

Environmental Product Declaration



Environmental Product Declaration for ready mix concrete products produced by Holcim Nicaragua at their KM14 facility in Managua, Nicaragua

ADMINISTRATIVE INFORMATION

International Certified Environmental Product Declaration

Declared Product:	This Environmental Product Declaration (EPD) covers concrete products produced by Holcim Nicaragua. Declared unit: 1 m ³ of concrete
Declaration Owner:	Holcim Nicaragua
	km 34.5 Carretera Nueva a Leon-Nagarote-Leon
	Nagarote, Nicaragua
	www.holcim.com.ni
Program Operator:	Labeling Sustainability
	Address, 11670 W Sunset Blvd.
	City, State, Los Angeles, CA
	www.labelingsustainability.com/
Product Category Rule:	Core PCR: ISO 21930:2017 Sustainability in buildings and civil engineering works – Core rules for environmental product declarations of construction products and services SubPCR: NSF International (March 2020). Product Category Rule (PCR) for Environmental Product Declarations (EPD) PCR for Concrete, v2.1
	Sub PCR Program Operator: NSF International
	Sub-category PCR review was conducted by: Thomas P. Gloria, Ph. D. of Industrial Ecology Consultants: 35 Bracebridge Rd., Newton, MA 02459-1728, t.gloria@industrial-ecology.com. Dr. Michael Overcash of Environmental Clarity: 2908 Chipmunk Lane, Raleigh, NC 27607-3117, mrovercash@earthlink.net. Mr. Bill Stough of Sustainable Research Group: PO Box 1684, Grand Rapids, MI 49501-1684, bstough@sustainableresearchgroup.com . Mr. Jack Geilbig, EcoForm: 2624 Abelia Way, Suite 611, Knoxville, TN 37931, jgeilbig@ecoform.com .
Independent LCA Reviewer and EPD Verifier:	This EPD was independently verified in accordance with ISO 14025 and ISO 21930. The life cycle assessment was independently reviewed in accordance ISO 14044 and the referenced PCR.
	Independent verification of the declaration, according to ISO 14025:2006
	Internal <input type="checkbox"/> ; External X
	Third Party Verifier Geoffrey Guest, Certified 3rd Party Verifier under the International EPD Program (www.environdec.com), CSA Group (www.csaregistry.ca)
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COMPANY DESCRIPTION

Holcim (Nicaragua) SA was born in 1997 as a result of the union of a group of distinguished Nicaraguan investors and Holcim Ltd. The Company is part of the Holcim Group, formerly the LafargeHolcim Group, created in July 2015, as a result of the merger of Holcim and Lafarge.

Holcim Nicaragua is a member of the international group of the same name, leader in the construction materials industry, operating in Nicaragua for 23 years, producing cement, concrete, aggregates and solutions for the construction market. The company offer different types of cement solutions with special qualities: Holcim Fuerte EcoPlanet, Holcim Industrial and Holcim Superbloque, our leading Fuerte EcoPlanet cement has ECO Labels that guarantee a cement with 35% less CO₂ emissions per ton.

Currently, Holcim (Nicaragua) SA, with a cement production capacity of more than 400,000 tons per year, occupies a preferential place among consumers, an achievement obtained from product quality, technical support and excellence in customer service. The company has a cement grinding plant in Nagarote, a fixed concrete plant in Managua, mobile concrete equipment in Chinandega, and an aggregates plant in Cofradía. It has Disensa, the largest hardware network in the country, generating value for the owners of more than 78 points of sale and their clients with a presence in 14 departments and two autonomous regions of Nicaragua.

STUDY GOAL

The intended application of this life cycle assessment (LCA) is to comply with the procedures for creating a Type III environmental product declaration (EPD) and publish the EPD for public review on the website, <http://labelingsustainability.com/>. This level of study is in accordance with EPD Product Category Rule (PCR) for Ready Mix Concrete published by NSF International (2019) and is a sub-PCR of International Standards Organization (ISO) 21930:2017 Sustainability in buildings and civil works - Core rules for EPDs of construction products and services; International Standards Organization (ISO) 14025:2006 Environmental labels and declarations, Type III environmental declarations-Principles and procedures; ISO 14044:2006 Environmental management, Life cycle assessment- Requirements and guidelines; and ISO 14040:2006 Environmental management, Life cycle assessment-Principles and framework. The performance of this study and its subsequent publishing is in alignment with the business-to-business (B2B) communication requirements for the environmental assessment of building products. The study does not intend to support comparative assertions and is intended to be disclosed to the public.

This project report was commissioned to differentiate Holcim Nicaragua from their competition for the following reasons: generate an advantage for the organization; offer customers information to help them make informed product decisions; improve the environmental performance of Holcim Nicaragua by continuously measuring, controlling and reducing the environmental impacts of their products; help project facilitators working on Leadership in Energy and Environmental Design (LEED) projects achieve their credit goal; and to strengthen Holcim Nicaragua's license to operate in the community. The intended audience for this LCA report is Holcim Nicaragua's employees, their suppliers, project specifiers of their products, architects, and engineers. The EPD report is also available for policy makers, government officials interested in sustainability, academic professors, and LCA professionals. This LCA report does not include product comparisons from other facilities.



DESCRIPTION OF PRODUCT AND SCOPE

This EPD reports on 29 concrete mixes manufactured at the KM14 Holcim Nicaragua concrete facility in Managua, Nicaragua.

This LCA assumes the impacts from products manufactured in accordance with the standards outlined in this report. This LCA is a cradle-to-gate study, and therefore, stages extending beyond the plant gate are not included in this LCA. Excluded stages include transportation of the manufactured material to the construction site; on-site construction processes and components; building (infrastructure) use and maintenance; and "end-of-life" effects.

READY MIX CONCRETE DESIGN SUMMARY

The following tables provide a list of the cement products considered in this EPD along with key performance parameters.

All Declared Products:

Table 1: Declared products with Mix designs: 0 to 15MPa considered in this environmental product declaration

Mix#	Unique name/ID	Short description	Product type	28 day strength, MPa	H ₂ O to cement ratio
1	M36-L68D28	0.980665 MPa 28d strength ready mix concrete.	Ready Mix	0.980665	3.9062500
2	A32-M46B03	3.530394 MPa 28d strength ready mix concrete.	Ready Mix	3.530394	0.7115385
3	F18-M46B28	4.118793 MPa 28d strength ready mix concrete.	Ready Mix	4.118793	0.6153846
4	F21-M46B28	4.118793 MPa 28d strength ready mix concrete.	Ready Mix	4.118793	0.5555556
5	F21-M44B28	4.707192 MPa 28d strength ready mix concrete.	Ready Mix	4.707192	0.4505495
6	F24-M46B28	17.65197 MPa 28d strength ready mix concrete.	Ready Mix	17.65197	0.7121212
7	F28-M46B28	20.59397 MPa 28d strength ready mix concrete.	Ready Mix	20.59397	0.6785714
8	F28-M44B28	20.59397 MPa 28d strength ready mix concrete.	Ready Mix	20.59397	0.7388316
9	F32-M46B28	20.59397 MPa 28d strength ready mix concrete.	Ready Mix	20.59397	0.6792453
10	F35-M46B28	20.59397 MPa 28d strength ready mix concrete.	Ready Mix	20.59397	0.7377049
11	F21-L46D28	20.59397 MPa 28d strength ready mix concrete.	Ready Mix	20.59397	0.5757576
12	F21-H44B28	20.59397 MPa 28d strength ready mix concrete.	Ready Mix	20.59397	0.6964286
13	A21-M46B07	20.59397 MPa 28d strength ready mix concrete.	Ready Mix	20.59397	0.4931507
14	A28-M46B07	20.59397 MPa 28d strength ready mix concrete.	Ready Mix	20.59397	0.6229508



15	A24-M46B03	23.53596 MPa 28d strength ready mix concrete.	Ready Mix	23.53596	0.6400000
16	F35-H46B28	23.53596 MPa 28d strength ready mix concrete.	Ready Mix	23.53596	0.4800000
17	A28-M46B03	23.53596 MPa 28d strength ready mix concrete.	Ready Mix	23.53596	0.6551724
18	F05-H44B28	27.45862 MPa 28d strength ready mix concrete.	Ready Mix	27.45862	0.6158730
19	L24-M68B28	27.45862 MPa 28d strength ready mix concrete.	Ready Mix	27.45862	0.6517857
20	l28-M46B28	27.45862 MPa 28d strength ready mix concrete.	Ready Mix	27.45862	0.5315068
21	F21-M88D28	27.45862 MPa 28d strength ready mix concrete.	Ready Mix	27.45862	0.4674699
22	AC35-M46B07	27.45862 MPa 28d strength ready mix concrete.	Ready Mix	27.45862	0.6000000
23	A28-M44B03	27.45862 MPa 28d strength ready mix concrete.	Ready Mix	27.45862	0.5022936
24	A21-L46D03	27.45862 MPa 28d strength ready mix concrete.	Ready Mix	27.45862	0.5705882
25	A21-M46B14	31.38128 MPa 28d strength ready mix concrete.	Ready Mix	31.38128	0.4558140
26	A28-M46B14	31.38128 MPa 28d strength ready mix concrete.	Ready Mix	31.38128	0.5939394
27	M42-L68D28	34.32328 MPa 28d strength ready mix concrete.	Ready Mix	34.32328	0.5823529
28	M42-L68D07	34.32328 MPa 28d strength ready mix concrete.	Ready Mix	34.32328	0.5826331
29	M48-M68D03	34.32328 MPa 28d strength ready mix concrete.	Ready Mix	34.32328	0.5263158

READY MIX CONCRETE DESIGN COMPOSITION

The following figures provide mass breakdown (kg per functional unit) of the material composition of each ready mix concrete design considered. Please note that the presented breakdown has been randomly altered by +/-10%, and is therefore only an approximation; this manipulation is to ensure confidentiality.

Table 2: Ready mix concrete composition

Product Components	Raw Material, weight%
Cement	Proprietary
Aggregates	30-60.00
Others	0.01-5.00
Total	100.00



A1 RAW MATERIAL RECYCLED CONTENT AND MATERIAL LOSSES –

The following table provides a list of the raw material inputs (module A1) across all products considered, their recyclability content and assumed material losses.

Table 3: **Module A1 raw material inputs, the recyclability content and assumed material losses (dry basis)**

product.name	mix.category	primary.content	post.industrial.content	post.consumer.content	material.losses
Cement HE Nicaragua	cement, unspecified	1	0	0	0
Water	tap water	1	0	0	0.05
Gravel	gravel, crushed	1	0	0	0.05
River sand	sand	1	0	0	0.05
Additives	chemical, organic	1	0	0	0.05

SYSTEM BOUNDARIES

The following figure depicts the cradle-to-gate system boundary considered in this study:

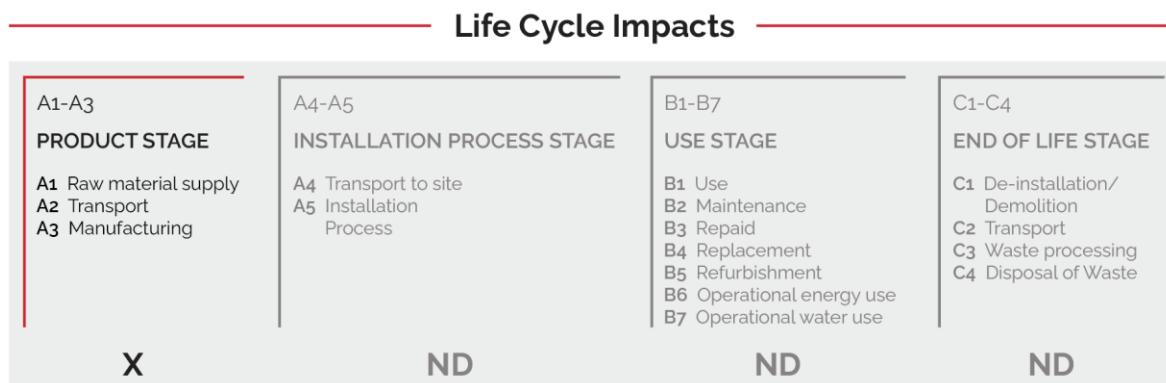


Figure 1: **General life cycle phases for consideration in a construction works system**

This is a Cradle-to-gate life cycle assessment and the following life cycle stages are included in the study:

- A1: Raw material supply (upstream processes) - Extraction, handling, and processing of the materials used in manufacturing the declared products in this LCA.
- A2: Transportation - Transportation of A1 materials from the supplier to the “gate” of the manufacturing facility (i.e. A3).
- A3: Manufacturing (core processes)- The energy and other utility inputs used to store, move, and manufacturer the declared products and to operate the facility.

As according to the PCR, the following figure illustrates the general activities and input requirements for producing cement products and is not necessarily exhaustive.



System Boundary

Raw Material Supply (A1)	Transport (A2)	Manufacturing (A3)
Cements & SCMs Aggregates Admixtures Batch Water Fibers & Pigments	Truck, Rail, Ship Energy Carriers (fuels)	Energy Carriers (electricity and fuels) Ancillary Materials (lubricants, motor oil, cleaning chemicals, other consumables) Water (manufacturing water, including wash water for cement trucks, but excluding batch water) Waste (end of life treatment of ancillary materials and any packaging) 30% total fleet energy transit mix plants only

Figure 2: General system inputs considered in the product system and categorized by modules in scope

In addition, as according to the relevant PCR, the following requirements are excluded from this study:

- Production, manufacture, and construction of A3 building/capital goods and infrastructure.
- Production and manufacture of steel production equipment, steel delivery vehicles, earth-moving equipment, and laboratory equipment.
- Personnel-related activities (travel, furniture, office supplies).
- Energy use related to company management and sales activities.

For this LCA the manufacturing plant, owned and operated by Holcim Nicaragua, is located at their KM14 facility in Nicaragua. All operating data is formulated using the actual data from Holcim Nicaragua's plant at the above location, including water, energy consumption and waste generation. All inputs for this system boundary are calculated for the plant.

This life cycle inventory was organized in a spreadsheet and was then input into an RStudio environment where pre-calculated LCIA results for relevant products/activities stemming from the ecoinvent v3.8 database and a local EPD database in combination with primary data from Holcim Nicaragua were utilized. Explanations of the contribution of each data source to this study are outlined in the section 'Data Sources and Quality'. Further LCI details for each declared product are provided in the sections 'Detailed LCI tables' and 'Transport tables' of the detailed LCA report. A parameter uncertainty analysis was also performed where key statistical results (e.g. min/mean/max etc.) are provided in the detailed LCA report.

CUT-OFF CRITERIA

ISO 14044:2006 and the focus PCR requires the LCA model to contain a minimum of 95% of the total inflows (mass and energy) to the upstream and core modules be included in this study. The cut-off criteria were applied to all other processes unless otherwise noted above as follows. A 1% cut-off is considered for all renewable and non-renewable primary energy consumption and the total mass of inputs within a unit process where the total of the neglected inputs does not exceed 5%.

DATA SOURCES AND DATA QUALITY ASSESSMENT

The following table summarizes the facility's (i.e. A3) electricity consumption and on-site generation or off-site contractual procurement (if applicable), process/space heating requirements, fuel inputs for on-site machinery, and waste generation.



Table 4: Inputs required by facility from 2022-06-01 to 2023-05-31 (364 days) to produce 32827.2 m3 of concrete

Activity	Value	Units
Electricity consumption and on-site generation or off-site contractual procurement (if applicable)		
Gross grid electricity:	134565	kWh
Fuel requirements for machinery		
Diesel	10099.2	L
Waste generation		
Wash water	1484.7	m3
Hazardous waste	2400	kg
Non-hazardous waste	6000	kg
High-level radioactive waste	0	kg

No recovered on-site energy occurs at this facility.

Table 5: Reused or recycled components/materials at the A3 facility site

Component/material for re-use/recycling	Value	Units	Re-used/recycled on-site or off-site
Returned concrete	10	m3	NA

The following statements explain how the above facility requirements/generation were derived:

Raw material transport: A combination of actual mode/distance combinations were assumed for key bulk materials whereas ecoinvent default multi-modal market mix distances were assumed for other inputs where no original data could be provided.

Electricity: No grid electricity is consumed at this plant. A diesel powered generator is deployed at site to meet the electricity requirements of the plant.

Process/space heating: No fuel is used for space Heating at this plant.

Fuel required for machinery: Machinery-related fuel requirements were determined from direct Holcim information. The types of machinery used include generators, pumps to pump concrete to higher elevations, and transportation equipment used for moving materials. This plant does not have electricity therefore it uses diesel to power generators.

Waste generation: Waste generation values are directly reported from Holcim operations for bulk waste. No hazardous or high-level radioactive waste is generated on-site at this facility. Wash water for trucks was also primary reported data for 2022.

Recovered energy: Not applicable.

Recycled/reused material/components: The amount of returned concrete is based on Holcim primary data for the reference year, 2022.

Module A1 material losses: Due to lack of data, default loss factors of 5% were assumed. The PCR states " A3 shall include an assumption of 5% material loss unless product specific data is available and transparently reported in the project LCA report underlying the EPD;"



Direct A3 emissions accounting: Direct emissions for the on-site machinery use the actual fuel consumption and the ecoinvent database to calculate those emissions..

Waste transport requirements: Transportation distances are using estimated values. The waste hauler cannot guarantee the exact distances traveled due to the variation of route and actual location of disposal. Most waste disposal sites are near the plant therefore the 25 km distance is a representative estimate. Returned concrete and wash water, measured in kilograms, is based on direct Holcim reporting for the reference year 2022.

Product transport requirements: The diesel fuel used by the mixing trucks is direct primary information reported from Holcim Nicaragua records for the year 2022. Holcim records their fuel for their trucks in l/km and therefore the information was converted with the following formula: (Ave. km to site)* 2 for return L diesel/km /(ave. m3 of concrete in a load) total concrete volume in m3 * fraction allocated to A3. A4 is outside the scope of this study.

The following tables depict a list of assumed life cycle inventory utilized in the LCA modeling to generate the impact results across the life cycle modules in scope. An assessment of the quality of each LCI activities utilized from various sources is also provided.

Table 6: LCI inputs assumed for module A1 (i.e. raw material supply) **Data Quality Assessment Key Fair=1, Good=2, Very Good =3.**

Input	LCI.activity	Data.source	Geo	Year	Technology	Time	Geography	Reliability	Completeness
Water	tap water production, conventional with biological treatment/tap water/RoW/kg	ecoinvent v3.8	NA	v3.8 in 2021	2	3	2	3	3
Gravel	limestone quarry operation/limestone, unprocessed/RoW/kg	ecoinvent v3.8	Masaya	v3.8 in 2021	2	3	2	3	3
Additives	market for chemical, organic/chemical, organic/GLO/kg	ecoinvent v3.8	Managua	v3.8 in 2021	2	3	2	3	3
River Sand	sand quarry operation, extraction from river bed/sand/BR/kg	ecoinvent v3.8	Masaya	v3.8 in 2021	2	3	2	3	3
Cement HE Nicaragua	HE Cement	Progam Operator: Labeling Sustainability-EPD ID: 2efc7137-757b-4167-b0c7-96b45c849615	León	15 June 2023	3	3	3	3	3



Table 7: LCI inputs assumed for module A2 (i.e. transport of A1 inputs)

Input	LCI.activity	Data.source	Geo	Year	Technology	Time	Geography	Reliability	Completeness
Additives- freight transport via Truck	market for transport, freight, lorry 7.5-16 metric ton, EURO6/transport, freight, lorry 7.5-16 metric ton, EURO6/RoW/tkm	ecoinvent v3.8	RoW	v3.8 in 2021	2	3	1	3	3
Cement HE Nicragua- freight transport via Truck	market for transport, freight, lorry 16-32 metric ton, EURO6/transport, freight, lorry 16-32 metric ton, EURO6/RoW/tkm	ecoinvent v3.8	RoW	v3.8 in 2021	2	3	1	3	3
Gravel- freight transport via Truck	market for transport, freight, lorry 7.5-16 metric ton, EURO6/transport, freight, lorry 7.5-16 metric ton, EURO6/RoW/tkm	ecoinvent v3.8	RoW	v3.8 in 2021	2	3	1	3	3
River Sand- freight transport via Truck	market for transport, freight, lorry 16-32 metric ton, EURO6/transport, freight, lorry 16-32 metric ton, EURO6/RoW/tkm	ecoinvent v3.8	RoW	v3.8 in 2021	2	3	1	3	3

Table 8: LCI inputs assumed for module A3

Input	LCI.activity	Data.source	Geo	Year	Technology	Time	Geography	Reliability	Completeness
Diesel	diesel, burned in building machine/diesel, burned in building machine/GLO/MJ	ecoinvent v3.8	GLO	v3.8 in 2021	1	3	1	3	3
Diesel used for mixing trucks	transport, freight, lorry 7.5-16 metric ton, EURO6/transport, freight, lorry 7.5-16	ecoinvent v3.8	RoW	v3.8 in 2021	2	3	2	3	3



	metric ton, EURO6/RoW/tkm								
Grid electricity	market for electricity, medium voltage/electricity, medium voltage/SV/kWh	ecoinvent v3.8	SV	v3.8 in 2021	2	3	2	3	3
Hazardous waste	treatment of hazardous waste, hazardous waste incineration/hazardous waste, for incineration/RoW/kg	ecoinvent v3.8	RoW	v3.8 in 2021	2	3	1	3	3
Non-hazardous waste	treatment of municipal solid waste, sanitary landfill/municipal solid waste/RoW/kg	ecoinvent v3.8	RoW	v3.8 in 2021	1	3	1	3	3
Transport of Hazardous waste	transport, freight, lorry, all sizes, EURO4 to generic market for transport, freight, lorry, unspecified/transport, freight, lorry, unspecified/RoW/tkm	ecoinvent v3.8	RoW	v3.8 in 2021	2	3	1	3	3k
Transport of Non-hazardous waste	transport, freight, lorry, all sizes, EURO5 to generic market for transport, freight, lorry, unspecified/transport, freight, lorry, unspecified/RoW/tkm	ecoinvent v3.8	RoW	v3.8 in 2021	2	3	1	3	3
Transport of Returned concrete	transport, freight, lorry >32 metric ton, EURO6/transport, freight, lorry >32 metric ton, EURO6/RoW/tkm	ecoinvent v3.8	RoW	v3.8 in 2021	2	3	1	3	3
Transport of Wash water	transport, freight, lorry >32 metric ton, EURO6/transport, freight, lorry >32 metric ton, EURO6/RoW/tkm	ecoinvent v3.8	RoW	v3.8 in 2021	2	3	1	3	3
Wash water	tap water production, conventional with biological treatment/tap water/RoW/kg	ecoinvent v3.8	RoW	v3.8 in 2021	2	3	1	3	3



DATA QUALITY ASSESSMENT

Data quality/variability requirements, as specified in the PCR, are applied. This section describes the achieved data quality relative to the ISO 14044:2006 requirements. Data quality is judged based on its precision (measured, calculated, or estimated), completeness (e.g., unreported emissions), consistency (degree of uniformity of the methodology applied within a study serving as a data source) and representativeness (geographical, temporal, and technological).

Precision: Through measurement and calculation, the manufacturers collected and provided primary data on their annual production. For accuracy, the LCA practitioner and 3rd Party Verifier validated the plant gate-to-gate data.

Completeness: All relevant specific processes, including inputs (raw materials, energy, and ancillary materials) and outputs (emissions and production volume) were considered and modeled to represent the specified and declared products. The majority of relevant background materials and processes were taken from ecoinvent v3.8 LCI datasets where relatively recent region-specific electricity inputs were utilized. The most relevant EPDs requiring key A1 inputs were also utilized where readily available.

Consistency: To ensure consistency, the same modeling structure across the respective product systems was utilized for all inputs, which consisted of raw material inputs and ancillary material, energy flows, water resource inputs, product, and co-products outputs, returned and recovered Cement materials, emissions to air, water and soil, and waste recycling and treatment. The same background LCI datasets from the ecoinvent v3.8 database were used across all product systems. Crosschecks concerning the plausibility of mass and energy flows were continuously conducted. The LCA team conducted mass and energy balances at the plant and selected process level to maintain a high level of consistency.

Reproducibility: Internal reproducibility is possible since the data and the models are stored and available in a machine readable project file for all foreground and background processes, and in Labeling Sustainability's proprietary Ready Mix Concrete LCA calculator* for all production facility and product-specific calculations. A considerable level of transparency is provided throughout the detailed LCA report as the specifications and material quantity make-up for the declared products are presented and key primary and secondary LCI data sources are summarized. The provision of more detailed publicly accessible data to allow full external reproducibility was not possible due to reasons of confidentiality.

*Labeling Sustainability has developed a proprietary tool that allows the calculation of PCR-compliant LCA results for Ready Mix Concrete product designs. The tool auto-calculates results by scaling base-unit technosphere inputs (i.e. 1 kg sand, 1 kWh electricity, etc.) to replicate the reference flow conversions that take place in any typical LCA software like openLCA or SimaPro. The tool was tested against several LCAs performed in openLCA and the tool generated identical results to those realized in openLCA across every impact category and inventory metric (where comparisons could be readily made).

Representativeness: The representativeness of the data is summarized as follows.

- Time related coverage of the manufacturing processes' primary collected data from 2022-06-01 to 2023-05-31.



- Upstream (background) LCI data was either the PCR specified default (if applicable) or more appropriate LCI datasets as found in the country-adjusted ecoinvent v3.8 database.
- Geographical coverage for inputs required by the A3 facility(ies) is representative of its region of focus; other upstream and background processes are based on US, North American, or global average data and adjusted to regional electricity mixes when relevant.
- Technological coverage is typical or average and specific to the participating facilities for all primary data.

ENVIRONMENTAL INDICATORS AND INVENTORY METRICS

Per the PCR, this EPD supports the life cycle impact assessment indicators and inventory metrics as listed in the tables below. As specified in the PCR, the most recent US EPA Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI), impact categories were utilized as they provide a North American context for the mandatory category indicators to be included in the EPD. Additionally, the PCR requires a set of inventory metrics to be reported with the LCIA indicators (see tables below).

Table g: Life cycle impact categories and life cycle inventory metrics

ID	LCIA.indicators	Abbreviations	Units
1	environmental impact: acidification	AP	moles of H ⁺ -Eq
2	environmental impact: eutrophication	EP	kg N
3	environmental impact: global warming	GWP	kg CO ₂ -Eq
4	environmental impact: ozone depletion	ODP	kg CFC-11-Eq
5	environmental impact: photochemical oxidation	PCOP	kg NO _x -Eq
6	material resources: metals/minerals: abiotic depletion potential (ADP): elements (ultimate reserves)	ADPe	kg Sb-Eq
7	energy resources: non-renewable: abiotic depletion potential (ADP): fossil fuels	ADPf	MJ, net calorific value
Inventory metrics			
8	Total primary energy	TPE	MJ-Eq
9	Renewable energy	RE	MJ-Eq
10	Non-renewable energy	NRE	MJ-Eq
11	Non-Renewable Resources	NRR	kg
12	Renewable Resources	RR	m ³
13	water depletion: WDP	WDP	m ³
14	land filling: bulk waste	LFW	kg waste
15	land filling: hazardous waste	LFHW	kg waste
16	Concrete batching water consumption	CBWC	m ³
17	Concrete washing water consumption	CW/WC	m ³
18	Concrete hazardous waste	CHW	kg
19	Concrete non-hazardous waste	CNHW	kg

A summary description of each of the impact categories and inventory metrics is provided in the following table:



Table 10: Definitions of life cycle impact categories and life cycle inventory metrics

Midpoint impact categories	
Global Warming Potential (GWP) (units: kg CO₂-eq)	Global Warming Potential or climate change can be defined as the change in global temperature caused by the greenhouse effect that the release of greenhouse gases by human activity creates. The Environmental Profiles characterization model is based on factors developed by the United Nations Intergovernmental Panel on Climate Change (IPCC). Factors are expressed as Global Warming Potential over the time horizon of different years, being the most common 100 years (GWP ₁₀₀), measured in the reference unit, kg CO ₂ equivalent.
Ozone Depletion Potential (ODP) (kg CFC-11-eq)	Ozone-depleting gases cause damage to stratospheric ozone or the ozone layer. CFCs, halons and HCFCs are the major causes of ozone depletion. The characterization model has been developed by the World Meteorological Organization (WMO) and defines the ozone depletion potential of different gases relative to the reference substance chlorofluorocarbon-11 (CFC-11), expressed in kg CFC-11 equivalent.
Acidification Potential (AP) (kg SO₂-eq)	Acidic gases such as Sulphur dioxide (SO ₂) react with water in the atmosphere to form acid rain, a process known as acid deposition. Acidification potential is expressed using the reference unit, kg SO ₂ equivalent. The model does not take account of regional differences in terms of which areas are more or less susceptible to acidification. It accounts only for acidification caused by SO ₂ and NO _x . This includes acidification due to fertilizer use, according to the method developed by the Intergovernmental Panel on Climate Change (IPCC). CML has based the characterization factor on the RAINS model developed by the University of Amsterdam.
Eutrophication Potential (EP) (PO₄ 3- -eq)	Eutrophication is the build-up of a concentration of chemical nutrients in an ecosystem which leads to abnormal productivity. This causes excessive plant growth like algae in rivers which causes severe reductions in water quality and animal populations. This category is based on the work of Heijungs, and is expressed using the reference unit, kg PO ₄ 3- equivalents. Direct and indirect impacts of fertilizers are included in the method. The direct impacts are from production of the fertilizers and the indirect ones are calculated using the IPCC method to estimate emissions to water causing eutrophication.
Photochemical Ozone Creation/Smog Potential (POCP) (kg O₃-eq)	Ozone is protective in the stratosphere, but on the ground-level, it is toxic to humans in high concentration. Photochemical ozone, also called ground-level ozone, is formed by the reaction of volatile organic compounds and nitrogen oxides in the presence of heat and sunlight. The impact category depends largely on the amounts of carbon monoxide (CO), Sulphur dioxide (SO ₂), nitrogen oxide (NO), ammonium and NMVOC (non-methane volatile organic compounds). Photochemical ozone creation potential (also known as summer smog) for emission of substances to air is calculated with the United Nations Economic Commission for 22 Europe (UNECE) trajectory model (including fate) and expressed using the reference unit, kg ethylene (C ₂ H ₄) equivalent.
Abiotic Depletion Potential (ADPeI and ADPff) (kg Sb-eq)	The main concern of this category is the health of humans and the ecosystem and how it is affected by the extraction of minerals and fossil fuels, which are inputs into the system. For each extraction of minerals and fossil fuels, the abiotic depletion factor is determined. This indicator is on a global scale and is based on the concentration reserves and rate of deaccumulation. The results are presented in units of the reference



	element strontium (i.e. Sb). For the purposes of this EPD, this impact category is split between mineral elements (i.e. ADPeI) and fossil fuels (i.e. ADPff).
Inventory metrics	
Depletion of non-renewable material resources (NRM) (kg)	This indicator covers the cumulative life cycle consumption of non-renewable resources that are extracted from the ground but not including energy resources like coal, oil and natural gas. This indicator includes the consumption of metallic ores, aggregates, and other minerals. The units of measure are in terms of kilograms material extracted and utilized/wasted in the life cycle system considered.
Use of renewable material resources (RM) (kg)	This indicator covers the cumulative life cycle consumption of renewable resources that are extracted from nature like sustainably harvested biomass. The units of measure are in terms of kilograms material extracted and utilized/wasted in the life cycle system considered.
Depletion of non-renewable energy resources (NRE) (MJ HHV)	This indicator considers the cumulative life cycle consumption of non-renewable energy resources like oil, natural gas, and coal. The units of measure are in terms of Mega-Joules of energy resource extracted and utilized/wasted in the life cycle system considered.
Use of renewable primary energy (RE) (MJ HHV)	This indicator considers the cumulative life cycle extraction of renewable energy resources from nature like solar and wind energy as well as biomass for energy purposes. The units of measure are in terms of Mega-Joules of energy resource extracted and utilized/wasted in the life cycle system considered.
Total primary energy consumption (PEC) (MJ HHV)	This indicator is the summation of non-renewable and renewable energy extracted from nature, where the units of measure are in terms of Mega-Joules of energy resource extracted/used/wasted in the life cycle system considered.
Water Depletion Potential (WDP) (m3)	This indicator considers the cumulative life cycle consumption of water required to produce the declared functional unit of a given product. The units of measure are in cubic meters of water consumed.
Concrete batching water consumption (CBWC) (m3)	This indicator is defined as the direct water used in concrete mix batches. The units of measure are in cubic meters of water consumed.
Concrete washing water consumption (CWWC) (m3)	This indicator is defined as the direct washing water used at the facility. The units of measure are in cubic meters of wash water consumed.
Concrete hazardous waste (CHW) (kg)	This indicator considers the amount of hazardous waste generated at the concrete facility. The units of measure are in kilograms of waste generated.
Concrete non-hazardous waste (CNHW) (kg)	This indicator considers the direct amount of non-hazardous waste generated at the concrete facility. The units of measure are in kilograms of waste generated.

It should be noted that emerging LCA impact categories and inventory items are still under development and can have high levels of uncertainty that preclude international acceptance pending further development. Use caution when interpreting data in any of the following categories.

- Renewable primary energy resources as energy (fuel);
- Renewable primary resources as material;
- Non-renewable primary resources as energy (fuel);
- Non-renewable primary resources as material;
- Secondary Materials;
- Renewable secondary fuels;



- Non-renewable secondary fuels;
- Recovered energy;
- Abiotic depletion potential for non-fossil mineral resources.
- Land use related impacts, for example on biodiversity and/or soil fertility;
- Toxicological aspects;
- Emissions from land use change [GWP 100 (land-use change)];
- Hazardous waste disposed;
- Non-hazardous waste disposed;
- High-level radioactive waste;
- Intermediate and low-level radioactive waste;
- Components for reuse;
- Materials for recycling;
- Materials for energy recovery;
- Recovered energy exported from the product system.

TOTAL IMPACT SUMMARY

The following table reports the total LCA results for each product produced at the given cement facility on a per 1m³ of concrete basis.

All Declared Products

Table 11: Total life cycle (across modules in scope) impact results for All declared products, assuming the geometric mean point values on a per 1 m³ of concrete basis.

a) Midpoint Impact Categories:

Indicator/LCI Metric	AP	EP	GWP	ODP	PCOP	ADPe	ADPf
Unit	moles of H ⁺ -Eq	kg N	kg CO ₂ -Eq	kg CFC-11-Eq	kg NO _x -Eq	kg Sb-Eq	MJ, net calorific value
Minimum	16.5	0.0233	81	8.20E-06	0.27	0.000327	666
Maximum	37.8	0.068	394	2.02E-05	0.9	0.00172	2120
Mean	38.5	0.0546	293	1.65E-05	0.702	0.00127	1659
Median	38.5	0.055	295	1.66E-05	0.707	0.00128	1670
M36-L68D28	16.5	0.0233	81	8.2e-06	0.27	0.000327	666
A32-M46B03	37.8	0.0467	238	1.43e-05	0.592	0.00103	1400
F18-M46B28	44.5	0.0539	290	1.62e-05	0.693	0.00126	1630
F21-M46B28	48.2	0.0579	318	1.73e-05	0.749	0.00138	1770
F21-M44B28	58.2	0.0688	394	2.02e-05	0.9	0.00172	2120
F24-M46B28	38.5	0.0476	242	1.47e-05	0.604	0.00105	1430
F28-M46B28	40.2	0.0494	255	1.51e-05	0.629	0.0011	1490
F28-M44B28	41.1	0.0502	263	1.53e-05	0.642	0.00114	1520
F32-M46B28	38.7	0.0478	243	1.47e-05	0.607	0.00105	1440
F35-M46B28	42.4	0.0516	274	1.57e-05	0.662	0.00119	1560
F21-L46D28	45.5	0.0552	295	1.67e-05	0.709	0.00128	1670
F21-H44B28	40.1	0.0493	255	1.51e-05	0.628	0.0011	1490
A21-M46B07	49.7	0.0601	325	1.81e-05	0.774	0.00141	1830
A28-M46B07	42.8	0.0523	275	1.59e-05	0.669	0.00119	1580



A24-M46B03	42.3	0.0517	271	1.57e-05	0.66	0.00117	1560
F35-H46B28	52.8	0.0631	351	1.87e-05	0.819	0.00153	1930
A28-M46B03	40.9	0.0499	262	1.51e-05	0.638	0.00114	1500
F05-H44B28	43.8	0.0533	283	1.61e-05	0.683	0.00123	1610
L24-M68B28	46	0.0557	300	1.68e-05	0.717	0.0013	1690
I28-M46B28	49.1	0.0591	323	1.77e-05	0.763	0.0014	1800
F21-M88D28	54.4	0.0648	363	1.92e-05	0.843	0.00158	1990
AC35-M46B07	44.6	0.054	290	1.63e-05	0.695	0.00126	1640
A28-M44B03	56.3	0.0668	379	1.97e-05	0.872	0.00165	2060
A21-L46D03	46.4	0.0562	303	1.69e-05	0.723	0.00131	1710
A21-M46B14	55.9	0.0665	375	1.96e-05	0.867	0.00163	2040
A28-M46B14	45.4	0.055	295	1.66e-05	0.707	0.00128	1670
M42-L68D28	46.4	0.0561	303	1.68e-05	0.722	0.00131	1700
M42-L68D07	48.1	0.0578	316	1.73e-05	0.747	0.00137	1760
M48-M68D03	50.5	0.0605	335	1.8e-05	0.785	0.00145	1850

b) Inventory Metrics:

Indicator/ LCI Metric	TPE	RE	NRE	NR R	RR	WD P	LFW	LFHW	CBW C	CWW C	CH W	CNH W
Unit	MJ- Eq	MJ- Eq	MJ- Eq	kg	m3	m3	kg waste	kg waste	m3	m3	kg	kg
Minimum	738	38.4	695	19.8	0.0004 29	8.59	15.8	0.0012 4	0.189	4.52E -05	0.07 31	0.183
Maximum	2370	153	2220	71.1	0.0019 9	14.8	27.5	0.0021 1	0.262	4.52E -05	0.07 31	0.183
Mean	1852. 34	116. 31	1733. 97	55.0 3	0.0014 87	9.9 6	24.37	0.0018 57	0.20 9	4.52E -05	0.07 31	0.183
Median	1870	117	1750	55.4	0.0015	9.7	24.5	0.0018 6	0.205	4.52E -05	0.07 31	0.183
M36- L68D28	738	38.4	695	19.8	0.0004 29	14.8	15.8	0.0012 4	0.262	4.52e- 05	0.07 31	0.183
A32- M46B03	1560	95.7	1460	45.7	0.00121	10.4	22.3	0.0016 9	0.194	4.52e- 05	0.07 31	0.183
F18- M46B28	1830	115	1710	54.6	0.0014 8	9.0 6	23.9	0.0018 1	0.21	4.52e- 05	0.07 31	0.183
F21- M46B28	1970	125	1840	58.9	0.0016 1	9.05	24.9	0.0019	0.21	4.52e- 05	0.07 31	0.183
F21- M44B28	2370	153	2220	71.1	0.0019 9	8.73	27.5	0.0021 1	0.215	4.52e- 05	0.07 31	0.183
F24- M46B28	1600	97.6	1490	47.1	0.0012 3	10.9	22.9	0.0017 4	0.197	4.52e- 05	0.07 31	0.183
F28- M46B28	1660	102	1560	48.8	0.0012 9	10.4	23.2	0.0017 7	0.2	4.52e- 05	0.07 31	0.183
F28- M44B28	1690	105	1580	50.1	0.0013 5	10.4	23.2	0.0017 7	0.226	4.52e- 05	0.07 31	0.183
F32- M46B28	1600	98.2	1500	47	0.0012 7	10.8	23	0.0017 5	0.189	4.52e- 05	0.07 31	0.183
F35- M46B28	1750	110	1630	51.4	0.0013 9	10.1	23.4	0.0017 8	0.236	4.52e- 05	0.07 31	0.183



F21-L46D28	1870	118	1750	55.5	0.00151	10.2	24.7	0.00188	0.2	4.52e-05	0.0731	0.183
F21-H44B28	1650	102	1560	48.9	0.00131	10.9	23.2	0.00177	0.205	4.52e-05	0.0731	0.183
A21-M46B07	2050	127	1900	60.8	0.00164	10.5	26.5	0.00202	0.189	4.52e-05	0.0731	0.183
A28-M46B07	1770	110	1650	52.3	0.00141	10.3	24	0.00182	0.2	4.52e-05	0.0731	0.183
A24-M46B03	1740	108	1640	51.6	0.00137	10.3	23.8	0.00181	0.202	4.52e-05	0.0731	0.183
F35-H46B28	2160	139	2010	64.6	0.00178	9.27	26.6	0.00203	0.202	4.52e-05	0.0731	0.183
A28-M46B03	1670	105	1570	49.8	0.00132	8.59	22.9	0.00173	0.2	4.52e-05	0.0731	0.183
F05-H44B28	1790	112	1690	53.8	0.00144	9.7	24.1	0.00183	0.204	4.52e-05	0.0731	0.183
L24-M68B28	1890	119	1770	56.1	0.0015	10.2	24.7	0.00189	0.23	4.52e-05	0.0731	0.183
I28-M46B28	2010	128	1880	59.7	0.00162	9.53	25.6	0.00195	0.204	4.52e-05	0.0731	0.183
F21-M88D28	2220	142	2080	66.4	0.00185	9.2	27	0.00206	0.204	4.52e-05	0.0731	0.183
AC35-M46B07	1830	115	1710	54.5	0.0015	10.1	24.1	0.00184	0.205	4.52e-05	0.0731	0.183
A28-M44B03	2300	147	2150	69.1	0.00192	9.16	27.2	0.00208	0.23	4.52e-05	0.0731	0.183
A21-L46D03	1900	120	1790	56.4	0.00155	9.61	24.8	0.00189	0.204	4.52e-05	0.0731	0.183
A21-M46B14	2280	147	2140	69.3	0.00191	8.9	27.3	0.00209	0.206	4.52e-05	0.0731	0.183
A28-M46B14	1870	117	1750	55.4	0.00147	9.63	24.5	0.00186	0.206	4.52e-05	0.0731	0.183
M42-L68D28	1900	120	1780	56.8	0.00151	9.39	24.8	0.00188	0.208	4.52e-05	0.0731	0.183
M42-L68D07	1970	125	1840	58.6	0.00158	9.05	25	0.0019	0.218	4.52e-05	0.0731	0.183
M48-M68D03	2080	132	1940	61.8	0.00168	9.6	25.8	0.00197	0.21	4.52e-05	0.0731	0.183

ADDITIONAL ENVIRONMENTAL INFO

No regulated substances of very high concern are utilized on site.



REFERENCES

ASTM Standards:

- ASTM A36/A36M Standard Specification for Carbon Structural Steel
- ASTM A108 Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished
- ASTM A123/A123M Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
- ASTM A153/A153M Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
- ASTM A184 Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement
- ASTM A307 Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength
- ASTM A416/A416M Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete
- ASTM A555/A555M Standard Specification for General Requirements for Stainless Steel Wire and Wire Rods
- ASTM A615/A615M Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
- ASTM A666 Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar
- ASTM A706/A706M Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement
- ASTM A767/A767M Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement
- ASTM A775/A775M Standard Specification for Epoxy-Coated Steel Reinforcing Bars
- ASTM A820/A820M Standard Specification for Steel Fibers for Fiber-Reinforced Concrete
- ASTM A884/A884M Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement
- ASTM A934/A934M Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars
- ASTM A1064/A1064M Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
- ASTM C33/C33M Standard Specification for Concrete Aggregates
- ASTM C94 Standard Specification for Ready-Mixed Concrete
- ASTM C150/C150M Standard Specification for Portland Cement
- ASTM C260/C260M Standard Specification for Air-Entraining Admixtures for Concrete
- ASTM C595 Standard Specification for Blended Hydraulic Cements
- ASTM C618 Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
- ASTM C979/C979M Standard Specification for Pigments for Integrally Colored Concrete
- ASTM C989/C989M Standard Specification for Slag Cement for Use in Concrete and Mortars



- ASTM C1017/C1017M Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
- ASTM C1116/C1116M Standard Specification for Fiber-Reinforced Concrete
- ASTM C1157/C1157M Standard Performance Specification for Hydraulic Cement
- ASTM C1240 Standard Specification for Silica Fume Used in Cementitious Mixtures
- ASTM C1602/C1602M Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
- ASTM G109 Standard Test Method for Determining Effects of Chemical Admixtures on Corrosion of Embedded Steel Reinforcement in Concrete Exposed to Chloride Environments
- ASTM C330/C330M Standard Specification for Lightweight Aggregates for Structural Concrete
- ASTM C494/C494M Standard Specification for Chemical Admixtures for Concrete

CSA Standards:

- CAN/CGSB-1.40 Anticorrosive Structural Steel Alkyd Primer
- CAN/CSA G30.18 Carbon steel bars for concrete reinforcement
- CAN/CSA A3000 Cementitious Materials Compendium
- CAN/CSA G40.20/G40.21 General requirements for rolled or welded structural quality steel / Structural quality steel
- CAN/CSA A23.1/A23.2 Concrete Materials and Methods of Concrete Construction/Test methods and Standard Practices for Concrete
- CAN/CSA A23.4 Precast concrete - Materials and construction
- CSA S806 Design and construction of building structures with fiber-reinforced polymers

ISO Standards:

- ISO 6707-1: 2014 Buildings and Civil Engineering Works - Vocabulary - Part 1: General Terms
- ISO 14021:1999 Environmental Labels and Declarations - Self-declared Environmental Claims (Type II Environmental Labeling)
- 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
- ISO 14067:2018 Greenhouse Gases - Carbon Footprint of Products - Requirements and Guidelines for Quantification
- ISO 14050:2009 Environmental Management - Vocabulary
- ISO 21930:2017 Sustainability in Building Construction - Environmental Declaration of Building Products



EN Standards:

- EN 16757 Sustainability of construction works - Environmental product declarations - Product Category Rules for concrete and concrete elements
- EN 15804 Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products

Other References:

- US EPA Waste Reduction Model (WARM), Fly Ash
Chapter: <http://epa.gov/climatechange/wycd/waste/downloads/fly-ash-chapter10-28-10.pdf>
- American Concrete Institute (ACI) 211: Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
- ACI 318-14 Building Code Requirements for Structural Concrete and Commentary. American Concrete Institute. Farmington Hills, MI, USA available at <https://www.concrete.org/store/>
- Mather, B & Ozyildirim, C. (2002). SP-1(02) : Concrete Primer. American Concrete Institute: SP0102. American Concrete Institute. Farmington Hills, MI, USA available at <https://www.concrete.org/store/>
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- Product Category Rules for Preparing an Environmental Product Declaration for Precast Concrete (UN CPC 37550), ASTM International, March 2015. https://www.astm.org/CERTIFICATION/DOCS/266.PCR_for_Precast_Concrete.pdf
- USGBC LEED v4 for Building Design and Construction, 11 Jan 2019 available at <https://www.usgbc.org/resources/pcr-committee-process-resources-part-b>
- USGBC PCR Committee Process & Resources: Part B, USGBC, 7 July 2017 available at <https://www.usgbc.org/resources/pcr-committee-process-resources-part-b>.

