ARMOS
CONCRETE PRODUCTS

EPD

Environmental Product Declaration for Ready Mixed Concrete

Σ028 - C25/30, XC2 XC3

Σ014 - C30/37, XC4 XF1 XD1 XA1

Programme The International EPD® System / www.environdec.com
Programme operator: EPD International AB
EPD registration number: S-P-09094
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In accordance with ISO 14025:2006 and EN 15804:2012+A2:2019/AC:2021

EPD® THE INTERNATIONAL EPD® SYSTEM

ECO PLATFORM EPD VERIFIED

BUSINESS QUALITY VERIFICATION BQV

An EPD should provide current information and may be updated if conditions change. The stated validity is therefore subject to the continued registration and publication at www.environdec.com.

EPD of multiple products, based on the average results of the product group.

GENERAL INFORMATION

Programme Operator:	EPD International AB
Address:	EPD International AB Box 210 60 SE-100 31 Stockholm Sweden
Website:	www.environdec.com
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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 1.3.1; 2023-07-08 c-PCR-003 Concrete and concrete elements (EN 16757); Version 2023-01-02
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 characterisation 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.
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Contact: Toulios Georgios, Quality Manager
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Description of the organisation: 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 presents a dedicated company in ready mixed concrete production, serving the wider area of Larisa through its main facility, while the company has also developed significant activities in precast concrete industry for the area of Greece, Cyprus and Balkans through its several production sites.

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 and decrease its environmental impact.

Through its operation consistency and quality excellence, result of its deep know-how, experienced personnel and strict control process, Armos Precast has served the most high-standard ready mixed concrete projects int he area of Larissa and captured a leading position in the local market.

PRODUCT INFORMATION

Product name:
Σ028 - C25/30, XC2 XC3

Σ014 - C30/37, XC4 XF1 XD1 XA1

Product identification:
Compressive Strength 28 days (Mpa): 30 and 37

Product description: Concrete is a material formed by mixing cement, coarse and fine aggregate and water, with or without the incorporation of admixtures and additions. Fresh concrete is manufactured at ready-mix batch plants and is delivered to the construction sites in a liquid state. Fresh concrete is placed, compacted and hardened in the desired shape, via a chemical reaction: the hydration of cement. The cement is the binding agent in concrete: it is a finely ground powder that when hydrated forms a paste that sets, hardens, and adheres to other materials and after hardening retains its strength even underwater. It is used as the main raw material in the production of concrete, mortar, grouts and plasters.

This is an EPD of multiple products, based on a weighted average product, for C25/30, XC2 XC3 and C30/37, XC4 XF1 XD1 XA1 concrete mix designs which complies with the requirements of ELOT EN 206 and the Concrete Technology Regulation KTS 2016. These specific concrete mix designs are produced regionally by ARMOS S.A.

These specific types of concrete have a wide range of applications and are mainly utilized in civil engineering works and in residential and commercial construction.

The product is delivered in bulk with ready-mix trucks.

LCA INFORMATION

Functional unit / declared unit: The declared unit is one (1) cubic meter (m^3).

Production Process: ARMOS S.A. manufactures ready-mixed concrete 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 materials (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.). Once manufactured, the fresh concrete is transported with concrete trucks to the construction sites.

Time representativeness: The data used in this study cover from January 2022 to December 2022.

Database(s) and LCA software used: GCCA Industry EPD Tool for Cement and Concrete and Ecoinvent database (v.3.5).

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 EPD tool (v3.0) is developed by Quantis https://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.3.5) and cement manufacturing data obtained through the GNR process (https://gccassociation.org/sustainability-innovation/gnr-gcca-in-numbers/).

The database of Ecoinvent v.3.5 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 labour 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:

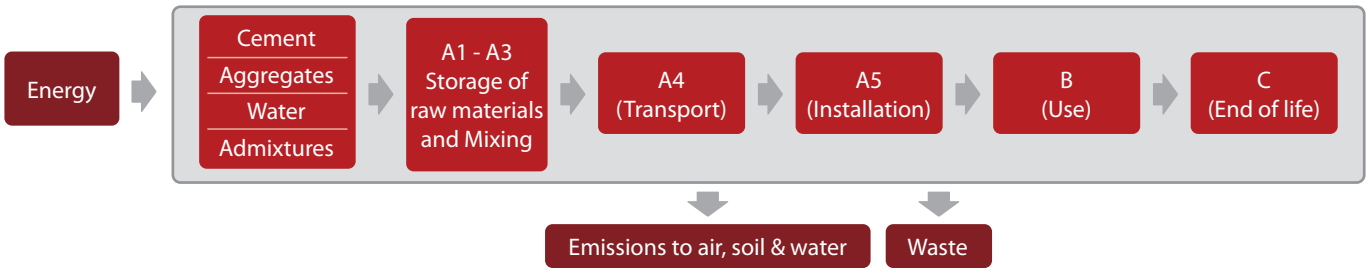
The scope of this study is "Cradle to gate" covering A1-A3.

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)**
Σ028 - C25/30, XC2 XC3	30	2,387
Σ014 - C30/37, XC4 XF1 XD1 XA1	37	2,397

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

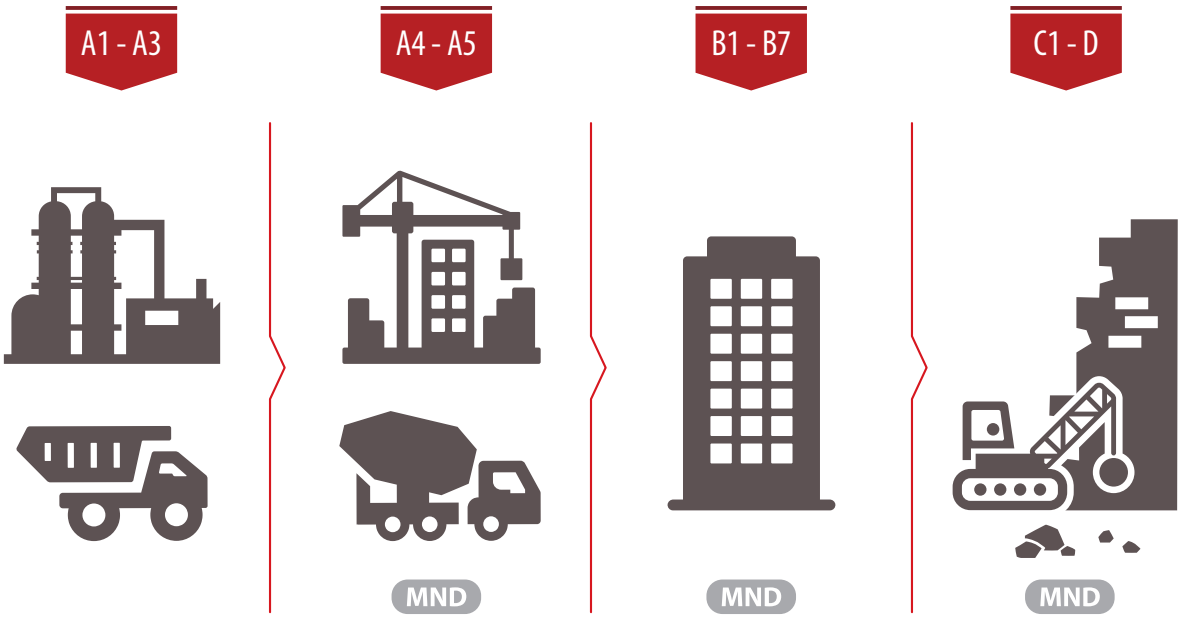


SYSTEM DIAGRAM

The scope of this study is Cradle to gate, A1-A3.

	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	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Geography	GR			-	-	-	-	-	-	-	-	-	-	-	-	-	-
Specific data used	>90%			-	-	-	-	-	-	-	-	-	-	-	-	-	-
Variation – products	<10%			-	-	-	-	-	-	-	-	-	-	-	-	-	-
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 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.

CONTENT INFORMATION

PRODUCT	CONCRETE DENSITY (Kg/m³)	CEMENT (kg)	COARSE AGGREGATE (kg)	FINE AGGREGATE (kg)	WATER (kg)	ADMIXTURES (kg)
Σ028 - C25/30, XC2 XC3	2,387	300	940	970	175	2.2
Σ014 - C30/37, XC4 XF1 XD1 XA1	2,397	330	950	945	169	2.65

ENVIRONMENTAL INFORMATION

The following tables present the overall impact on indicator groups assessed for A1-A3 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 average of the included products for indicators A1-A3.

The EPD is based on multiple, similar products. So, a check performed between the reported result and the results for the underlying products for modules A1-A3. The deviation between the results is within ±10%.

Core environmental impact indicators		
Indicator	**Unit**	**A1-A3**
GWP-tot	kg $CO_{2\ eq.}$	2.15E+02
GWP-GHG	kg $CO_{2\ eq.}$	2.20E+02
GWP-fos	kg $CO_{2\ eq.}$	2.20E+02
GWP-bio	kg $CO_{2\ eq.}$	-5.00E+00
GWP-luc	kg $CO_{2\ eq.}$	4.41E-02
ODP	kg $CFC_{11\ eq.}$	7.60E-06
AP	mol $H+_{\ eq.}$	5.19E-01
EP-fw	kg P eq.	1.38E-02
EP-mar	kg $N_{\ eq.}$	1.08E-03
EP-ter	mol $N_{\ eq.}$	1.69E+00
POCP	kg $NMVOC_{eq.}$	4.46E-01
ADPE[1]	kg Sbeq.	1.66E-04
ADPF[1]	MJ	1.29E+03
WDP[1]	m^3 eq.	9.25E+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**
PERE	MJ	7.11E+01
PERM	MJ	2.35E+01
PERT	MJ	9.47E+01
PENRE	MJ	1.29E+03
PENRM	MJ	1.48E+00
PENRT	MJ	1.29E+03
SM	kg	1.84E+01
RSF	MJ	7.69E+01
NRSF	MJ	6.06E+01
NFW	m^3	2.24E+00

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**
HWD	kg	0.00E+00
NHWD	kg	0.00E+00
RWD	kg	0.00E+00

Acronyms

HWD = Hazardous waste disposed; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposedQuontimi licereb efachui deffres halat, derei ipsenis cuperi

Outputs		
Indicator	**Unit**	**A1-A3**
CRU	kg	0.00E+00
MFR	kg	3.16E-01
MER	kg	0.00E+00
EE	MJ	0.00E+00

Acronyms

CRU = Components for re-use); **MR** = Materials for recycling; **MER** = Materials for energy recovery; **EE** = Exported energy

Additional environmental impact indicators		
Indicator	**Unit**	**A1-A3**
PM	Disease incidence	5.57E-06
IRP[2]	kBq U235 eq.	4.94E+03
ETP[1]	CTUe	5.00E+01
HTPC[1]	CTUh	6.27E-07
HTPNC[1]	CTUh	8.57E-06
SQP[1]	dimensionless	1.31E+03

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. The climate impact of this electricity source is 0.70 kg CO_2 eq./kWh (GWP-GHG).

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.

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.

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.1.3.1** 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
- **c-PCR-003** Concrete and concrete elements (EN 16757) Version 2023-01-02
- **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 (v4.0, International version, 28 April 2023)
  - LCA Model (v4.0, International version, 28 April 2023)
  - LCA Database (v4.0, 28 April 2023)
- **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**

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