration

DSI Underground Merol Sp. z o.o.
Przemyslowa 30
37-450 Stalowa Wola
Poland

Declared product / declared unit

1 ton DSI OMEGA-BOLT®

Scope:

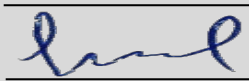
This EPD is based on a declared unit of 1 ton of DSI OMEGA-BOLT® produced at the production site in Stalowa Wola (Poland).

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.

The EPD was created according to the specifications of EN 15804+A2. In the following, the standard will be simplified as *EN 15804*.

Verification

The standard EN 15804 serves as the core PCR
Independent verification of the declaration and data according to ISO 14025:2011
☐ internally ☒ externally

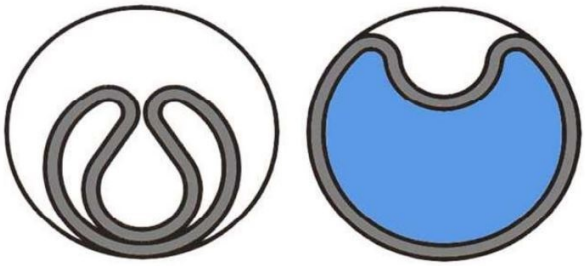


Dr.-Ing. Nikolay Minkov,
(Independent verifier)

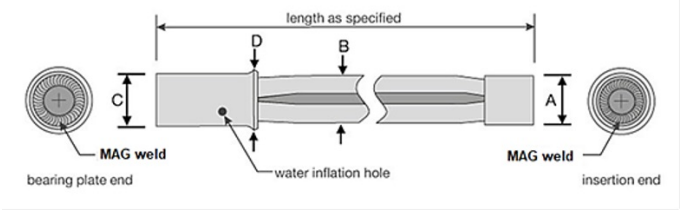
2. Product

2.1 Product description/Product definition

OMEGA BOLT is an inflatable, friction rock bolt used for ground support in underground excavation, such as mines and tunnels. OMEGA BOLT consists of a round tube made of highly ductile steel, which is longitudinally folded to create a new profile. The internal part has the shape of an Ω, while the external part has a round shape. The new profile has a smaller diameter than the original tube.



The profile is cut to the desired length (generally between 1.8 and 6 metres). At the two ends of the profile section, two steel ferrules are welded to seal off the inner space created into the new profile. In one of the two ferrules, there is a small diameter inlet hole, reaching the above-mentioned inner space. OMEGA BOLT is easy to install into a pre-drilled hole. After installation, using a special tool, high-pressure water can be injected into the sealed inner space. Such pressure is able to deform the omega-shaped profile and expand it toward its original, larger diameter round shape. This mechanism of modifying shape is also known as "hydroforming". The same internal water pressure creates a strong frictional bond between the steel and the surrounding rock, and the steel also follows the geometrical irregularities present in the hole (mechanical interlock).



After reaching the desired inflation pressure, water is discharged through the same inflation hole.
OMEGA Bolt does not require any grout or chemical bonding agent, so its installation is quicker, cleaner and more environmentally friendly.

As per today, for the use and application of the product, no harmonized standard or regulation is applicable. The products are delivered based on customer-specific technical performance characteristics.

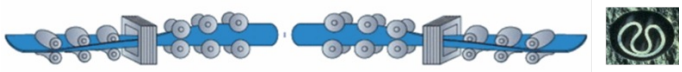
2.2 Application

OMEGA BOLT and in general all inflatable rock bolts are used in mining, mainly in metal mining and in production drifts and in tunnelling, mainly associated with so-called NATM (New Austrian Tunneling System) where rock bolts are an essential tool to secure rock stability immediately after excavation.

OMEGA BOLT range is produced in two sizes and 3 wall thicknesses so that customers can select the optimum solution for loading capacity and borehole diameter.

2.3 Technical Data

OMEGA BOLTS are delivered in 4 versions, featuring respectively 120 kN, 160 kN, 200 kN and 240 kN of loading capacity.
All OMEGA BOLTS are made with high ductility S355 steel, featuring respective thicknesses of 2.0 mm, 2.5 mm and 3.0 mm.
Steel is delivered from steel mills in coils with pre-set strip width and a special tubing mill provides the forming and welding of the round profile and the final Omega profile.



OMEGA BOLT 120	**Value**	**Unit**
Weight	2.0 - 2.1	kg/m
Nominal loading capacity	120	kN
Elongation A	> 10	%
External diameter Ω profile	26	mm
External diameter original tube	41	mm
Wall thickness	2.0	mm
Diameter inflation ferrule	30	mm
Diameter endcap	28	mm
Required borehole diameter	32 - 40	mm
Inflation pressure	300	bar
OMEGA BOLT 160	Value	**Unit**
Weight	2.8 - 3.0	kg/m
Nominal loading capacity	160	kN
Elongation A	>10	%
External diameter Ω profile	36	mm
External diameter original tube	54	mm
Wall thickness	2.0	mm
Diameter inflation ferrule	41	mm
Diameter endcap	38	mm
Required borehole diameter	45 - 53	mm
Inflation pressure	260	bar
OMEGA BOLT 200	**Value**	**Unit**
Weight	3.4 - 3.6	kg/m
Nominal loading capacity	200	kN
Elongation A	>10	%
External diameter Ω profile	36	mm
External diameter original tube	54	mm
Wall thickness	2.5	mm
Diameter inflation ferrule	41	mm
Diameter endcap	38	mm
Required borehole diameter	45 - 53	mm
Inflation pressure	300	bar
OMEGA BOLT 240	**Value**	**Unit**
Weight	3.9 - 4.2	kg/m
Nominal loading capacity	240	kN
Elongation A	>10	%
External diameter Ω profile	36	mm
External diameter original tube	54	mm
Wall thickness	3.0	mm
Diameter inflation ferrule	41	mm
Diameter endcap	38	mm
Required borehole diameter	45 - 53	mm
Inflation pressure	300	bar

Performance data of the product with respect to its characteristics in accordance with the relevant technical provision (no CE-marking).

2.4 Delivery status

OMEGA BOLTS are shipped in bundles of 2 to 6 m length. One bundle holds 50 to 100 OMEGA BOLTs, depending on their dimension.

2.5 Base materials/Ancillary materials

The base material of all components is steel of different grades and origins. All components forming the OMEGA BOLTS are produced in Stalowa Wola, Poland by DSI Underground Merol, part of Sandvik.
OMEGA profile is produced by its own tube mill, starting from coils and by longitudinal welding. Steel coils are 100 % made in Europe.
Steel tubes for the production of other components such as endcap and inflation ferrule are bought from European producers. Cutting, chamfering and forming of the same is performed in Stalowa Wola.
Assembly of the bolt takes place in DSI Underground Merol, Stalowa Wola and it is performed by fully robotic production lines.

Components of the OMEGA BOLTS system:

- 94 % - Omega profile (steel)
- 4 % - inflation ferrule (steel)
- 3 % - endcap (steel)

Ancillary materials/additives

- cooling lubricant (water based)

For the production of the OMEGA BOLTS a water-based cooling lubricant is used. The cooling lubricant is cleaned and circulated in the process. At the end of its lifetime, it is disposed of in accordance with local regulations.

This product/article/at least one partial article contains substances listed in the *candidate list* (date: 18.03.2024) exceeding 0.1 percentage by mass: no

This product/article/at least one partial article contains other carcinogenic, mutagenic, reprotoxic (CMR) substances in categories 1A or 1B which are not on the candidate list, exceeding 0.1 percentage by mass: no

Biocide products were added to this construction product or it has been treated with biocide products (this then concerns a treated product as defined by the (EU) *Ordinance on Biocide Products* No. 528/2012): no

2.6 Manufacture

The base material of all components is steel, which is purchased by the holder of this EPD or his sub-suppliers.
The Omega Bolt consists of steel tubes that are bent into omega profiles, inflation ferrules and endcaps welded at each end of the profile. Omega profiles are made from steel coils, which are formed on a special tube mill and next cut to required length. Inflation ferrules are made from steel tubes which are cut and machined on a lathe and then a flange is formed on a hydraulic press. Endcaps are made from steel tubes which are cut and machined on a lathe.
Those parts go to the robotic assembly line where the inflation ferrule and endcap are welded at each end of the omega profile. The last operation is drilling a small diameter inlet hole in the welded inflation ferrule.

2.7 Environment and health during manufacturing

The production of DSI Underground Merol in Stalowa Wola is certified according to *ISO 14001*. Following the underlying requirements of this certification, data related to the environment and health is continuously collected and evaluated. The company continuously invests in the improvement of environmental protection, occupational health and safety and monitors and evaluates the results.

2.8 Product processing/Installation

Installation of OMEGA BOLT occurs in underground space, so the operator must respect all precautions and regulations valid in the country the project is located.
The products are typically installed on the jobsite by roto-percussive drilling with water flushing. Noise protection and dust suppression or dust collection systems ensure that no environmental and health risks result from the installation of the product described in this EPD.

2.9 Packaging

The OMEGA BOLTS are bundled in 50 to 100 pieces depending on the dimension. The bundles are fixed with steel straps. No further packaging is applied within Europe. Plastic and wooden materials are also used as auxiliaries.

For transport overseas, the OMEGA BOLTS are packed into containers.

2.10 Condition of use

The declared product is made of steel. On specific customer demand, OMEGA BOLT may be covered by a thermo-plastic, anticorrosion coating. This declaration describes the most common version, i.e. black steel with no protective coating.

2.11 Environment and health during use

During the use of the product, no hazardous influence to the environment or health is to be expected. The components of the product and any potential emissions during their use were analyzed and reviewed during the evaluation of the products for technical approvals and were rated as harmless.

2.12 Reference service life

The reference service life depends on specific application conditions. Presence of water and type of water greatly influence the corrosion rate of steel installed in the ground. In general, all friction-based rock bolts are considered a temporary solution, meaning with a service life fit for the purpose. The product acts as an integrated load bearing member in the structure over its entire service life and is only removed or deconstructed together with said structure. In mining it can be measured in months, in tunneling typically in years or decades.

2.13 Extraordinary effects

Fire

Not relevant, the product is made of steel.

Water

No negative effects on the environment are to be expected from the declared product if exposed to water.

Mechanical destruction

No negative effects on the environment are to be expected from the declared product if mechanically destructed.

2.14 Re-use phase

The declared product can be recycled after use. Specifically, it can be reused in the steel industry as a secondary raw material.

2.15 Disposal

The declared product can be fully recycled as secondary raw material.
The waste code according to the *European Waste Index* is 17 04 05 - iron and steel.

2.16 Further information

Further information on the product declared in this EPD can be found on the website of DSI Underground Merol: https://www.dsiunderground.com

3. LCA: Calculation rules

3.1 Declared Unit

This environmental product declaration refers to a declared unit of 1 ton of average DSI OMEGA-BOLT®.

Declared unit

Name	Value	Unit
Declared unit	1	t
Conversion factor [Mass/Declared Unit]	1000	-

For the calculation of the declared average, input and production quantities for the entire calendar year 2022 were taken into account and broken down into the declared product group. The calculated results can thus be considered representative for the declared product portfolio of OMEGA-BOLTs® of DSI Underground Merol Sp. z o.o.

Mass fractions of individual components in the OMEGA BOLTs® may vary based on the specific design. The OMEGA profile dominates with more than 90 % by mass. A linear correlation of the environmental impacts with the product weight is to be expected. Therefore, the conversion from the declared unit to a specific product is possible using a mass-specific scaling factor.

3.2 System boundary

The life cycle assessment of average DSI OMEGA-BOLTs refers to a cradle-to-gate analysis with modules (A1–A3 + C +D). Subsequent life cycle phases are part of the analysis:

Module A1–A3 | Production stage
The production stage includes the upstream burdens of raw material supply, their transports and production of the DSI OMEGA-BOLT at DSI Underground Merol sp. z o.o. at the production site in Stalowa Wola (Poland). App. 30 % of the electricity is provided by the newly installed photovoltaic plant at site. Since the PV is first installed in March 2024, no real data on the produced electricity is available and thus the 30 % electricity substitution is an estimation. The remaining share of electricity needed for production is purchased from the Polish grid (represented by the residual grid mix). In addition, the site uses thermal energy from natural gas.
The production of the packaging of the OMEGA-BOLTs is included in modules A1–A3 as well.

Module C1 | Deconstruction and demolition
The end-of-life scenario considers the homogenous deconstruction of the end product. Referring energy demand is considered to be negligible, resulting in a declaration of '0' in module C1.

Module C2 | Transport to disposal
The transport to the disposal of the material is estimated declaring a 50 km radius to the waste processing.

Module C3 | Waste processing
Product flows that reach Module D for recycling leave the product system in C3.
Environmental impacts resulting from the grinding and sorting of steel scrap are not included due to the negligible expected environmental impact.

Module C4 | Landfilling
Module C4 declares the environmental impacts incurred by landfilling (5 % of the product).

Module D | Benefits and loads beyond the system boundary
The potential for substituting primary steel with a recycling scenario (95 % of the product) is outlined in Module D.

3.3 Estimates and assumptions

All assumptions are verified through detailed documentation and correspond to the best possible representation of reality based on the available data. Regional applicability of the used background data refers to average data under European or Polish conditions taken from the *MLC*-database.

3.4 Cut-off criteria

The LCA model covers all available input and output flows, which can be represented based on robust data. Data gaps are filled with conservative assumptions from average data (when available) or with generic data and are documented accordingly. Only data with a contribution lower than 1 % were cut off. Thus, no data were neglected, of which a substantial impact is to be expected. All relevant data were collected comprehensively. Cut-off material and energy flows were chosen carefully based on their expected quantitative contribution as well as potential environmental impacts. Thus, it can be assumed that the sum of all neglected input flows does not account for more than 5 % of the total material, water and energy flows. Environmental impacts of machines and infrastructure were not included.

3.5 Background data

This study uses generic background data for the evaluation of upstream environmental impacts from *MLC*-database 2023.2 and is modelled in *LCA FE*-software version 10.7.

3.6 Data quality

Data collection is based on sector-specific questionnaires. It follows an iterative process of clarifying questions via e-mail, telephone calls or web meetings. Intensive discussions between DSI Underground Merol and Daxner & Merl result in an accurate mapping of product-related material and energy flows. This leads to a high quality of foreground data collected. Data collection relies on a consistent process according to *ISO 14044*. The technological, geographical and time-related representativeness of the data base are kept in mind when selecting background data. Whenever specific data were missing, either generic datasets or representative average data were used instead. The implemented *MLC* background datasets are not more than ten years old.

3.7 Period under review

Foreground data were collected in the 2022 production year, and are based on the volumes produced on an annual basis.

3.8 Geographic Representativeness

Land or region, in which the declared product system is manufactured, used or handled at the end of the product´s lifespan: Poland

3.9 Allocation

Background data for the supply chain of the steel are published by worldsteel (*MLC*-databases). Representing an average of the global steel industry, worldsteel background datasets ensure a good geographical and technological representation of steel production. All worldsteel datasets are modelled according to the worldsteel LCA methodology, applying the system expansion approach for the allocation of co-products from steel production. As a result, these datasets are not fully compliant with the requirements of *EN 15804*, which emphasises the so-called partitioning approach applying a subdivision of environmental impacts according to their physical relationships. Due to their high representativeness, the worldsteel data were used to calculate the LCA.
Scrap input is regarded as burden-free. To calculate the net flows, the mass of external steel scrap used in the production, is subtracted from the total mass of the product.

3.10 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. The *MLC* 2023.2 background database in the *LCA FE*-software-version 10.7 was used to calculate the LCA.

4. LCA: Scenarios and additional technical information

Characteristic product properties of biogenic carbon

The declared product does not contain any biogenic carbon.

Information describing the biogenic carbon content at the factory gate

Name	Value	Unit
Biogenic carbon content in product	-	kg C
Biogenic carbon content in accompanying packaging	0.87	kg C

The carbon stored in the packaging was taken into account as "CO_2-neutral". Thus the storage effect of the carbon bound in the packaging is not included in the calculation but is considered as emitted immediately.

Note: 1kg of biogenic carbon content is equivalent to 44/12 kg of CO_2.

Installation in building (A5)

The end-of-life of the packaging materials is not declared in Module A5.

Name	Value	Unit
Packaging (steel strip)	1.72	kg
Packaging (PET-strip)	0.20	kg
Packaging (wood)	0.53	kg

After dismantling, recycling is assumed as a probable end-of-life scenario of the DSI OMEGA-BOLTs. A large proportion of the bolts are likely to remain in the rock structure/ground after use. As it is not possible to quantify the proportion, the end-of-life scenario must be adjusted to the respective application if necessary.
The end-of-life scenario used in this LCA study is based on the following assumptions and thus complies with the specifications published in *ökobaudat 2023*:

End-of-life (C1–C4)

Name	Value	Unit
Collected separately waste type (steel)	1000	kg
Recycling 95 %	950	kg
Landfilling 5 %	50	kg

Re-Use, recovery and recycling potential (D), relevant scenario information

Name	Value	Unit
Net flow of steel scrap	782	kg

This scenario contains a recycling rate of 95 %. Since a certain amount of steel scrap is used in the production of the raw materials, and steel scrap is produced in the production of the OMEGA-BOLTs, this is offset against the steel scrap for recycling (net flow).

5. LCA: Results

The following table contains the LCA results for a declared unit of 1 ton DSI OMEGA-BOLT®.

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

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	X	X	X	X	X

RESULTS OF THE LCA - ENVIRONMENTAL IMPACT according to EN 15804+A2: 1 ton DSI OMEGA-BOLT

Parameter	Unit	A1-A3	C1	C2	C3	C4	D
Global Warming Potential total (GWP-total)	kg CO_2 eq	2.45E+03	0	3.14E+00	0	2.45E+00	-1.35E+03
Global Warming Potential fossil fuels (GWP-fossil)	kg CO_2 eq	2.43E+03	0	2.89E+00	0	2.33E+00	-1.36E+03
Global Warming Potential biogenic (GWP-biogenic)	kg CO_2 eq	1.57E+01	0	2.19E-01	0	1.23E-01	7.55E+00
Global Warming Potential luluc (GWP-luluc)	kg CO_2 eq	7.95E-01	0	2.71E-02	0	2.38E-03	-1.81E-01
Depletion potential of the stratospheric ozone layer (ODP)	kg CFC11 eq	1.8E-05	0	3.8E-13	0	3.86E-12	1.82E-09
Acidification potential of land and water (AP)	mol H^+ eq	4.74E+00	0	2.51E-03	0	4.07E-03	-2.49E+00
Eutrophication potential aquatic freshwater (EP-freshwater)	kg P eq	1.91E-01	0	1.07E-05	0	2.1E-06	-3.16E-04
Eutrophication potential aquatic marine (EP-marine)	kg N eq	4.2E-01	0	6.59E-04	0	8.13E-05	-9.45E-02
Eutrophication potential terrestrial (EP-terrestrial)	mol N eq	3.93E+00	0	8.26E-03	0	9.53E-04	1.12E-02
Formation potential of tropospheric ozone photochemical oxidants (POCP)	kg NMVOC eq	3.05E+00	0	1.65E-03	0	1.19E-03	-1.05E+00
Abiotic depletion potential for non fossil resources (ADPE)	kg Sb eq	3.77E-03	0	1.94E-07	0	6.4E-08	-7.69E-03
Abiotic depletion potential for fossil resources (ADPF)	MJ	2.75E+04	0	3.98E+01	0	3.49E+01	-1.35E+04
Water use (WDP)	m^3 world eq deprived	2.34E+03	0	2.17E-01	0	6.54E-01	-1.73E+03

RESULTS OF THE LCA - INDICATORS TO DESCRIBE RESOURCE USE according to EN 15804+A2: 1 ton DSI OMEGA-BOLT

Parameter	Unit	A1-A3	C1	C2	C3	C4	D
Renewable primary energy as energy carrier (PERE)	MJ	1.67E+03	0	2.9E+00	0	3.14E+00	5.33E+02
Renewable primary energy resources as material utilization (PERM)	MJ	8.78E+00	0	0	0	0	0
Total use of renewable primary energy resources (PERT)	MJ	1.68E+03	0	2.9E+00	0	3.14E+00	5.33E+02
Non renewable primary energy as energy carrier (PENRE)	MJ	2.83E+04	0	4E+01	0	3.5E+01	-1.35E+04
Non renewable primary energy as material utilization (PENRM)	MJ	4.51E+00	0	0	0	0	0
Total use of non renewable primary energy resources (PENRT)	MJ	2.83E+04	0	4E+01	0	3.5E+01	-1.35E+04
Use of secondary material (SM)	kg	2.04E+02	0	0	0	0	7.82E+02
Use of renewable secondary fuels (RSF)	MJ	0	0	0	0	0	0
Use of non renewable secondary fuels (NRSF)	MJ	0	0	0	0	0	0
Use of net fresh water (FW)	m^3	7.58E+01	0	7.12E-03	0	1.5E-02	-1.74E+02

RESULTS OF THE LCA – WASTE CATEGORIES AND OUTPUT FLOWS according to EN 15804+A2: 1 ton DSI OMEGA-BOLT

Parameter	Unit	A1-A3	C1	C2	C3	C4	D
Hazardous waste disposed (HWD)	kg	1.79E+01	0	1.24E-10	0	2.89E-09	-1.01E-04
Non hazardous waste disposed (NHWD)	kg	1.51E+02	0	6.09E-03	0	5.01E+01	1.63E+02
Radioactive waste disposed (RWD)	kg	1.15E-01	0	7.34E-05	0	3.99E-04	1.45E-03
Components for re-use (CRU)	kg	0	0	0	0	0	0
Materials for recycling (MFR)	kg	0	0	0	9.5E+02	0	0
Materials for energy recovery (MER)	kg	0	0	0	0	0	0
Exported electrical energy (EEE)	MJ	0	0	0	0	0	0
Exported thermal energy (EET)	MJ	0	0	0	0	0	0

RESULTS OF THE LCA – additional impact categories according to EN 15804+A2-optional: 1 ton DSI OMEGA-BOLT

Parameter	Unit	A1-A3	C1	C2	C3	C4	D
Incidence of disease due to PM emissions (PM)	Disease incidence	ND	ND	ND	ND	ND	ND
Human exposure efficiency relative to U235 (IR)	kBq U235 eq	ND	ND	ND	ND	ND	ND

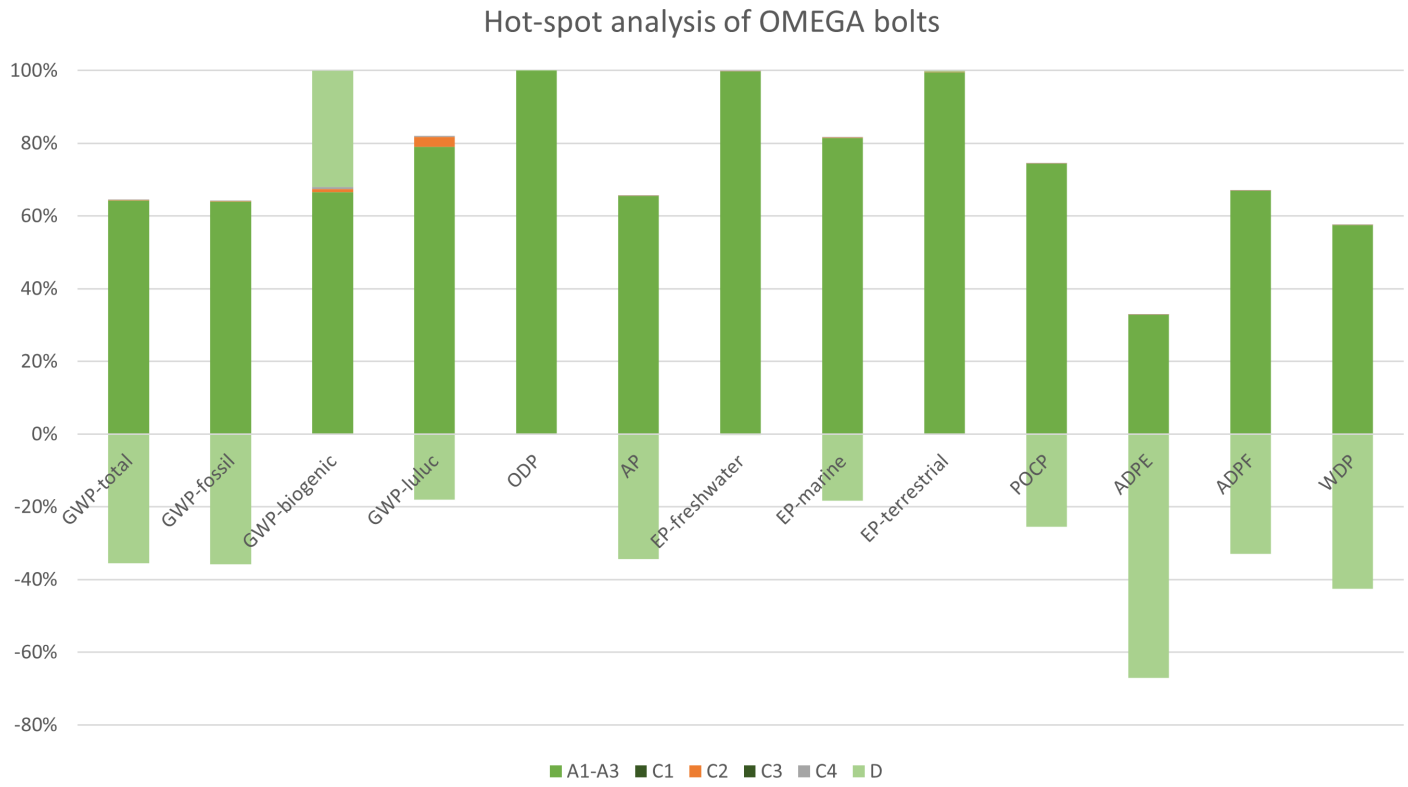
Comparative toxic unit for ecosystems (ETP-fw)	CTUe	ND	ND	ND	ND	ND	ND
Comparative toxic unit for humans (carcinogenic) (HTP-c)	CTUh	ND	ND	ND	ND	ND	ND
Comparative toxic unit for humans (noncarcinogenic) (HTP-nc)	CTUh	ND	ND	ND	ND	ND	ND
Soil quality index (SQP)	SQP	ND	ND	ND	ND	ND	ND

The additional and optional impact categories according to *EN 15804+A2* are not declared, as the uncertainty of these indicators is to be classified as high.

Disclaimer – for the indicators 'abiotic depletion potential for non-fossil resources', 'abiotic depletion potential for fossil resources', 'water (user) deprivation potential, deprivation-weighted water consumption', 'potential comparative toxic unit for ecosystems', 'potential comparative toxic unit for humans – cancerogenic', 'Potential comparative toxic unit for humans - not cancerogenic', 'potential soil quality index'.
The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high as there is limited experience with the indicator.

6. LCA: Interpretation

The following interpretation contains a summary of the LCA results referenced to a declared unit of 1 ton DSI OMEGA-Bolt.



A comparison of the individual life cycle phases results in a clear dominance of the production phase (Modules A1–A3). The environmental effects in the production phase are mainly dominated by the provision of raw materials, especially steel coils.
The product functions as a load-bearing component throughout the lifespan of the overall structure and is only demolished or removed together with the overall structure. A large proportion of the bolts are likely to remain in the rock structure/ground after use. As a result of product recyclability, the material removed at the end of life can substitute primary steel. Following the method applied, the secondary material input in module A is first saturated with material from module C. The remaining quantity from Module C ("net flow") can substitute primary steel and lead to corresponding substitution potentials in Module D.

The environmental impact of the transport of the products to recycling (C2) as well as landfilling of the losses at the end of life (C4) represents a minor contribution to the overall environmental impact of the product.

When it comes to the environmental impacts in the production phase of the OMEGA bolts, the upstream supply chain of the steel coils represents the major hot-spot in all of the impact categories considered. In general, environmental impacts from steel production represent the decisive factors in the results. The processes at the production site of DSI are responsible for less than 10 % of the products' environmental impacts.

Specific variants differ mainly in the specification of the OMEGA profile (outer diameter, length, etc.). Thus, a linear correlation of the environmental impacts with the product weight can be assumed. Taking into account a certain degree of uncertainty from the extrapolation of the non-linearly scalable components (e.g. ferrule, endcap), the conversion of the declared unit into a specific product is possible via a mass-related scaling factor. Product-related variances such as the ferrule and endcap, which are not linearly scalable with product weight but are product-based, tend to be less dominant factors in terms of their mass-based contribution as well as the expected environmental impact.

7. Requisite evidence

The corrosion of rock bolts used in underground mines and tunnels depends on many factors and there is no harmonized norm to calculate corrosion rates. We use references and data available in literature, and the table here enclosed is a good example. Omega Bolt service life is normally calculated case by case, setting the required loading capacity and considering the expected corrosion rate.

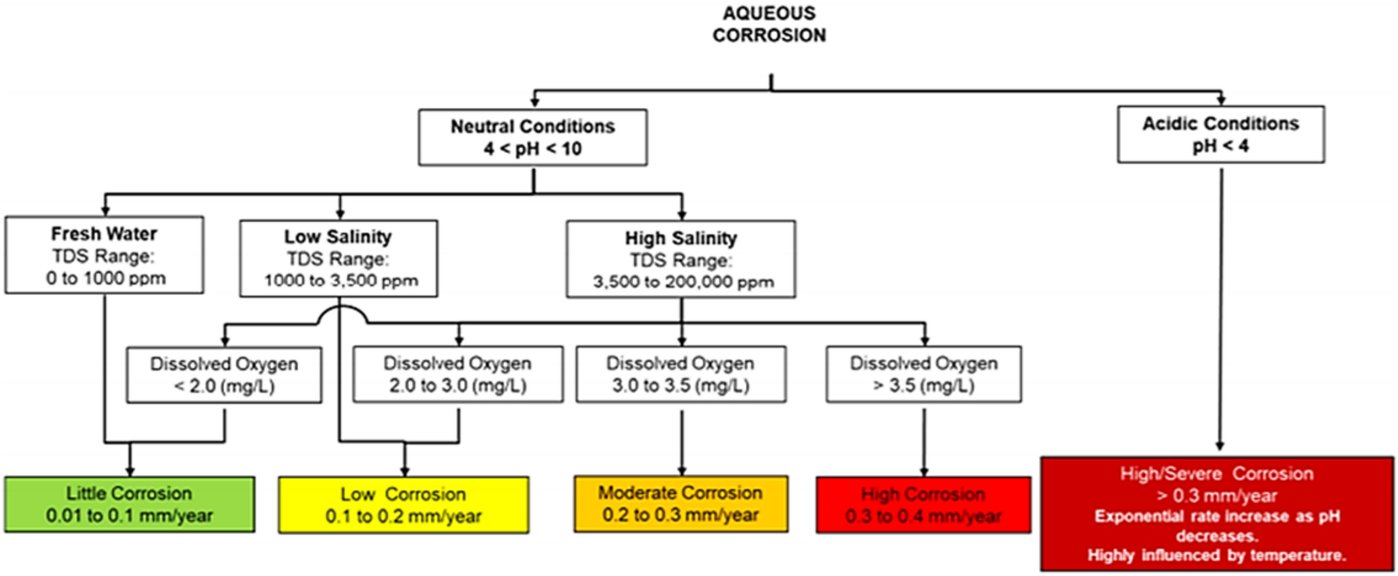


Figure 2 – Classification of aqueous corrosive environments and estimated uniform corrosion rates for carbon steel

8. References

Standards

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Further Literature

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