EPD

Environmental Product Declaration for Precast Concrete products,

C1	Columns
B1	Beams (U, T or L shaped)
RF1	Roof girders (prestressed)
RF2	Roof purlins (prestressed)
S1	Side Beams

Programme The International EPD® System / www.environdec.com
Programme operator: EPD International AB
EPD registration number: S-P-14287
Publication date: 2024-06-03
Valid until: 2029-06-02

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

GENERAL INFORMATION

Programme Operator:	EPD International AB
Address:	EPD International AB Box 210 60 SE-100 31 Stockholm Sweden
Website:	www.environdec.com
E-mail:	info@environdec.com

Accountabilities for PCR, LCA and third-party verification

Product Category Rules (PCR)

CEN standard EN 15804 serves as the Core Product Category Rules (PCR)

Product Category Rules (PCR):
PCR 2019:14 Construction products (EN 15804:A2); Version 1.3.2; 2023-12-08
c-PCR-003 Concrete and concrete elements (EN 16757:2022); Version 2024-04-30

PCR review was conducted by: The Technical Committee of the International EPD® System.
See **www.environdec.com** for a list of members. Review chair: Claudia A. Peña, University of Concepción, Chile.
The review panel may be contacted via the Secretariat
www.environdec.com/contact

Life Cycle Assessment (LCA)

LCA accountability: TITAN Cement Company S.A.

Third-party verification

Independent third-party verification of the declaration and data, according to ISO 14025:2006, via:
☒ EPD verification by accredited certification body
Third-party verification: Business Quality Verification P.C. is an approved certification body accountable for the third-party verification
The certification body is accredited by: Hellenic Accreditation System ESYD with accreditation number 1218

Procedure for follow-up of data during EPD validity involves third party verifier:
☐ Yes ☒ No

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

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

COMPANY INFORMATION

Owner of the EPD: ARMOS Precast S.A.
4th km Larissas - Sykourio, 41500 Larissa, Greece

Contact: Toulios Georgios, Quality Manager
T: +30 2410 575035, E: g.toulios@armosprokat.gr

Description of the organization: Building materials manufacturer

Product-related or management system-related certifications:
The company is certified with ISO 9001:2015 Quality Management System

INTRODUCTION

Established in 1985 in Larisa, Armos Precast SA is a precast manufacturing company providing precast concrete products and solutions across the construction sector, serving the wider area of area of Greece, Cyprus and Balkans through its several production sites.

Through its operation consistency and quality excellence, result of its deep know-how, experienced personnel and strict control process, Armos Precast SA has delivered efficient and sustainable precast solutions for multiple industrial, commercial, public and residential building projects in Greece and abroad. Whether it's warehouses or factories, multi-use buildings or offices, schools or hospitals, hotels or residences, Armos Precast SA provides comprehensive precast solutions that include the design, the manufacturing and the assembly of the precast components that form part of or the total of building cell.

Armos product portfolio includes the full spectrum of buildings components, indicatively columns, beams, prestressed roof girders and purlins, slabs and walls, pre-slabs, while in addition can offer specially adapted elements to the needs of each construction.

Building with precast concrete elements has various advantages for all stakeholders: enhanced fireproofing, design flexibility with large openings/spans, durability and long lifetime, low need of maintenance, and lower environmental impact (compared with other construction methods).

Being focused on servicing high quality concrete -based solutions to its customers, and with respect towards the local communities and the environment protection, Armos Precast has continuously invested in new technologies and equipment to improve its quality, enlarge its product portfolio, improve its operations efficiency, decrease its environmental impact and enhance its positive impact on personnel and local communities. Faithful to these principles, Armos is certified according to EN ISO 9001, 14001 and 45001 for its Quality, Environmental and Health & Safety management. All precast products and elements are CE marked, according to European norms.

PRODUCT INFORMATION

Product name: Precast concrete linear elements for Industrial and Commercial buildings

Product identification:

- Columns
- Beams (U, T or L shaped)
- Roof girders (prestressed)
- Roof purlins (prestressed)
- Side beams

Product description:

These five variously shaped precast linear concrete elements are commonly utilized in the construction of large-scale commercial and industrial buildings (forming one or several storeys), forming the main framework of the structure.

While different in shape and sizes, these five types of precast linear concrete element have identical manufacturing processes and materials.

All five types belong to the category of precast concrete linear structural elements and their factory production control complies with the harmonized European standard EN 13225. They bear the CE mark and are accompanied by a manufacturer-issued declaration of performance, meeting the requirements outlined in Regulation (EU) No. 305/2011.

Their concrete compressive strength class is C30/37 or higher for the non-prestressed types, while C35/45 or higher for the prestressed ones.

Columns:

Columns are vertical components engineered to withstand vertical loads and transfer them to the foundation. Typically, square or rectangular, their dimensions range from 50x50 cm to 100x120 cm (and variations in between), depending on the casting mold. Columns (usually) support the beams carrying slabs and transmit the loads across their entire influence area. Concrete columns come in various sizes, with lengths up to 25 m, featuring one or more reinforced concrete or steel corbels, or none at all. They can be equipped with steel elements (e.g. column shoes or grouted couplers) at the base (to facilitate fastening to foundation), screw-type fastenings at the top, or without them. Together with beams and other elements (precast or not), columns compose a structural frame, forming integral building units suitable for diverse purposes such as parking lots, shopping malls, schools, and industrial buildings.

Beams (U, T or L shaped):

Beams are essential linear components in construction primarily designed to withstand bending forces and typically supported by corbels or column capitals. They are characterized by their elongated shape, where length dominates over width and height, and their main

role is to provide structural support for various types of slab elements, including pre-slabs, solid slabs, or hollow-core slabs. Precast concrete beams come in a variety of sizes and configurations, including single-shelf (L-shaped), double-shelf (T-shaped), U-shaped (used for gutter applications), or rectangular shapes. Standard cross-sectional dimensions vary from 25x60 cm to 60x100 cm, with different shapes and lengths available.

U-beams, particularly sought after in the market, are known for their ability to span significant distances, offering stability and efficient rainwater drainage. They are commonly used in commercial buildings, allowing for exposed roof elements and eliminating the need for separate drainage channels by acting as gutters, directing water to the building's ends and connecting it directly to the drainpipe.

Roof girders (prestressed):

Prestressed roof girders, similar to the precast beams described earlier, are specifically designed for industrial buildings or other large-span frame structures with a sloped roof and no intermediate columns in the central area, as they incorporate the beam's slope. The slope of these girders typically stands at 10%. Their width ranges from 15 cm to 70 cm, length varies from 12 m to 35 m, and height ranges from 120 cm to 250 cm. When the length exceeds a certain threshold, usually around 12 meters, prestressing becomes necessary.

Roof purlins (prestressed):

Roof purlins serve as secondary structural components, akin to the previously mentioned beams, specifically engineered to uphold the roof covering of diverse building types. Predominantly found in industrial structures or constructions with expansive roof spans, they assume a critical function in distributing the weight of the roof covering, typically composed of steel panels, and ensuring the stability of the entire roof system. Typically affixed to the primary roof girder, these T-shaped elements are available in a spectrum of dimensions and configurations. Heights typically range from 40 to 65 cm, while widths span from 11 to 40 cm, contingent upon the specific design requirements of the building and considerations of the imposed loads. Lengths can vary, with maximum dimensions usually extending up to 15 meters.

Side Beams:

Side beams are secondary structural components tailored for supporting vertical cladding of the building (cladding usually made of steel panels). Primarily fastened to the main structural elements, side beams assume a diverse array of shapes and sizes to accommodate specific architectural requirements and load considerations. These elements, often characterized by their L or T shaped profiles, come in a range of dimensions. Heights typically vary between 40 to 80 cm, while widths span from 20 to 40 cm, contingent upon the unique demands of the building design and the nature of the imposed loads. Lengths may vary according to the specific application, with maximum dimensions typically extending up to 14 meters.


ΑΡΜΟΣ

LCA INFORMATION

Functional unit / declared unit: The declared unit is one (1) ton.

Production Process: ARMOS S.A. manufactures ready-mixed concrete and precast products in a state-of-the-art facility in Larissa. The production process is fully automated to ensure superior quality products, conforming to the national and European concrete standards. The raw mate- rials (cement, aggregates, water, admixtures etc.) are accurately weighed according to the proprietary ARMOS S.A. mix designs to produce ready-mixed concrete with specific characteristics (strength, durability, finishability, pumpability etc.).

Time representativeness: The data used in this study cover from January 2023 to December 2023.

Database(s) and LCA software used: GCCA Industry EPD Tool for Cement and Concrete and Ecoinvent database (v.4).

Goal and scope: This EPD evaluates the environmental impacts of one cubic meter of concrete for modules A1-A3.

Data quality: ISO 14044 was applied in terms of data collection and quality requirements. The data concerning the modules A1 (raw material supply), A2 (transportation) and A3 (product manufacturing) were provided by ARMOS S.A., incorporating cement EPD data for Titan Cement Company S.A. and involved all input and output materials to our premises. Regarding electricity mix, the latest (2022) national residual electricity mix as published in DAPEEP SA, were utilized **(https://www.dapeep.gr/viosimi-anaptixi/energeiako-meigma/).** The background data for the module A1 e.g. raw materials (amount used by type) as well energy consumption, waste production and transport distances of raw materials and aggregates from cement plants, quarries have been obtained from the company's Quality Assurance system and correspond the exact and accurate mix designs for each ready-mix plant. Core indicators for every cement type / cement sourcing plant are obtained from the TITAN CEMENT S.A. publicly available cement EPDs.

The GCCA Environmental Product Declaration tool (v4.0). GCCA's Industry EPD Tool for Cement and Concrete is a web-based calculation tool for EPDs of clinker, cement, concrete, mortars and precast elements, available in both International and North American versions. The present report refers to the International version only.

The latter complies with the latest cement and concrete PCRs registered at the International EPD® System (Environdec), namely c-PCR-001 Cement and building limes (EN 16908) for cement and c-PCR003 Concrete and concrete elements (EN 16757) for concrete and precast elements, both registered as complementary PCRs of PCR 2019:14 Construction products (EN 15804+A2).

The GCCA EPDtool (v3.0) is developed by Quantishttps://quantis-intl. com/ and verified by Studio Fieschi http://www.studiofieschi.it/en. The International EPD® System, which provides the framework to develop and publish EPDs based on ISO 14025 and EN 15804, gives the final approval of the tool's compliance with the rules. The underpinning database for the GCCA EPD tool is the version of the Ecoinvent database (v.4.0) and cement manufacturing data obtained through the GNR process (https://gccassociation.org/ sustainability-innovation/gnr-gcca-in-numbers/).

The database of Ecoinvent v.4.0 was used to complete any missing data. Generic data used in this study concerning:

- CO_2 emission factors for different transportation way
- CO_2 emission factors for plant diesel and raw materials
- Specific emission factor of used energy mix (kg CO_2/kWh)

There is no missing data for these concrete mixes, since all the required raw data were provided from the Quality Assurance system that company uses. Data collection and processing for EPD and LCA development is performed according to ARMOS S.A. quality systems

Geographical scope: National (Greece)

Allocations: The allocation is performed according to the PCR. As no co-products are produced, the flow of materials and energy and the associated release of substances and energy into the environment is related exclusively to the concrete produced. No by-products occur during ready mix concrete production; therefore, there is no need for allocations in by-products.

The study does not include the followings:

- Capital equipment production
- Equipment maintenance
- Human labor and employee transport

Assumptions:

Pre-defined cement and clinker data provided by the GCCA tool are used for TITAN cements manufactured at Kamari, Patras and Thessaloniki cement plants.

- All modelling assumptions adopted from the GCCA Tool.
- Raw material (inbound) transport distances are generated from company data and are accurate across operations.
- The calculation of the bill of materials for the plant is based on company data. The concrete mix design (materials percentage participation) was defined by the pre-verified and automated Quality Assurance system that company uses.
- Water usage in batching operations is, per mix design.

Cut-off rules: The cut-off rule for insufficient data or data gaps that are less than 1% of the total input mass or mass per module was applied. In case of insufficient input data or data gaps for a unit process, the cut-off criteria shall be 1% of renewable and non-renewable primary energy usage and 1% of the total mass input of that unit process. The total of neglected input flows for the stages 'cradle through gate' shall be a maximum of 5% of energy usage and mass." (EN 15804:2012+A2:2019). Regarding the LCA model, the default cut-off criteria are applied for all processes from the Ecoinvent database. In addition, all custom processes developed for the specific purposes of the project are consistent with the rules and guidelines of the Ecoinvent database, and hence the same cut-off criteria are applied.

Comparability: EPD performance for construction products that they do not comply with EN 15804 may not be comparable. EPDs from separate programs but within the same product category may not be comparable as well.

Description of system boundaries:

The scope of this study is "Cradle to grave" covering A to D.

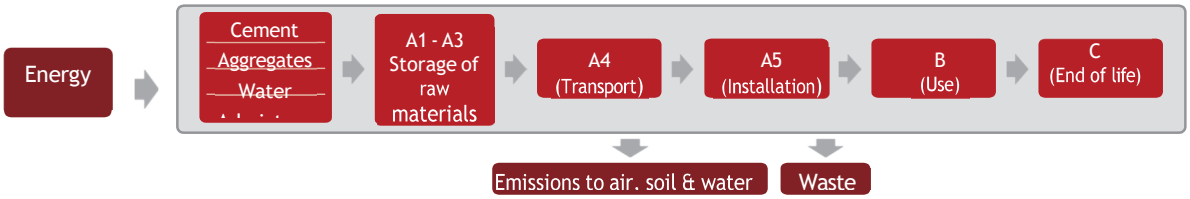
Reference Service Life (RSL): the Reference Service Life is estimated to at least 50 years.

The technical characteristics and composition of the product are shown in the table below.

Mechanical properties		
Product name	**Minimum Compressive Strength fck,cube (Mpa)**	**Product Density (Kg/m^3)**
C1-Columns	37	2.535
B1-Beams (U, T or L shaped)	37	2.473
RF1-Roof girders (prestressed)	50	2.671
RF2-Roof purlins (prestressed)	50	2.572
Side beams	37	2.500

The data of density and strength are based on the standards ELOT EN 12350.06 and ELOT EN 12390.03 respectively.

UN CPC code: 375

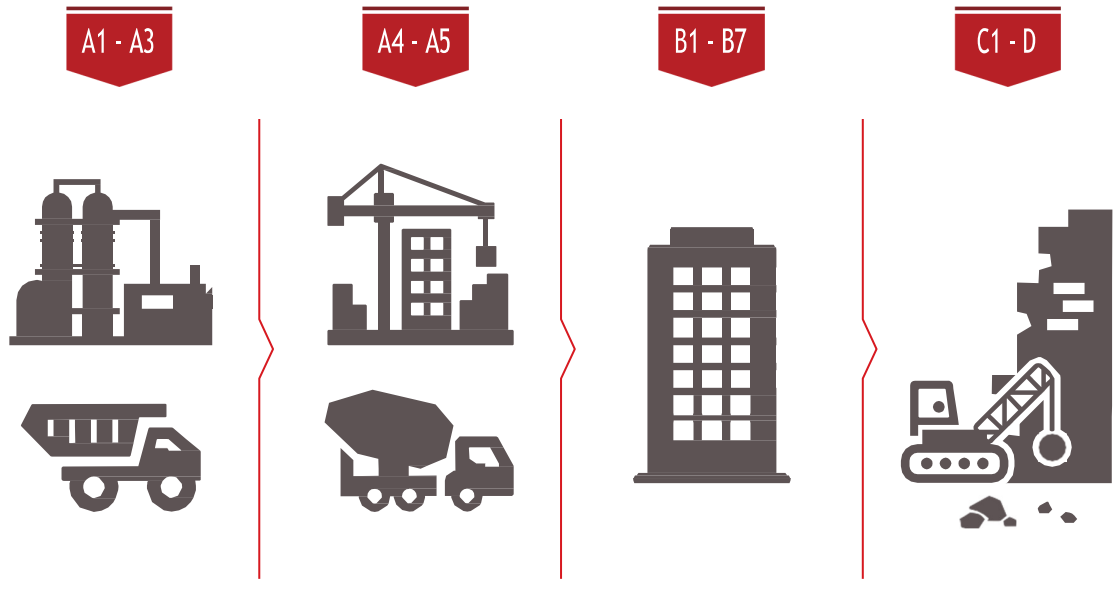


SYSTEM DIAGRAM

The scope of this study is Cradle to grave, A to D.

	Product Stage			Construction Stage		Use Stage							End-of-life Stage				Resource Recovery
	Raw Materials Supply	Transport	Manufacturing	Transport	Construction installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction and demolition	Transport	Waste processing	Disposal	Reuse-Recovery-Recycling-potential
Module	**A1**	**A2**	**A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
Modules declared	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Geography	GR			GR	GR	GR	GR	GR	GR	GR	GR	GR	GR	GR	GR	GR	GR
Specific data used	>90%			-	-	-	-	-	-	-	-	-	-	-	-	-	-
Variation - products	from -17% to 23%			-	-	-	-	-	-	-	-	-	-	-	-	-	-
Variation - sites	0%			-	-	-	-	-	-	-	-	-	-	-	-	-	-

More information: X= included, ND = module not declared



The final product does not contain dangerous substances of high concern from the candidate list of SVHC for Authorization.

- **A1-A3 Product stage**
  - A1 Raw materials supply: this module takes into account the extraction and processing of raw materials and the associated energy that is produced prior to manufacturing reinforced concrete.
  - A2 Transport: this module includes the transport of the different raw materials from the supplier to the ready-mix plant.
  - A3 Manufacturing: this module includes the consumption of energy and water during the concrete manufacturing process, as well as the transport and management of the factory-produced waste. The manufacture of concrete consists mainly of a mixing process of different components.
  - A4 The section includes transport of concrete products to the customers. The distance is the average distance to customers, and it is calculated to 300 km
  - A5 The construction life cycle inventory comprises of the use of electricity consumption 2,7 kWh/m3, water consumption 669 lt/m3, wastewater 0.669 lt/m3 and waste concrete. The waste concrete from construction site was defined as 3%.
- **B1-B7: Use stage**
  - B1 During the use stage (B1), concrete uptakes part of the CO2 emitted during the cement production via the concrete carbonation process. This is the reaction of CO2 in the environment with the calcium hydroxide in the cement paste. Carbonation is a natural process, however if it reaches the reinforcement, corrosion may start thus adequate cover is required. Calculation of concrete carbonation in the Use stage (B1) is based on EN 16757.
  - Product does not require maintenance (B2), repair (B3), replacement (B4), refurbishment (B5), operational energy use (B6) or operational water use (B7) during its Reference Service Life.
- **C1-C4: End of life stage**
  - C1 Demolition The present section aims at characterizing the demolition of the building or structure (module C1). As the latter goes beyond the visibility of the producer, the data is imposed and not modifiable. The calculation is based on the volume of concrete per declared unit and the concrete density provided in the 'Product description'
  - C2 Transport The present section aims at characterizing the transport of the demolished precast element from the demolition site to the waste processing site (module C2). As the latter goes beyond the visibility of the producer, the data is imposed and not modifiable. The average transport distance is set to 50 km (see 'LCA Model' report for the specific data sources). The calculation is based on the volume of concrete per declared unit and the concrete density provided in the 'Product description'.
  - C3 Waste processing
  - The present section aims at characterizing the recarbonation of recycled concrete, as well as the processing and sorting of the recycled demolition waste, including i) concrete recycling, ii) reinforcement sorting (separation of the steel and non-steel components), iii) reinforcement steel recycling (module C3), and iv) incineration (with energy recovery) of incinerated waste. The calculation is based on the recycling rate and other parameters listed in the section below, with the hypothesis that reinforcement steel is recycled at the same rate as concrete, and on the quantities of the respective materials. As these processes are mostly beyond the producer's visibility, most of the data is imposed and not modifiable.
  - C4 Disposal The present section aims at characterizing the recarbonation of disposed concrete, as well as the
  - disposal of the non-recycled and non-incinerated demolition waste, including i) concrete disposal, ii) reinforcement disposal, and iii) disposal of non-incinerated insulation materials, void formers, architectural finish and lifting/fixing inserts (module C4). The calculation is based on the recycling rate and the various parameters defined in C3 and on the quantities of the respective materials. As these processes go beyond the producer's visibility, the data is imposed and not modifiable.
    The only materials sent to recycling are the concrete itself and the reinforcement steel when applicable. Other materials (e.g. insulation, void formers, etc.) are considered to be either incinerated (incinerable fraction) or landfilled (non-incinerable fraction). We assume the recycled materials are really recycled and accounted for as recycled material. The potential credits in module D therefore apply to i) the recycling of concrete at the end of life, ii) the recycling of reinforcing steel at the end of life and iii) the incineration with energy recovery of (a fraction of) packaging and/or product waste. This methodological choice is consistent with the reality of the cement and concrete industry.

- **D Benefits and Loads**

The present section aims at characterizing the benefits and loads beyond the system boundaries (module D). These include i) the substitution of natural aggregates by recycled concrete, ii) the substitution of primary reinforcement steel by recycled reinforcement steel and iii) the substitution of heat from natural gas thanks to the incineration with energy recovery of (a fraction of) packaging and/or product waste.

The recycling potential is considered to be 20 % w/w as recycled aggregates. It must be noticed, that the use of recycled aggregates in concrete is not widely applicable in Greece since KTS 2016 does not wet allow the use of recycled aggregates.

CONTENT INFORMATION (1tn)

PRODUCT	CONCRETE DENSITY (Kg/m^3)	CEMENT (kg)	COARSE AGGREGATE (kg)	FINE AGGREGATE (kg)	WATER (kg)	Steel (kg)
Columns C30/37 XC4,XS3,XF1,XA1	2,353	134	284	439	71	72
Beams (U, T or L shaped) C30/37 XC4,XF1,XA1	2,353	137	292	450	73	48
Roof girders (prestressed) C40/50 XC4,XS3,XD3,XF1,XA1	2,405	146	312	378	65	99
Roof purlins (prestressed) C40/50 XC4,XS3,XD3,XF1,XA1	2,405	152	323	393	67	65
Side beams C30/37 XC4,XF1,XA1	2,353	136	288	445	72	59

ENVIRONMENTAL INFORMATION

The following tables present the overall impact on indicator groups assessed for A+B+C+D stages of these products Life Cycle.

All products are produced in the same plant and have the same material composition with a slight difference in ratios. This EPD represent the representative product which had the highest production of the included products for indicators A+B+C+D, at the year 2023.

The EPD is based on multiple, similar products and on the most representative product which is Columns and is based on total weight percentage So, a check was performed between the reported result and the results for the underlying products for modules A+B+C. The deviation between the results is above ±10%.

Core environmental impact indices

Indicator	Unit	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
GWP-tot	kg CO2 eq.	3.65E+02	2.60E+01	1.52E+01	-1.03E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.51E+00	3.69E+00	2.17E+00	4.66E+00	-3.40E+01
GWP-GHG	kg CO2 eq.	3.65E+02	2.60E+01	1.52E+01	-1.03E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.51E+00	3.69E+00	2.17E+00	4.66E+00	-3.40E+01
GWP-fos	kg CO2 eq.	3.65E+02	2.60E+01	1.52E+01	-1.03E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.51E+00	3.69E+00	2.17E+00	4.65E+00	-3.90E+01
GWP-bio	kg CO2 eq.	1.62E-02	1.05E-02	6.96E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.26E-04	2.73E-03	2.52E-03	3.08E-03	-3.11E+02
GWP-luc	kg CO2 eq.	5.48E-01	9.11E-03	1.81E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.42E-04	2.20E-03	1.91E-03	2.50E-03	-2.14E-02
ODP	kg CFC11 eq.	2.11E-05	5.14E-06	1.45E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.33E-07	6.37E-07	3.46E-07	1.52E-06	-1.83E-06
AP	mol H+ eq.	1.49E+00	8.58E-02	8.34E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.68E-02	1.72E-02	2.21E-02	4.46E-02	-1.74E-01
EP-fw	kg P eq.	1.51E-01	2.01E-03	5.07E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.57E-04	5.06E-04	4.28E-04	5.46E-04	-1.93E-02
EP-mar	kg N eq.	6.53E-03	1.75E-04	4.52E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.30E-05	3.74E-05	3.07E-05	5.15E-05	-8.15E-04
EP-ter	mol N eq.	3.33E+00	1.90E-01	2.59E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.73E-01	4.81E-02	9.14E-02	1.60E-01	-3.09E-01
POCP	kg NMVOCeq.	1.32E+00	7.72E-02	8.43E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.77E-02	1.59E-02	2.52E-02	4.69E-02	-1.48E-01
ADPE1	kg Sbeq.	1.69E-03	5.02E-05	5.50E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.04E-06	6.86E-06	1.02E-06	5.07E-06	-1.47E-01
ADPF1	MJ	3.23E+03	4.24E+02	1.68E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.06E+01	5.64E+01	3.30E+01	1.30E+02	-3.41E+02
WDP1	m^3 eq.	1.02E+02	3.13E+00	2.57E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.99E-01	4.89E-01	2.67E-01	6.26E+00	-1.46E+01

Acronyms: GWP-tot = Global Warming Potential total; **GWP-fos** = Global Warming Potential fossil fuels; **GWP-bio** = Global Warming Potential biogenic; **GWP-luc** = Global Warming Potential land use and land use change; **ODP** = Depletion potential of the stratospheric ozone layer; **AP** = Acidification potential, Accumulated Exceedance; **EP-fw** = Eutrophication potential, fraction of nutrients reaching freshwater end compartment; **EP-mar** = Eutrophication potential, fraction of nutrients reaching marine end compartment; **EP-ter** = Eutrophication potential, Accumulated Exceedance; **POCP** = Formation potential of tropospheric ozone; **ADPE** = Abiotic depletion potential for non-fossil resources; **ADPF** = Abiotic depletion for fossil resources potential; **WDP** = Water (user) deprivation potential, deprivation-weighted water consumption.

Use of resources

Indicator	Unit	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
PERE	MJ	1.78E+02	6.09E+00	8.36E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.96E-01	1.42E+00	1.10E+00	3.37E+00	-2.02E+01
PERM	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	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	1.78E+02	6.09E+00	8.36E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.96E-01	1.42E+00	1.10E+00	3.37E+00	-2.02E+01
PENRE	MJ	3.23E+03	4.24E+02	1.68E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.06E+01	5.64E+01	3.31E+01	1.30E+02	-3.41E+02
PENRM	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	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	3.23E+03	4.24E+02	1.68E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.06E+01	5.64E+01	3.31E+01	1.30E+02	-3.41E+02
SM	kg	2.65E+00	0.00E+00	7.96E-02	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	0.00E+00	0.00E+00	0.00E+00
RSF	MJ	4.59E+01	0.00E+00	1.38E+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	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ	3.62E+01	0.00E+00	1.09E+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	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NFW	m3	2.83E+00	9.36E-02	1.31E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.77E-03	1.51E-02	8.77E-03	1.46E-01	-3.69E-01

Acronyms: PERE = Use of renewable primary energy excluding renewable primary energy resources used as raw materials; **PERM** = Use of renewable primary energy resources used as raw materials; **PERT** = Total use of renewable primary energy resources; **PENRE** = Use of non- renewable primary energy excluding non-renewable primary energy resources used as raw materials; **PENRM** = Use of non-renewable primary energy resources used as raw materials; **PENRT** = Total use of non-renewable primary energy re-sources; NFW = Use of net fresh water

Other environmental information describing waste categories

Indicator	Unit	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
HWD	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	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NHWD	kg	0.00E+00	0.00E+00	2.36E+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	0.00E+00	0.00E+00	7.88E+02	0.00E+00
RWD	kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Acronyms: HWD = Hazardous waste disposed; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed

Outputs

Indicator	Unit	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
CRU	kg	4.00E+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	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	kg	1.82E-01	0.00E+00	6.37E+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	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MER	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	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EE	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	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Acronyms: HWD = Hazardous waste disposed; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed

Outputs

Indicator	Unit	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
PM	Disease	2.02E-05	2.26E-06	1.49E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.54E-07	3.30E-07	4.97E-07	8.32E-07	-2.49E-06
IRP2	KBq U235	1.24E+01	2.23E+00	9.17E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.37E-01	3.24E-01	2.08E-01	5.99E-01	-1.36E+00
ETP1	CTUe	3.76E+02	8.95E+01	1.58E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.87E-01	9.90E+00	5.13E-01	2.45E+00	-5.86E+01
HTPC1	CTUh	2.28E-05	1.72E-07	7.65E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.48E-08	4.30E-08	1.92E-08	4.07E-08	-4.57E-06
HTPNC1	CTUh	1.77E-05	4.82E-06	1.01E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.59E-08	5.39E-07	7.96E-08	2.61E-07	-9.41E-06
SQP1	dimensionle	1.77E+03	7.53E+02	9.92E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.01E+00	9.20E+01	8.63E+00	2.42E+02	-1.78E+02

Acronyms: PM = Potential incidence of disease due to pm emissions; **IRP** = Potential human exposure efficiency relative to U235; **ETP** = Potential comparative toxic unit for ecosystems; **HTPC** = Potential comparative toxic unit for humans; **HTPNC** = Potential comparative toxic unit for humans; **SQP** = Potential soil quality index

The electricity used by the manufacturing plant is coming 100% from national network.

Disclaimers:

1. The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experienced with the indicator. The climate impact of this electricity source is 0.70 kg/KWh (GWP-CHG)
2. This impact category deals mainly with the eventual impact of low dose ionizing radiation on human health of the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents, occupational exposure nor due to radioactive waste disposal in underground facilities. Potential ionizing radiation from the soil, from radon and from some construction materials is also not measured by this indicator.
3. Module C is included in the EPD

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

ADDITIONAL ENVIRONMENTAL INFORMATION

This EPD is based on multiple similar concrete precast products. So a check performed between the reported results and the results for the underlying products for modules A1-C. Variations in some impact indicators between products are mainly due to the cement, iron of the products.

Core environmental impact categories

Indicator	Unit	BEAMS U,T,L	Roof girders	Side Beams	Roof purlins
GWP-tot	kg CO2	-17%	23%	-7%	-1%
GWP-GHG	kg CO2	-17%	23%	-7%	-1%
GWP-fos	kg CO2	-17%	23%	-7%	-1%
GWP-bio	kg CO2	-25%	38%	-5%	1%
GWP-luc	kg CO2	-30%	34%	-17%	-9%
ODP	kg	-12%	16%	-6%	-2%
AP	mol H+	-20%	25%	-11%	-9%
EP-fw	kg P eq.	-30%	35%	-17%	-9%
EP-mar	kg N eq.	-26%	32%	-15%	-8%
EP-ter	mol N	-16%	21%	-9%	-3%
POCP	kg	-20%	25%	-11%	-5%
ADPE	kg Sbeq.	-27%	32%	-15%	-8%
ADPF	MJ	-16%	21%	-9%	-3%
WDP	m^3 eq.	-25%	31%	-14%	-7%

Acronyms: GWP-tot = Global Warming Potential total; **GWP-fos** = Global Warming Potential fossil fuels; **GWP-bio** = Global Warming Potential biogenic; **GWP-luc** = Global Warming Potential land use and land use change; **ODP** = Depletion potential of the stratospheric ozone layer; **AP** = Acidification potential, Accumulated Exceedance; **EP-fw** = Eutrophication potential, fraction of nutrients reaching freshwater end compartment; **EP-mar** = Eutrophication potential, fraction of nutrients reaching marine end compartment; **EP-ter** = Eutrophication potential, Accumulated Exceedance; **POCP** = Formation potential of tropospheric ozone; **ADPE** = Abiotic depletion potential for non-fossil resources; **ADPF** = Abiotic depletion for fossil resources potential; **WDP** = Water (user) deprivation potential, deprivation-weighted water consumption

Other environmental information describing waste categories

Indicator	Unit	BEAMS U,T,L	Roof girders	Side Beams	Roof purlins
HWD	kg	0%	0%	0%	0%
NHWD	kg	0%	-1%	-3%	-1%
RWD	kg	0%	0%	0%	0%

Acronyms: HWD = Hazardous waste disposed; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed

Outputs

Indicator	Unit	BEAMS U,T,L	Roof girders	Side Beams	Roof purlins
PM	Disease	-20%	22%	-11%	-5%
IRP	kBq U235	-13%	16%	-7%	-3%
ETP	CTUe	-19%	24%	-11%	-5%
HTPC	CTUh	-31%	36%	-17%	-10%
HTPNC	CTUh	-12%	16%	-6%	-2%
SQP	dimensionless	-11%	17%	-6%	-2%

Outputs

Indicator	Unit	BEAMS U,T,L	Roof girders	Side Beams	Roof purlins
PM	Disease	-20%	22%	-11%	-5%
IRP	kBq U235	-13%	16%	-7%	-3%
ETP	CTUe	-19%	24%	-11%	-5%
HTPC	CTUh	-31%	36%	-17%	-10%
HTPNC	CTUh	-12%	16%	-6%	-2%
SQP	dimensionless	-11%	17%	-6%	-2%

Acronyms: PM = Potential incidence of disease due to pm emissions; IRP = Potential human exposure efficiency relative to U235; ETP = Potential comparative toxic unit for ecosystems; HTPC = Potential comparative toxic unit for humans; HTPNC = Potential comparative toxic unit for humans; SQP = Potential soil quality index

Use of resources

Indicator	Unit	BEAMS U,T,L	Roof girders	Side Beams	Roof purlins
PERE	MJ	-22%	28%	-12%	-6%
PERM	MJ	0%	0%	0%	0%
PERT	MJ	-22%	28%	-12%	-6%
PENRE	MJ	-16%	21%	-9%	-3%
PENRM	MJ	0%	0%	0%	0%
PENRT	MJ	-16%	21%	-9%	-3%
SM	kg	2%	9%	1%	13%
RSF	MJ	3%	9%	1%	13%
NRSF	MJ	2%	9%	1%	13%
NFW	m3	-22%	27%	-12%	-7%

Acronyms: PERE **= Use of renewable primary energy excluding renewable primary energy resources used as raw materials;** PERM **= Use of renewable primary energy resources used as raw materials;** PERT **= Total use of renewable primary energy resources;** PENRE **= Use of non- renewable primary energy excluding non-renewable primary energy resources used as raw materials;** PENRM **= Use of non-renewable primary energy resources used as raw materials;** PENRT **= Total use of non-renewable primary energy re-sources; NFW = Use of net fresh water**

Outputs

Indicator	Unit	BEAMS U,T,L	Roof girders	Side Beams	Roof purlins
CRU	kg	0%	0%	0%	0%
MFR	kg	-1%	4%	-3%	2%
MER	kg	0%	0%	0%	0%
MER	MJ	0%	0%	0%	0%

Acronyms: **HWD = Hazardous waste disposed; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed**

The electricity used by the manufacturing plant is coming 100% from national network. The climate impact of this electricity source is 0.70 kg/KWh (GWP-CHG).

Disclaimers:

The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experienced with the indicator.

This impact category deals mainly with the eventual impact of low dose ionizing radiation on human health of the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents, occupational exposure nor due to radioactive waste disposal in underground facilities. Potential ionizing radiation from the soil, from radon and from some construction materials is also not measured by this indicator.

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

ADDITIONAL INFORMATION

Differences versus previous versions

First EPD version – No previous versions

References

- **GPI v.4.0:2021-03-29** General Programme Instructions of the International EPD® System
- **PCR 2019:14 v.1.3.2/2023-12-08** Product Category rules | Construction products | The International EPD® System
- **EN 15804:2012+A2:2019/AC:2021** Sustainability of construction works - Environmental Product Declarations - Core rules for the product category of construction products
- **EN 197-1:2011** Cement - Part 1: Composition, specifications, and conformity criteria for common cements
- **c-PCR-003** Concrete and concrete elements (EN 16757) Version 2024-04-030
- **ISO 14020:2000** Environmental labels and declarations - General principles
- **ISO 14025:2006** Environmental labels and declarations - Type III environmental declarations - Principles and procedures
- **ISO 14040:2006** Environmental management - Life Cycle Assessment - Principles and framework
- **ISO 14044:2006** Environmental management - Life Cycle Assessment - Requirements and guidelines
- **Industry EPD Tool for Cement and Concrete** (https://concrete-epd-tool.org/)
  - User Guide (v4.2, International version, 18 December 2023) (PDF)
  - LCA Model (v4.2, International version, 18 December 2023) (PDF)
  - LCA Database (v4.2, 23 April 2024) (XLSX)
- **DAPEEP SA:** Renewable Energy Sources Operator & Guarantees of Origin | Greece | www.dapeep.gr
- **ELOT EN 206:2013+A2:2021** Concrete – Part 1: Specification, performance, production and conformity
- **Hellenic Concrete Technology Regulation KTS 2016**

CONTACT INFORMATION

EPD owner		4th km Larisa- Sykourio, 41500 Larisa, Greece email: info@armosprokat.gr •www.armosprokat.gr
LCA author		22A Halkidos Str.111 43, Athens, Greece **email:** info@titan.gr • www.titan.gr
Programme operator		Valhallavägen 81, 114 27 Stockholm, Sweden **email:**info@environdec.com •www.environdec.com
Verifier		5, Konitsis Street, Marousi Attica, GR 15125, Greece email: info@bqv.gr www.bqv.gr