Environmental Product Declaration Type III ITB No. 232/2021

Issuance date: 30.06.2021
Validity date: 30.06.2026

HDPE sheathed stay cable strands

EPD Program Operator:

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ITB is the verified member of The European Platform for EPD program operators and LCA practitioner www.eco-platform.org

Basic information

This declaration is the Type III Environmental Product Declaration (EPD) based on EN 15804:2012+A1 and verified according to ISO 14025 by an external auditor. It contains the information on the impacts of the declared construction materials on the environment. Their aspects were verified by the independent body according to ISO 14025. Basically, a comparison or evaluation of EPD data is possible only if all the compared data were created according to EN 15804:2012+A1 (see point 5.3 of the standard).

Life cycle analysis (LCA): A1-A4, C1-C4 and D modules in accordance with EN 15804:2012+A1 (Cradle to Gate with options)

The year of preparing the EPD: 2021

Service Life: 100 years

PCR: ITB-PCR A (PCR based on EN 15804+A1)

Declared unit: 1 kg of cable stay strands

Product Standards: fib bulletin 89

Reasons for performing LCA: B2B

Representativeness: manufactured in Slovakia, year 2020

PRODUCTS DESCRIPTION

This EPD covers the seven wire strands products with multilayer corrosion protection consisting of Zinc, wax and HDPE sheathing produced by Bekaert in manufacturing plant in Hlohovec, Slovakia. Bekaert (www.bekaert.com) is a global technological and market leader in advanced solutions based on metal transformation, and the world's largest independent manufacturer of drawn steel wire products. Galvanized&waxed&HDPE sheathed stay cable strand is used as tension member for cable stay structures (mainly bridges). Bekaert' tension strands for cable stay bridges feature tensile strengths up to 2 160 MPa. The strands are protected by layers of corrosion protective coatings (Figure 1). Inner wax coating is completely water resistant and has been specifically designed for stay cables, the wax features have high mechanical stability, and offer additional corrosion resistance to the metallic coating below. The final coating, HDPE sheath, consists of PE that has been tightly extruded around the strand. The standard wall thickness of the sheath is 1.5mm, though thicker sizes can be produced upon request.

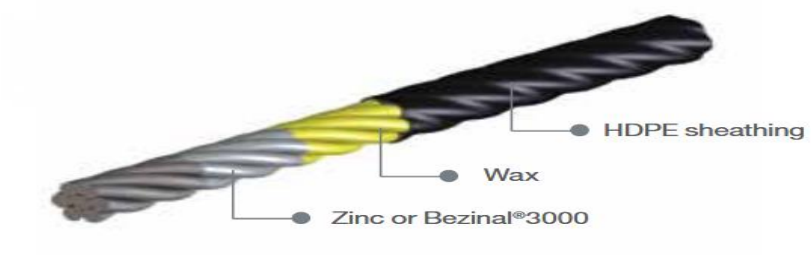

Figure 1. Technical concept of the HDPE sheathed stay cable strands.

Bekaert HDPE extruded stay cable strands comply with fib bulletin 89Acceptance of cable systems using prestressing steels and PTI DC45.1-18 Recommendations for Stay Cable Design, Testing, and Installation. The strands successfully pass the pull-pull fatigue test of 2 000 000 cycles. Table 1 describes product's standard specifications. More specific product technical data is available at Bekaert.com.

Table 1: Product specification

Nominal diameter	15,20 or 15,70 mm
HDPE wall thickness	1,5 mm (+0,5)
Body mass (inclusive HDPE coating)	1,20/1,30 kg/m
Nominal section	140 / 150 mm²
Tensile strength	1860 Mpa
Breaking load	260 / 279 kN
Elongation at break	≥ 4.5%
Max. relaxation at 1000 hours, 20°C	< 2,5% (initial tension 0,7 Fma)
Elastic modulus	195 GPa + 5%
Coating	Bezinal® 3000 or galvanized redrawn acc.to NFA35-035 190-350 g/m²
Fatigue resistance	meets NF A35-035 and ISO15630-3 > 2 000 000 cycles

LIFE CYCLE ASSESSMENT (LCA) – general rules applied

Unit

The declared unit is 1 kg of HDPE sheathed stay cable strands (1.2 – 1.3 kg/m)

System boundary

The life cycle analysis of the declared product covers “Product Stage” A1-A3 modules, transport to site A4, “End of Life stage” C1, C2, C3, C4 modules and gains and loads beyond system in D module (Cradle to Gate with options) in accordance with EN 15804:2012+A1 and ITB PCR A.

Allocation

The allocation rules used for this EPD are based on general ITB PCR A. Production of products is a line process in a manufacturing plant located at Hlohovec, Slovakia. Allocation of impacts is done on product mass basis. All impacts from raw materials production (wire rod, wax, HDPE, wood packaging, paper, foil and pallets) are allocated in A1 module of the LCA. 99% of the impacts from a line production were allocated to product covered by this declaration. Module A2 includes transport of raw materials such as steel and HDPE from supplier to manufacturing plant. Municipal wastes of the factory were allocated to module A3. Energy supply and electricity was inventoried and 100% was allocated to the product assessed. Emissions in the factory are assessed using statistical KOBIZE 2019 emission factors for energy carriers.

System limits

99% materials and 100% energy consumption (grid electricity, gas, LPG) were inventoried in the factory and were included in the calculation. In the assessment, all significant parameters from gathered production data are considered, i.e. all material used per formulation (main input is steel Wire Rod and HDPE), utilized thermal energy, and electric power consumption, direct production waste, and available emission measurements. Tires consumption for transport was not taken into account. Precomponents like labels, tapes, minor chemicals with a percentage share of less than 0.2% were not included in the calculations. It is assumed that the total sum of omitted processes does not exceed 1% of all impact categories. In accordance with EN 15804 machines and facilities (capital goods) required for and during production are excluded, as is transportation of employees.

A1 and A2 Modules: Raw materials supply and transport

The steel input materials are produced in the mixed EAF/BOF technology (mix based on Ecoinvent data). Data on transport of the different input products to the manufacturing plants were inventoried in detail and modelled by the assessor. For calculation purposes European fuel averages are applied in module A2.

A3: Production

All process operations such as wire drawing, galvanization, stranding, extrusion and packaging are carried out in manufacturing plant. The production process options (Hlohovec, Slovakia) is:

Batch pickling → Pre-drawing → Galvanizing → Final drawing → Stranding → Extrusion → Rewinding → Packing

The main input products are: steel (approx. 89%), wax (1%) and HDPE (9%). Packaging is wooden drums (recommended weight: 2.8 tons), the coils on a palette (carries 2 - 4.5 tons) .

A4: Transport to construction site

The following transport scenario to the place of use was assumed based on the manufacturer's declaration: large vehicle, 75% capacity over an average distance of 500 km. For calculation purposes, European fuel averages are applied in module A4.

C and D modules: End of life scenarios

The end-of-life scenario has been generalized. The manufacturer declares the technology and the scenario in which the HDPE sheated stay cable strands can be easly recovered form building object in demolition process. 100% of recovered steel can be used for new steel production (EAF process). 100% of HDPE is desitnated to

incinertaion plant, therefore, the profit is added in the replacement of gas fuel (HDPE calority is adopted at 40 MJ / kg).

It is assumed that at the end of life the transport distance from the product deconstruction place to waste processing (C2) is 50 km on > 16 t loaded lorry with 75% capacity utilization and fuel consumption of 35 l per 100 km. The reuse, recovery and recycling potential for a new product system is considered beyond the system boundaries (module D) based on World Steel recommendations and national practice (see references).

Table 2. End of life scenarios for HDPE sheated stay cable strands *products*

Progress products	Material recovery	Reuse	Recycling	Landfilling
Steel products	100%	0%	100% (EAF)	0%
HDPE	100%	0%	100% (incineration)	0%

Data collection period

The data for manufacture of the declared products refer to period between 01.01.2020– 31.12.2020 (1 year). The life cycle assessments were done for Slovakia as reference area.

Data quality - production

The values determined to calculate A3 originate from verified Progress LCI inventory data. A1 values were prepared considering European made steel products based on Ecoinvent. Allocation for steel production impacts is done in accordance with *LCI data for Steel products Report* compiled by Brayan Hughes and William Hare (2012 for World Steel Association).

Assumptions and estimates

The impacts of the representative products were aggregated using weighted average. Data regarding production per 1 kg of product was averaged for the analysed production of product group. All production processes (A3) were assigned to different types of products in an equal way.

Calculation rules

LCA was done in accordance with ITB PCR A document. Characterization factors are CML ver. 4.2 based. ITB-LCA algorithms were used for impact calculations. A1 was calculated based on data from the database and specific EPD for steel, A3 and A2 are calculated based on the LCI questionnaire provided by the manufacturer.

Databases

The background data for the processes come from the following databases: Ecoinvent v.3.7 (steel, wax, ancillary items, packaging), Plastic Europe (HDPE), specific production data (Bekaert), energy data (Ecoinvent, ZSE, Slovenské elektrárne, Messer), KOBIZE and (Slovak electricity mix and combustion factors for fuels), Specific (LCI) data quality analysis was a part of the audit. The time related quality of the data used is valid (5 years).

LIFE CYCLE ASSESSMENT (LCA) – Results

Declared unit

The declaration refers to the unit DU – 1 kg of the HDPE sheathed stay cable strands (table 3). The conversion coefficient per 1 running meter is 1.25 to 1.30 for a specific product.
The following life cycle modules are included in the declaration (table 4).

Table 3. System boundaries (life stage modules included) in a product environmental assessment

Environmental assessment information (MA – Module assessed, MNA – Module not assessed, INA – Indicator Not Assessed)																
Product stage			Construction process		Use stage							End of life				Benefits and loads beyond the system boundary
Raw material supply	Transport	Manufacturing	Transport to construction site	Construction-installation process	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Deconstruction 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**
MA	**MA**	**MA**	**MA**	**MNA**	**MNA**	**MNA**	**MNA**	**MNA**	**MNA**	**MNA**	**MNA**	**MA**	**MA**	**MA**	**MA**	**MA**

Table 4. Environmental product characteristic – 1 kg of HDPE sheathed stay cable strands

Environmental impacts: (DU) 1 kg										
Indicator	**Unit**	**A1**	**A2**	**A3**	**A4**	**C1**	**C2**	**C3**	**C4**	**D**
Global warming potential	kg CO_2	6.71E-01	6.55E-04	3.29E-01	5.25E-02	6.11E-02	4.00E-02	3.03E-01	0.00E+00	-5.56E-02

Depletion potential of the stratospheric ozone layer	kg CFC 11	9.43E-08	0.00E+00	1.19E-08	0.00E+00	5.56E-09	0.00E+00	6.25E-08	0.00E+00	-3.80E-09
Acidification potential of soil and water	kg SO_2	2.41E-03	5.04E-06	9.92E-04	4.16E-04	5.56E-04	3.03E-06	3.66E-04	0.00E+00	-2.20E-04
Formation potential of tropospheric ozone	kg Ethene	1.50E-04	3.39E-07	4.16E-05	2.67E-05	2.31E-05	2.04E-07	3.58E-04	0.00E+00	-1.00E-05
Eutrophication potential	kg $(PO_4)^{3-}$	1.19E-03	8.92E-07	4.42E-04	7.38E-05	2.50E-04	5.35E-07	2.63E-04	0.00E+00	-1.20E-04
Abiotic depletion potential (ADP-elements) for non-fossil resources	kg Sb	5.19E-04	0.00E+00	7.72E-04	0.00E+00	4.17E-04	0.00E+00	1.01E-03	0.00E+00	-3.40E-05
Abiotic depletion potential (ADP-fossil fuels) for fossil resources	MJ	1.21E+01	8.97E-03	1.34E+00	7.17E-01	7.14E-01	5.38E-03	1.62E+00	0.00E+00	-5.91E-01
Environmental aspects: (DU) 1 kg										
Indicator	**Unit**	**A1**	**A2**	**A3**	**A4**	**C1**	**C2**	**C3**	**C4**	**D**
Use of renewable primary energy excluding renewable primary energy resources used as raw materials	MJ	INA	INA	INA	INA	INA	INA	INA	INA	INA
Use of renewable primary energy resources used as raw materials	MJ	INA	INA	INA	INA	INA	INA	INA	INA	INA
Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials)	MJ	9.92E-01	8.97E-05	1.48E+00	7.17E-03	8.40E-01	5.38E-05	2.20E-01	0.00E+00	-1.01E-01
Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials	MJ	INA	INA	INA	INA	INA	INA	INA	INA	INA
Use of non-renewable primary energy resources used as raw materials	MJ	INA	INA	INA	INA	INA	INA	INA	INA	INA
Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials)	MJ	1.53E+01	9.42E-03	5.39E+00	7.5E-01	3.01E+00	5.65E-03	1.83E+00	0.00E+00	-8.74E-01
Use of secondary material	kg	9.01E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of renewable secondary fuels	MJ	0.00E+00	4.71E-04	0.00E+00	3.77E-02	0.00E+00	2.82E-04	0.00E+00	0.00E+00	0.00E+00
Use of non-renewable secondary fuels	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Net use of fresh water	m^3	2.51E-02	9.60E-08	3.33E-03	1.29E-06	1.88E-03	5.76E-08	8.73E-04	0.00E+00	-2.60E-04
Other environmental information describing waste categories: (DU) 1 kg										
Indicator	**Unit**	**A1**	**A2**	**A3**	**A4**	**C1**	**C2**	**C3**	**C4**	**D**
Hazardous waste disposed	kg	1.79E-05	3.45E-07	2.01E-04	4.64E-06	5.33E-07	2.07E-07	2.51E-06	0.00E+00	-5.70E-07
Non-hazardous waste disposed	kg	3.88E-01	6.10E-04	5.16E-03	5.51E-03	2.78E-03	3.66E-04	2.34E-02	0.00E+00	-4.36E-02
Radioactive waste disposed	kg	4.19E-05	0.00E+00	4.91E-06	0.00E+00	2.78E-06	0.00E+00	4.05E-06	0.00E+00	-4.70E-06
Components for re-use	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for recycling	kg	0.00E+00	0.00E+00	7.00E-04	0.00E+00	0.00E+00	0.00E+00	0.00E-00	0.00E+00	0.00E+00
Materials for energy recover	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	000E-00	0.00E+00	0.00E+00
Exported energy	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.00E+01	0.00E+00	0.00E+00

RESULTS INTERPRETATION

The environmental impact of HDPE sheathed stay cable strands (cradle to gate with options) is largely dependent on the energy-intensive production of steel (half product) on which the manufacturer has a limited

influence. The carbon impact of steel production (Wire Rods) in the product stage A1 is as high as 73%. The carbon impact of HDPE in the resource product stage A1 is also noticeable as 25% of total impact. The impact of the production line A3 largely depends on the amount of grid electricity consumed by manufacturing plant (0.49 kWh/kg of product). There are not significant air emissions or environmental impacts in the A3 production processes alone (mainly emissions from gas and LPG combustion). Interrogation of the LCA results show that the cradle-to-gate carbon (Global Warming Potential) impact of 1 kg of HDPE sheathed stay cable strands production is 1.0 kg CO_2eq. For comparison kg of steel produced worldwide in 2019 emitted on average 1.85 kg of carbon dioxide.

The LCA results show that the cradle-to gate primary energy demand of fossil fuel is equal to 13.4 MJ. The transport of raw materials from considerable distances is optimized and not significant (0.001 kg CO_2/kg).

The products due to the high potential for recycling (100%) may have some positive benefit to other product system (steel production) potential.

VERIFICATION

The process of verification of this EPD was in accordance with ISO 14025 and ISO 21930. After verification. this EPD is valid for a 5-year-period. EPD does not have to be recalculated after 5 years if the underlying data have not changed significantly.

The basis for LCA analysis was EN 15804:2012+A1 and ITB PCR A
Independent verification corresponding to ISO 14025 (sub clause 8.1.3.) [X] external [ ] internal
External verification of EPD: Ph.D. Eng. Halina Prejzner LCA. LCI audit and input data verification: Ph.D. D.SC.Eng. Michał Piasecki. m.piasecki@itb.pl Verification of LCA: Ph.D. Eng. Justyna Tomaszewska. j.tomaszewska@itb.pl

Normative references

- ITB PCR A General Product Category Rules for Construction Products
- FIB Bulletin No. 89. Acceptance of stay cable systems using prestressing steels. Recommendation. (116 pages, ISBN 978-2-88394-130-4, March 2019)
- ISO 15630-3:2019 Steel for the reinforcement and prestressing of concrete — Test methods — Part 3: Prestressing steel
- LCI data for steel products at https://www.worldsteel.org/en/dam/jcr:04f8a180-1406-4f5c-93ca-70f1ba7de5d4/LCI%2520study_2018%2520data%2520release.pdf
- ISO 14025:2006. Environmental labels and declarations – Type III environmental declarations – Principles and procedures
- ISO 21930:2017 Sustainability in buildings and civil engineering works – Core rules for environmental product declarations of construction products and services
- ISO 14044:2006 Environmental management – Life cycle assessment – Requirements and guidelines
- EN 15804:2012+A1 Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products
- PN-EN 1992-1-1:2008 „Eurokod 2 - Projektowanie konstrukcji z betonu - Część 1-1: Reguły ogólne i reguły dla budynków”
- KOBIZE 2019 http://www.kobize.pl/uploads/materialy/WO_i_WE_do_monitorowania-ETS-2019.pdf

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CERTIFICATE № 232/2021
of TYPE III ENVIRONMENTAL DECLARATION

Products:

Galvanized, waxed & HDPE sheathed 7 wire strand with low relaxation (stay cable strand)

Manufacturer:

Bekaert Hlohovec a. s.

Mierová 2317, 920 28 Hlohovec, Slovakia

confirms the correctness of the data included in the development of
Type III Environmental Declaration and accordance with the requirements of the standard

PN-EN 15804

Sustainability of construction works.
Environmental product declarations.
Core rules for the product category of construction products.

This certificate, issued for the first time on 30th June 2021 is valid for 5 years
or until amendment of mentioned Environmental Declaration

Head of the Thermal Physic, Acoustics and Environment Department
Agnieszka Winkler-Skalna, PhD

INSTYTUT TECHNIKI BUDOWLANEJ

Deputy Director
for Research and Innovation
Krzysztof Kuczyński, PhD

Warsaw, June 2021