Environmental Product Declaration Type III ITB No. 198/2021

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PFEIFER Hybridbeam®

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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: not declared by producer**,** calculation in accordance to EN 1990:2004

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

Declared unit: 1 kg of hybrid beam

Reasons for performing LCA: B2B

Representativeness: Polish production, year 2020

PRODUCTS DESCRIPTION

Hybrid beams covered by this EPD are manufactured at the Pfeifer manufacturing plant in Krępice, Poland. The PFEIFER Hybridbeam® is designed as an intermediate beam with two steel flanges which allow precast floor slabs to be instantly supported (see product concept in figure 1). It enables immediate slab assembly once the beams are in position on walls or columns. Installation is continued using continuity reinforcement passed through holes in the Hybridbeam®. This product is a new supporting structure for concrete ceilings - a ready-made pre-fabricated element with a steel and concrete cross-section. It is a combination of two different materials - steel and concrete. The steel part takes tensile stresses, the concrete part takes over the compressive stresses, and both are connected with each other by means of head bolts welded to the internal steel surfaces, ensuring extremely high strength parameters of the hybrid composite obtained in this way. The Hybridbeam® is designed to fit the height of the ceiling. Thanks to this, the smallest possible structural height of the designed ceiling is obtained.

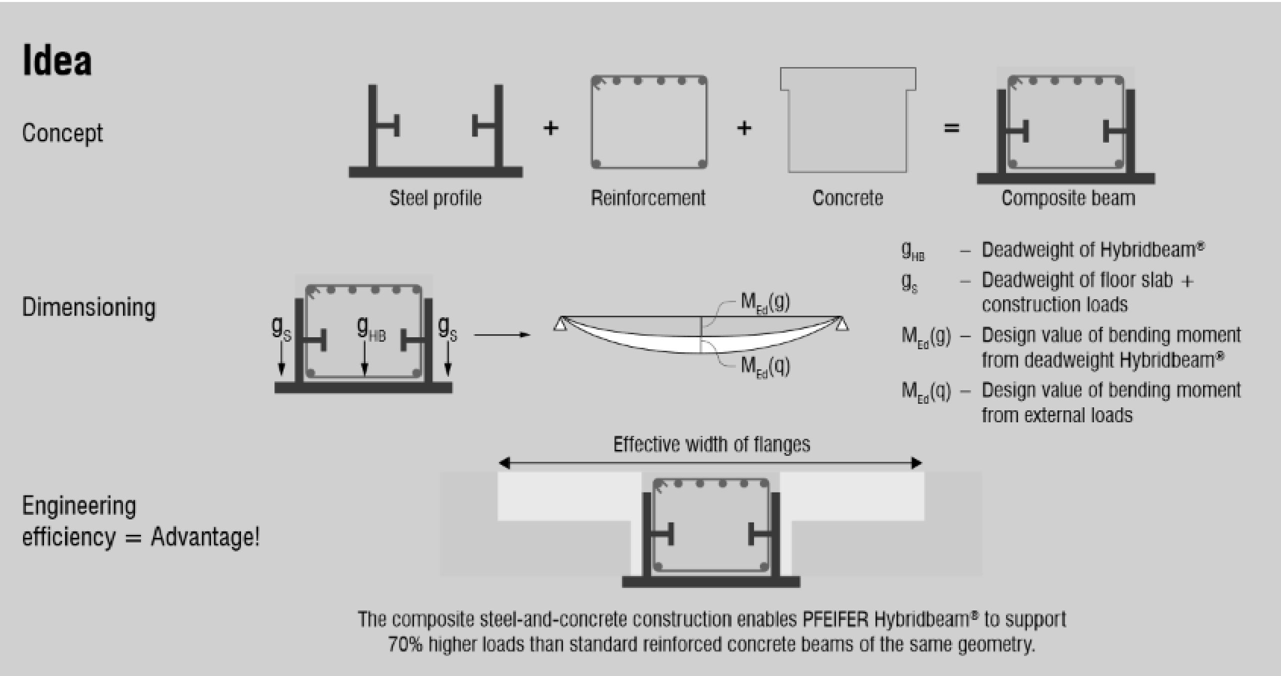

Figure 1. Technical concept of the Hybridbeam®.

Advantages of Hybridbeam® are: ready-to-install complete element made of materials with very high strength parameters, low construction height of a flat ceiling - savings in construction height • possibility of mounting installations at the ceiling height, large span of the ceiling - a perfect solution for creating large voids inside the building, no technological breaks when erecting the next storeys, easy to select due to the required load capacity, wide range of standard types, freedom to rest on supports, high fire resistance, corrosion protection Base input materials used in the beam production presented in the process flow chart (Figure 2) are:

- Concrete C60/75
- Steel plates S460N/NL acc. To EN 10025-3:2007, steel plates S235JR, S355J2 acc. to EN10025-2:2007
- Ribbed bars (Rebars) class A/B acc. To EN 1992-1-1:2008 and additional reinforcing equipment anchors
- Shear connectors (SD) S235J2+C470 (C60/75) acc. to EN ISO 206+A1:2016
- Fire protection paint system
- Elastomer strip
- Anticorrosion paint system acc. to PN-EN-ISO 12944
- Packaging material (weight less than 0,1% of total mass of product input)

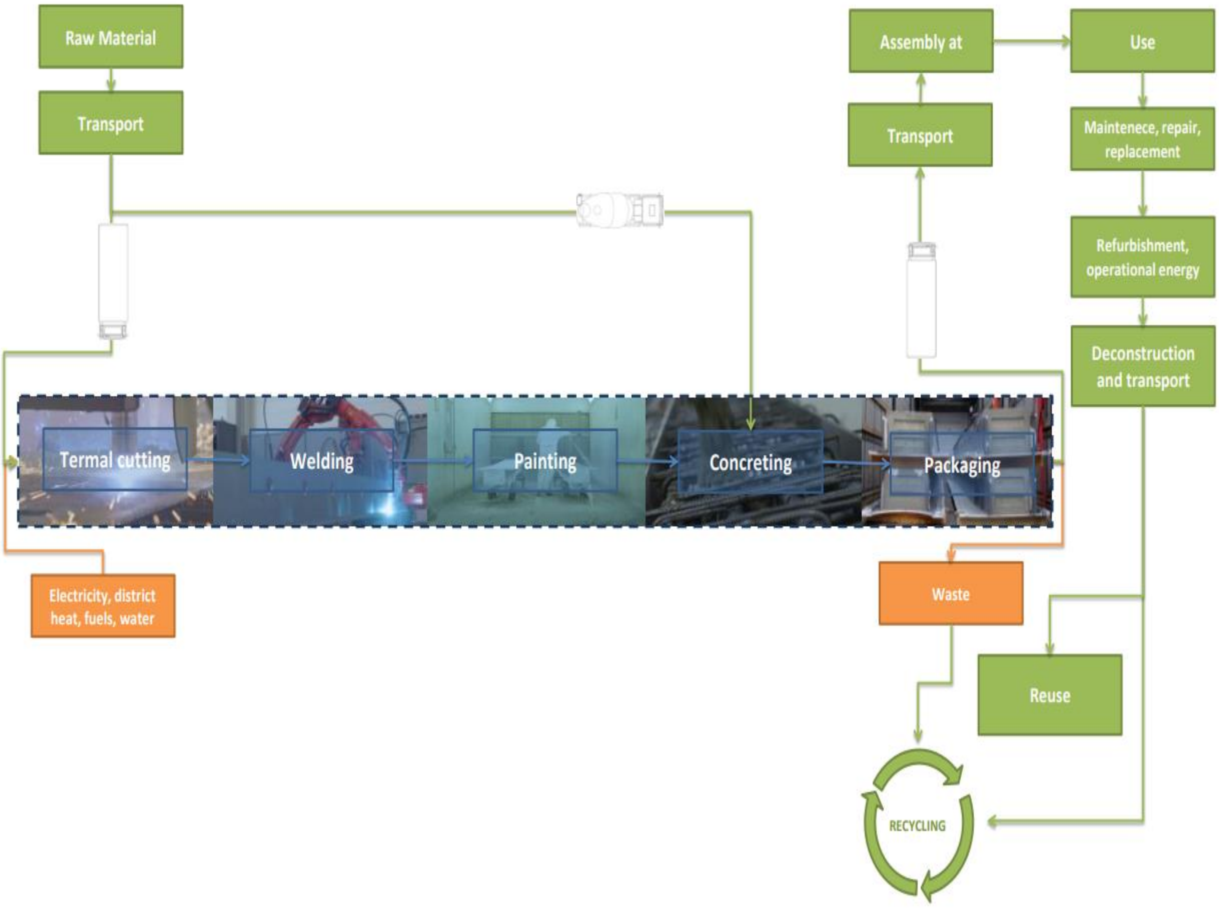

Figure 2. A scheme of manufacturing process of the hybrid beam products.

Technical approvals / certificates:
National Technical Assessment ITB-KOT-2017/0032 edition 1.

Product types: They are available in two types - as intermediate (BHM) and extreme (BHR) beams, each in eighteen cross-section sizes.

A specific product technical data can be found at https://www.pfeifer.info

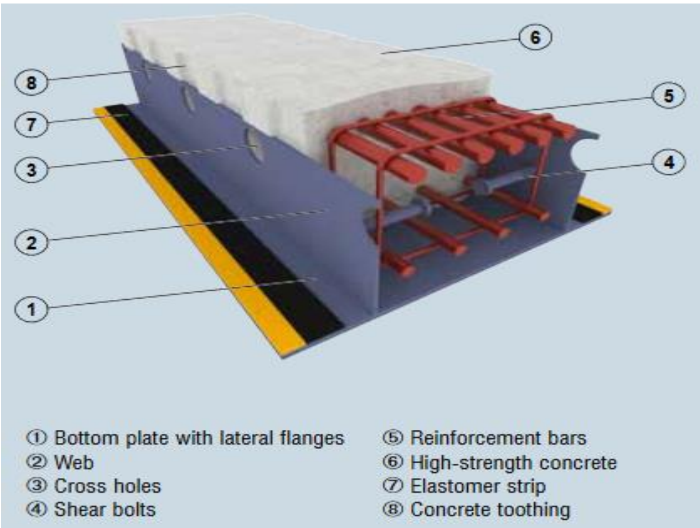

Figure 3. Typical cross-section of Hybridbeam®.

LIFE CYCLE ASSESSMENT (LCA) – general rules applied

Unit

The declared unit is 1 kg of Hybridbeam®. Product assessment is carried out for five variants of the beam, and each variant has a different percentage of concrete.

System boundary

The life cycle analysis of the declared product covers “Product Stage” A1-A4 modlues, “End of Life stage” C1, C2, C3, C4 modlues and gains 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 Hybridbeam® is a line process in an manufacturing plant located at Krępice, Poland (see Figure 2). Allocation of impact is done on product mass basis. All impacts from raw materials production (concrete C60/75, steel plates S460N/NL, steel plates S235JR, S355J2, ribbed bars (Rebars) class A/B, shear connectors, fire protection paint system, elastomer strip, anticorrosion paint, packaging material, technical gases) are allocated in A1 module of the LCA. 99% of impacts from a line production were allocated to product covered by this declaration. Module A2 includes transport of raw materials such as steel and concrete from supplier to manufacturing plant. Municipal wastes of factory were allocated to module A3. Energy supply (gas and electricity)was inventoried for whole factory and 100% was allocated to the product assessed. Emissions in the factory are assessed using national KOBIZE 2019 emission factors for energy carriers were allocated to module A3.

System limits

99,5% materials and 100% energy consumption (electricity, gas, oxygen) was inventoried in factory and were included in calculation. In the assessment, all significant parameters from gathered production data are considered, i.e. all material used per formulation (99% of input is steel and concrete e), utilized thermal energy, and electric power consumption, direct production waste, and available emission measurements. Tires consumption for transport was not taken into account. Precomponents, dyes, foils, labels, tapes 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

Reinforcing bars are produced in inventoried polish steel mills based on EAF technology (90% of recycled content). The steel plates used in the manufactory are produced in the mixed EAF/BOF technology. The concrete used for production contains about 20% of CEM I produced in Poland. Input steel product come from suppliers providing environmental data (EPD or other) on a production. Data on transport of the different input products to the manufacturing plants were inventoried in detail and modelled by assessor. For calculation purposes European fuel averages are applied in module A2.

A3: Production

The production process is presented in Figure 1.

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 674 km. For calculation purposes European fuel averages are applied in module A4.

End of life scenarios (C and D modules)

The end-of-life scenario for all products has been generalized. The beams are disassembled (C1 module) by crane and power tools. The manufacturer declares the technology and the scenario in which the beams can be reused or adapted (change in length, fulfillment) to new applications after the end of their life cycle with a low expenditure of energy and materials (90%). Other materials (10%) steel and concrete are recyclable, and typically are recycled by demolition contractors, who sell the recovered steel (bars and reinforcement) as ferrous scrap. The steel is reclaimed by crushing and retrieving the wires with hammers, breakers, and grappling hooks mounted onto heavy equipment. It is assumed that the recovered steel will be prepared (C3) for further steel production process. 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. Materials recovered from dismantled products are recycled according to the BAT treatment practice. 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 1. End of life scenarios for Hybridbeam® products

Progress products	Material recovery	Reuse	Recycling	Landfilling
Steel products	100%	90%	10%	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 Poland as reference area.

Data quality - production

The values determined to calculate A3 originate from verified Progress LCI inventory data. A1 values were prepared considering several specific EPDs for the European made steel products. Allocation for steel production impacts is done in accordance with *LCI data for Steel products Report* compiled by Braian 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 were averaged for the analysed production of each 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, specific EPD for a steel producers (CMC, Arcelor, Celsa, Thyssen), cement CEM I (SPC), concrete C60/75 components (specific EPDs), KOBIZE and Tauron (Polish electricity mix and combustion factors for fuels). Specific (LCI) data quality analysis was a part of 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 PFEIFER Hybridbeam®. The following life cycle modules are included in the declaration (table 2).

Table 2. 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**

The environmental characteristics have been prepared for five groups of beams having a different concrete content in the whole product;

Group no.	Concrete C60/75 mass content in a hybrid beam group	Data in
1+	>70%	see Table 3
1	65-70%	see Table 4
2	60-65%	see Table 5
3	55-60%	see Table 6
4	<55%	see Table 7

Table 3. Environmental product characteristic – 1 kg of hybrid beam (group 1+)

Environmental impacts: (DU) 1 kg										
Indicator	**Unit**	**A1**	**A2**	**A3**	**A4**	**C1**	**C2**	**C3**	**C4**	**D**
Global warming potential	kg CO_2	7.57E-01	4.06E-02	1.02E-01	7.00E-02	4.72E-02	5.28E-03	8.71E-02	0.00E+00	-4.28E-03
Depletion potential of the stratospheric ozone layer	kg CFC 11	2.86E-08	0.00E+00	2.18E-08	0.00E+0	5.20E-10	0.00E+00	1.29E-09	0.00E+00	0.00E+00
Acidification potential of soil and water	kg SO_2	1.55E-03	3.23E-04	2.96E-04	5.55E-04	4.15E-05	4.20E-05	9.21E-05	0.00E+00	-2.95E-05
Formation potential of tropospheric ozone	kg Ethene	2.96E-04	2.07E-05	2.30E-04	3.56E-05	2.15E-04	2.69E-06	3.87E-04	0.00E+00	-2.01E-07
Eutrophication potential	kg $(PO_4)^{3-}$	2.47E-04	5.72E-05	1.47E-05	9.84E-05	1.73E-06	7.44E-06	7.17E-06	0.00E+00	-1.46E-07
Abiotic depletion potential (ADP-elements) for non-fossil resources	kg Sb	9.98E-04	0.00E+0	9.22E-04	0.00E+0	3.50E-04	0.00E+00	6.46E-04	0.00E+00	-1.51E-08
Abiotic depletion potential (ADP-fossil fuels) for fossil resources	MJ	6.58E+00	5.56E-01	1.31E+00	9.56E-01	5.40E-01	7.23E-02	1.01E+00	0.00E+00	-4.31E-02
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	3.79E-01	5.56E-03	3.60E-02	9.56E-03	8.10E-02	7.23E-04	1.46E-01	0.00E+00	-2.93E-03
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	6.71E+00	5.84E-01	1.50E+00	1.00E+0	5.94E-01	7.59E-02	1.11E+00	0.00E+00	-4.69E-02
Use of secondary material	kg	1.19E-01	0.00E+00	0.00E+00	0.00E+0	0.00E+0	0.00E+00	0.00E+00	0.00E+00	-2.94E-03
Use of renewable secondary fuels	MJ	1.28E-01	2.92E-02	1.10E-03	5.02E-02	0.00E+0	3.80E-03	0.00E+00	0.00E+00	0.00E+00
Use of non-renewable secondary fuels	MJ	1.85E-01	0.00E+00	0.00E+00	0.00E+0	0.00E+0	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Net use of fresh water	m^3	5.44E-02	1.00E-06	3.28E-05	1.72E-06	1.71E-04	1.30E-07	3.10E-04	0.00E+00	-1.12E-05
Other environmental information describing waste categories: (DU) 1 kg										
Indicator	**Unit**	**A1**	**A2**	**A3**	**A4**	**C1**	**C2**	**C3**	**C4**	**D**
Hazardous waste disposed	kg	1.50E-05	3.60E-06	4.33E-05	6.19E-06	7.20E-07	4.68E-07	1.38E-06	0.00E+00	-3.36E-11
Non-hazardous waste disposed	kg	1.15E-02	4.27E-03	4.86E-03	7.34E-03	6.50E-03	5.55E-04	1.17E-02	0.00E+00	-2.91E-05
Radioactive waste disposed	kg	8.59E-06	0.00E+00	7.14E-08	0.00E+0	7.20E-07	0.00E+00	1.30E-06	0.00E+00	-4.90E-08
Components for re-use	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+0	0.00E+0	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for recycling	kg	9.08E-11	0.00E+00	0.00E+00	0.00E+0	0.00E+0	0.00E+00	1.00E+00	0.00E+00	0.00E+00
Materials for energy recover	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+0	0.00E+0	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+0	0.00E00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 4. Environmental product characteristic – 1 kg of hybrid beam (group 1)

Environmental impacts: (DU) 1 kg										
Indicator	**Unit**	**A1**	**A2**	**A3**	**A4**	**C1**	**C2**	**C3**	**C4**	**D**
Global warming potential	kg CO_2	7.98E-01	4.06E-02	1.02E-01	7.00E-02	4.72E-02	5.28E-03	8.71E-02	0.00E+00	-4.28E-03
Depletion potential of the stratospheric ozone layer	kg CFC 11	2.84E-08	0.00E+0	2.18E-08	0.00E+0	5.20E-10	0.00E+00	1.29E-09	0.00E+00	0.00E+00
Acidification potential of soil and water	kg SO_2	1.63E-03	3.23E-04	2.96E-04	5.55E-04	4.15E-05	4.20E-05	9.21E-05	0.00E+00	-2.95E-05
Formation potential of tropospheric ozone	kg Ethene	3.05E-04	2.07E-05	2.30E-04	3.56E-05	2.15E-04	2.69E-06	3.87E-04	0.00E+00	-2.01E-07
Eutrophication potential	kg $(PO_4)^{3-}$	2.55E-04	5.72E-05	1.47E-05	9.84E-05	1.73E-06	7.44E-06	7.17E-06	0.00E+00	-1.46E-07
Abiotic depletion potential (ADP-elements) for non-fossil resources	kg Sb	9.80E-04	0.00E+0	9.22E-04	0.00E+0	3.50E-04	0.00E+00	6.46E-04	0.00E+00	-1.51E-08
Abiotic depletion potential (ADP-fossil fuels) for fossil resources	MJ	6.96E+00	5.56E-01	1.31E+00	9.56E-01	5.40E-01	7.23E-02	1.01E+00	0.00E+00	-4.31E-02
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	3.86E-01	5.56E-03	3.60E-02	9.56E-03	8.10E-02	7.23E-04	1.46E-01	0.00E+00	-2.93E-03
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	7.09E+00	5.84E-01	1.50E+0	1.00E+0	5.94E-01	7.59E-02	1.11E+00	0.00E+00	-4.69E-02
Use of secondary material	kg	1.28E-01	0.00E+0 0	0.00E+0	0.00E+0	0.00E+0	0.00E+00	0.00E+00	0.00E+00	-2.94E-03
Use of renewable secondary fuels	MJ	1.23E-01	2.92E-02	1.10E-03	5.02E-02	0.00E+0	3.80E-03	0.00E+00	0.00E+00	0.00E+00
Use of non-renewable secondary fuels	MJ	1.79E-01	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Net use of fresh water	m^3	5.45E-02	1.00E-06	3.28E-05	1.72E-06	1.71E-04	1.30E-07	3.10E-04	0.00E+00	-1.12E-05
Other environmental information describing waste categories: (DU) 1 kg										
Indicator	**Unit**	**A1**	**A2**	**A3**	**A4**	**C1**	**C2**	**C3**	**C4**	**D**
Hazardous waste disposed	kg	1.54E-05	3.60E-06	4.33E-05	6.19E-06	7.20E-07	4.68E-07	1.38E-06	0.00E+00	-3.36E-11
Non-hazardous waste disposed	kg	1.16E-02	4.27E-03	4.86E-03	7.34E-03	6.50E-03	5.55E-04	1.17E-02	0.00E+00	-2.91E-05
Radioactive waste disposed	kg	8.84E-06	0.00E+0	7.14E-08	0.00E+0	7.20E-07	0.00E+00	1.30E-06	0.00E+00	-4.90E-08
Components for re-use	kg	0.00E+00	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for recycling	kg	8.76E-11	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+00	1.00E+00	0.00E+00	0.00E+00
Materials for energy recover	kg	0.00E+00	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy	MJ	0.00E+00	0.00E+0	0.00E+0	0.00E+0	0.00E00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 5. Environmental product characteristic – 1 kg of hybrid beam (group 2)

Environmental impacts: (DU) 1 kg										
Indicator	**Unit**	**A1**	**A2**	**A3**	**A4**	**C1**	**C2**	**C3**	**C4**	**D**
Global warming potential	kg CO_2	8.78E-01	4.06E-02	1.02E-01	7.00E-02	4.72E-02	5.28E-03	8.71E-02	0.00E+00	-4.28E-03
Depletion potential of the stratospheric ozone layer	kg CFC 11	2.80E-08	0.00E+0	2.18E-08	0.00E+0	5.20E-10	0.00E+00	1.29E-09	0.00E+00	0.00E+00
Acidification potential of soil and water	kg SO_2	1.79E-03	3.23E-04	2.96E-04	5.55E-04	4.15E-05	4.20E-05	9.21E-05	0.00E+00	-2.95E-05
Formation potential of tropospheric ozone	kg Ethene	3.23E-04	2.07E-05	2.30E-04	3.56E-05	2.15E-04	2.69E-06	3.87E-04	0.00E+00	-2.01E-07
Eutrophication potential	kg $(PO_4)^{3-}$	2.69E-04	5.72E-05	1.47E-05	9.84E-05	1.73E-06	7.44E-06	7.17E-06	0.00E+00	-1.46E-07
Abiotic depletion potential (ADP-elements) for non-fossil resources	kg Sb	9.46E-04	0.00E+0	9.22E-04	0.00E+0	3.50E-04	0.00E+00	6.46E-04	0.00E+00	-1.51E-08
Abiotic depletion potential (ADP-fossil fuels) for fossil resources	MJ	7.72E+00	5.56E-01	1.31E+0	9.56E-01	5.40E-01	7.23E-02	1.01E+00	0.00E+00	-4.31E-02
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	4.00E-01	5.56E-03	3.60E-02	9.56E-03	8.10E-02	7.23E-04	1.46E-01	0.00E+00	-2.93E-03
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	7.85E+00	5.84E-01	1.50E+0	1.00E+0	5.94E-01	7.59E-02	1.11E+00	0.00E+00	-4.69E-02
Use of secondary material	kg	1.45E-01	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+00	0.00E+00	0.00E+00	-2.94E-03
Use of renewable secondary fuels	MJ	1.14E-01	2.92E-02	1.10E-03	5.02E-02	0.00E+0	3.80E-03	0.00E+00	0.00E+00	0.00E+00
Use of non-renewable secondary fuels	MJ	1.65E-01	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Net use of fresh water	m^3	5.46E-02	1.00E-06	8.58E-05	1.72E-06	1.71E-04	1.30E-07	3.10E-04	0.00E+00	-1.12E-05
Other environmental information describing waste categories: (DU) 1 kg										
Indicator	**Unit**	**A1**	**A2**	**A3**	**A4**	**C1**	**C2**	**C3**	**C4**	**D**
Hazardous waste disposed	kg	1.62E-05	3.60E-06	4.33E-05	6.19E-06	7.20E-07	4.68E-07	1.38E-06	0.00E+00	-3.36E-11
Non-hazardous waste disposed	kg	1.17E-02	4.27E-03	4.86E-03	7.34E-03	6.50E-03	5.55E-04	1.17E-02	0.00E+00	-2.91E-05
Radioactive waste disposed	kg	9.34E-06	0.00E+0	7.14E-08	0.00E+0	7.20E-07	0.00E+00	1.30E-06	0.00E+00	-4.90E-08
Components for re-use	kg	0.00E+00	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for recycling	kg	8.11E-11	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+00	1.00E+00	0.00E+00	0.00E+00
Materials for energy recover	kg	0.00E+00	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy	MJ	0.00E+00	0.00E+0	0.00E+0	0.00E+0	0.00E00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 6. Environmental product characteristic – 1 kg of hybrid beam (group 3)

Environmental impacts: (DU) 1 kg										
Indicator	**Unit**	**A1**	**A2**	**A3**	**A4**	**C1**	**C2**	**C3**	**C4**	**D**
Global warming potential	kg CO_2	9.59E-01	4.06E-02	1.02E-01	7.00E-02	4.72E-02	5.28E-03	8.71E-02	0.00E+00	-4.28E-03
Depletion potential of the stratospheric ozone layer	kg CFC 11	2.75E-08	0.00E+0	2.18E-08	0.00E+0	5.20E-10	0.00E+00	1.29E-09	0.00E+00	0.00E+00
Acidification potential of soil and water	kg SO_2	1.95E-03	3.23E-04	2.96E-04	5.55E-04	4.15E-05	4.20E-05	9.21E-05	0.00E+00	-2.95E-05
Formation potential of tropospheric ozone	kg Ethene	3.41E-04	2.07E-05	2.30E-04	3.56E-05	2.15E-04	2.69E-06	3.87E-04	0.00E+00	-2.01E-07
Eutrophication potential	kg $(PO_4)^{3-}$	2.83E-04	5.72E-05	1.47E-05	9.84E-05	1.73E-06	7.44E-06	7.17E-06	0.00E+00	-1.46E-07
Abiotic depletion potential (ADP-elements) for non-fossil resources	kg Sb	9.11E-04	0.00E+0	9.22E-04	0.00E+0	3.50E-04	0.00E+00	6.46E-04	0.00E+00	-1.51E-08
Abiotic depletion potential (ADP-fossil fuels) for fossil resources	MJ	8.48E+00	5.56E-01	1.31E+0	9.56E-01	5.40E-01	7.23E-02	1.01E+00	0.00E+00	-4.31E-02
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	4.14E-01	5.56E-03	3.60E-02	9.56E-03	8.10E-02	7.23E-04	1.46E-01	0.00E+00	-2.93E-03
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	8.61E+00	5.84E-01	1.50E+0	1.00E+0	5.94E-01	7.59E-02	1.11E+00	0.00E+00	-4.69E-02
Use of secondary material	kg	1.63E-01	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+00	0.00E+00	0.00E+00	-2.94E-03
Use of renewable secondary fuels	MJ	1.05E-01	2.92E-02	1.10E-03	5.02E-02	0.00E+0	3.80E-03	0.00E+00	0.00E+00	0.00E+00
Use of non-renewable secondary fuels	MJ	1.52E-01	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Net use of fresh water	m^3	5.46E-02	1.00E-06	3.28E-05	1.72E-06	1.71E-04	1.30E-07	3.10E-04	0.00E+00	-1.12E-05
Other environmental information describing waste categories: (DU) 1 kg										
Indicator	**Unit**	**A1**	**A2**	**A3**	**A4**	**C1**	**C2**	**C3**	**C4**	**D**
Hazardous waste disposed	kg	1.69E-05	3.60E-06	4.33E-05	6.19E-06	7.20E-07	4.68E-07	1.38E-06	0.00E+00	-3.36E-11
Non-hazardous waste disposed	kg	1.19E-02	4.27E-03	4.86E-03	7.34E-03	6.50E-03	5.55E-04	1.17E-02	0.00E+00	-2.91E-05
Radioactive waste disposed	kg	9.84E-06	0.00E+0	7.14E-08	0.00E+0	7.20E-07	0.00E+00	1.30E-06	0.00E+00	-4.90E-08
Components for re-use	kg	0.00E+00	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for recycling	kg	7.46E-11	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+00	1.00E+00	0.00E+00	0.00E+00
Materials for energy recover	kg	0.00E+00	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy	MJ	0.00E+00	0.00E+0	0.00E+0	0.00E+0	0.00E00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 7. Environmental product characteristic – 1 kg of hybrid beam (group 4)

Environmental impacts: (DU) 1 kg										
Indicator	**Unit**	**A1**	**A2**	**A3**	**A4**	**C1**	**C2**	**C3**	**C4**	**D**
Global warming potential	kg CO_2	1.00E+00	4.06E-02	1.02E-01	7.00E-02	4.72E-02	5.28E-03	8.71E-02	0.00E+00	-4.28E-03
Depletion potential of the stratospheric ozone layer	kg CFC 11	2.73E-08	0.00E+0	2.18E-08	0.00E+0	5.20E-10	0.00E+00	1.29E-09	0.00E+00	0.00E+00
Acidification potential of soil and water	kg SO_2	2.03E-03	3.23E-04	2.96E-04	5.55E-04	4.15E-05	4.20E-05	9.21E-05	0.00E+00	-2.95E-05
Formation potential of tropospheric ozone	kg Ethene	3.50E-04	2.07E-05	2.30E-04	3.56E-05	2.15E-04	2.69E-06	3.87E-04	0.00E+00	-2.01E-07
Eutrophication potential	kg $(PO_4)^{3-}$	2.91E-04	5.72E-05	1.47E-05	9.84E-05	1.73E-06	7.44E-06	7.17E-06	0.00E+00	-1.46E-07
Abiotic depletion potential (ADP-elements) for non-fossil resources	kg Sb	8.93E-04	0.00E+0	9.22E-04	0.00E+0	3.50E-04	0.00E+00	6.46E-04	0.00E+00	-1.51E-08
Abiotic depletion potential (ADP-fossil fuels) for fossil resources	MJ	8.86E+00	5.56E-01	1.31E+00	9.56E-01	5.40E-01	7.23E-02	1.01E+00	0.00E+00	-4.31E-02
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	4.21E-01	5.56E-03	3.60E-02	9.56E-03	8.10E-02	7.23E-04	1.46E-01	0.00E+00	-2.93E-03
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	9.00E+00	5.84E-01	1.50E+0	1.00E+0	5.94E-01	7.59E-02	1.11E+00	0.00E+00	-4.69E-02
Use of secondary material	kg	1.71E-01	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+00	0.00E+00	0.00E+00	-2.94E-03
Use of renewable secondary fuels	MJ	1.01E-01	2.92E-02	1.10E-03	5.02E-02	0.00E+0	3.80E-03	0.00E+00	0.00E+00	0.00E+00
Use of non-renewable secondary fuels	MJ	1.46E-01	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Net use of fresh water	m^3	5.47E-02	1.00E-06	3.28E-05	1.72E-06	1.71E-04	1.30E-07	3.10E-04	0.00E+00	-1.12E-05
Other environmental information describing waste categories: (DU) 1 kg										
Indicator	**Unit**	**A1**	**A2**	**A3**	**A4**	**C1**	**C2**	**C3**	**C4**	**D**
Hazardous waste disposed	kg	1.73E-05	3.60E-06	4.33E-05	6.19E-06	7.20E-07	4.68E-07	1.38E-06	0.00E+00	-3.36E-11
Non-hazardous waste disposed	kg	1.20E-02	4.27E-03	4.86E-03	7.34E-03	6.50E-03	5.55E-04	1.17E-02	0.00E+00	-2.91E-05
Radioactive waste disposed	kg	1.01E-05	0.00E+0	7.14E-08	0.00E+0	7.20E-07	0.00E+00	1.30E-06	0.00E+00	-4.90E-08
Components for re-use	kg	0.00E+00	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for recycling	kg	7.13E-11	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+00	1.00E+00	0.00E+00	0.00E+00
Materials for energy recover	kg	0.00E+00	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy	MJ	0.00E+00	0.00E+0	0.00E+0	0.00E+0	0.00E00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

RESULTS INTERPRETATION

The environmental impact of PFEIFER Hybridbeam® product (cradle to gate with options) is largely dependent on the energy-intensive production of steel and concrete on which the manufacturer has only a limited influence. Various types of steel are used in the production, but a significant amount of steel comes from steel mills in the EAF technology with a lower environmental/carbon impact. The average carbon footprint of the steels used in production is approximately 1.8 kg CO_2 / kg of steel. The concrete used in the production contains about 20% CEM I, which gives a concrete carbon footprint of 0.2 kg CO_2 / kg. These two products have a life cycle impact with almost 80 % of the impact on the global product carbon footprint. The production A3 itself accounts for only 10% of the energy consumption in the life cycle and 8% of the impact on the carbon footprint. A further improvement of the environmental footprint should be sought in the use of environmentally friendly steel (eco EAF), CEM I substitutes in concrete used or green electric energy.
The impact of the production line A3 largely depends on the amount of electricity consumed by manufacturing plant (0.22 MJ/kg of product). There are no significant emissions or environmental impacts in the A3 production processes alone (partly welding process with technical gases use and gas combustion). The production process itself does not have significant environmental impacts in the life cycle.
Interrogation of the LCA results show that the cradle-to-gate carbon (Global Warming Potential) impact of 1 kg of beam for group 4 (most impactful) is 1.0 kg CO_2eq. The LCA results show that the cradle-to gate primary has the energy demand of fossil fuels equal 13.1MJ.
The transport of raw materials from considerable distances is optimized and not significant.
The products. due to the high potential for reuse (90%) has no significant recycling or disposal impacts.

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 (subclause 8.1.3.) ☒ external ☐ internal
External verification of EPD: Ph.D. Eng. Halina Prejzner LCA. LCI audit and input data verification: Ph.D. 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
- National Technical Assessment ITB-KOT-2017/0032 edition 1.
- 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 10080:2007 „Stal do zbrojenia betonu - Spajalna stal zbrojeniowa - Postanowienia ogólne"
- PN-EN 1992-1-1:2008 „Eurokod 2 - Projektowanie konstrukcji z betonu - Część 1-1: Reguły ogólne i reguły dla budynków"

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Thermal Physics, Acoustics and Environment Department
02-656 Warsaw, Ksawerów 21

CERTIFICATE № 198/2021
of TYPE III ENVIRONMENTAL DECLARATION

Products:
PFEIFER Hybridbeam®

Manufacturer:
Pfeifer Steel Production Poland Sp. z.o.o.
Wrocławska 68, 55-330 Krępice, Poland

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 1st April 2021 is valid for 5 years
or until amendment of mentioned Environmental Declaration

Acting 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, April 2021