ENVIRONMENTAL PRODUCT DECLARATION

Environmental Product Declaration for ready mix concrete products produced by Holcim Nicaragua at their KM15 facility in Chinandega, Nicaragua.

HOLCIM

ADMINISTRATIVE INFORMATION

International Certified Environmental Product Declaration

Declared Product:	This Environmental Product Declaration (EPD) covers concrete products produced by Holcim Nicaragua. Declared unit: 1 m3 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 Rul (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 ☐ ; External X
	Third Party Verifier
	Geoffrey Guest, Certified 3rd Party Verifier under the International EPD Program (www.environdec.com), CSA Group (www.csaregistries.ca)
Date of Issue:	04 August 2023
Period of Validity:	5 years; valid until 03 August 2028
EPD Number:	d4083c49-f268-4168-b679-bcc460a0954e

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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 CO_2 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 61 concrete mixes manufactured at the KM15 Holcim Nicaragua concrete facility in Chinandega, 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: **All declared products are considered in this environmental product declaration**

Mix#	Unique name/ID	Short description	Product type	28 day strength, MPa	H2O to cement ratio
1	F05-H44B28	0.980665 MPa 28d strength ready mix concrete.	Ready Mix	0.980665	3.9062500
2	R03-H00B28 RF	2.941995 MPa 28d strength ready mix concrete.	Ready Mix	2.941995	1.6551724
3	M36-L68D14	3.530394 MPa 28d strength ready mix concrete.	Ready Mix	3.530394	0.6307692
4	M42-L68D28	4.118793 MPa 28d strength ready mix concrete.	Ready Mix	4.118793	0.6153846
5	M42-L68D03	4.118793 MPa 28d strength ready mix concrete.	Ready Mix	4.118793	0.5125000
6	M42-L68D07	4.118793 MPa 28d strength ready mix concrete.	Ready Mix	4.118793	0.5555556
7	M42-M46B28	4.118793 MPa 28d strength ready mix concrete.	Ready Mix	4.118793	0.6231884
8	M45-L68D28	4.4129925 MPa 28d strength ready mix concrete.	Ready Mix	4.412992	0.5522388
9	M45-L67D28	4.4129925 MPa 28d strength ready mix concrete.	Ready Mix	4.412992	0.5671642
10	M45-L68D03	4.4129925 MPa 28d strength ready mix concrete.	Ready Mix	4.412992	0.4880952
11	M48-M68D03	4.707192 MPa 28d strength ready mix concrete.	Ready Mix	4.707192	0.4505495
12	F18-M46B28	17.65197 MPa 28d strength ready mix concrete.	Ready Mix	17.65197	0.7121212
13	F18-M44B28	17.65197 MPa 28d strength ready mix concrete.	Ready Mix	17.65197	0.7745455

14	Q18-L44D28 ARQUI	17.65197 MPa 28d strength ready mix concrete.	Ready Mix	17.65197	0.4505495
15	F21-L68D28	20.593965 MPa 28d strength ready mix concrete.	Ready Mix	20.59397	0.7743056
16	F21-L46D28	20.593965 MPa 28d strength ready mix concrete.	Ready Mix	20.59397	0.6792453
17	F21-M46B28	20.593965 MPa 28d strength ready mix concrete.	Ready Mix	20.59397	0.6785714
18	F21-H46B28	20.593965 MPa 28d strength ready mix concrete.	Ready Mix	20.59397	0.6779661
19	F21-L44D28	20.593965 MPa 28d strength ready mix concrete.	Ready Mix	20.59397	0.7400722
20	F21-M44B28	20.593965 MPa 28d strength ready mix concrete.	Ready Mix	20.59397	0.7388316
21	A21-L46D03	20.593965 MPa 28d strength ready mix concrete.	Ready Mix	20.59397	0.4931507
22	A21-M46B03	20.593965 MPa 28d strength ready mix concrete.	Ready Mix	20.59397	0.5757576
23	A21-M44B03	20.593965 MPa 28d strength ready mix concrete.	Ready Mix	20.59397	0.5498721
24	A21-M46B07	20.593965 MPa 28d strength ready mix concrete.	Ready Mix	20.59397	0.5757576
25	A21-L46D14	20.593965 MPa 28d strength ready mix concrete.	Ready Mix	20.59397	0.6206897
26	A21-L44D14	20.593965 MPa 28d strength ready mix concrete.	Ready Mix	20.59397	0.6788079
27	A21-M44B14	20.593965 MPa 28d strength ready mix concrete.	Ready Mix	20.59397	0.6803797
28	F24-M46B28	23.53596 MPa 28d strength ready mix concrete.	Ready Mix	23.53596	0.6400000
29	F24-M44B28	23.53596 MPa 28d strength ready mix concrete.	Ready Mix	23.53596	0.6867089
30	A24-L46D03	23.53596 MPa 28d strength ready mix concrete.	Ready Mix	23.53596	0.4739583
31	A24-M46B03	23.53596 MPa 28d strength ready mix concrete.	Ready Mix	23.53596	0.4800000
32	A24-M44B03	23.53596 MPa 28d strength ready mix concrete.	Ready Mix	23.53596	0.5216346
33	A24-M46B07	23.53596 MPa 28d strength ready mix concrete.	Ready Mix	23.53596	0.5485714
34	L24-M68B28	23.53596 MPa 28d strength ready mix concrete.	Ready Mix	23.53596	0.6551724
35	F28-L46D28	27.45862 MPa 28d strength ready mix concrete.	Ready Mix	27.45862	0.6153846
36	F28-M46B28	27.45862 MPa 28d strength ready mix concrete.	Ready Mix	27.45862	0.6158730
37	F28-H46B28	27.45862 MPa 28d strength ready mix concrete.	Ready Mix	27.45862	0.6163142
38	F28-L68D28	27.45862 MPa 28d strength ready mix concrete.	Ready Mix	27.45862	0.6510903
39	F28-M68D28	27.45862 MPa 28d strength ready mix concrete.	Ready Mix	27.45862	0.6517857

40	F28-M44B28	27.45862 MPa 28d strength ready mix concrete.	Ready Mix	27.45862	0.6517857
41	F28-H44B28	27.45862 MPa 28d strength ready mix concrete.	Ready Mix	27.45862	0.6524217
42	A28-L46D03	27.45862 MPa 28d strength ready mix concrete.	Ready Mix	27.45862	0.4611529
43	A28-M46B03	27.45862 MPa 28d strength ready mix concrete.	Ready Mix	27.45862	0.4674699
44	A28-M44B03	27.45862 MPa 28d strength ready mix concrete.	Ready Mix	27.45862	0.5022936
45	A28-L46D07	27.45862 MPa 28d strength ready mix concrete.	Ready Mix	27.45862	0.5272206
46	A28-M46B07	27.45862 MPa 28d strength ready mix concrete.	Ready Mix	27.45862	0.5315068
47	A28-H46B07	27.45862 MPa 28d strength ready mix concrete.	Ready Mix	27.45862	0.5354331
48	A28-H44B07	27.45862 MPa 28d strength ready mix concrete.	Ready Mix	27.45862	0.5710723
49	A28-M46B14	27.45862 MPa 28d strength ready mix concrete.	Ready Mix	27.45862	0.5705882
50	R50-X28-M46B28 REL A/C 0.50	27.45862 MPa 28d strength ready mix concrete.	Ready Mix	27.45862	0.4852941
51	R48-X28-M46B28 REL A/C 0.48	27.45862 MPa 28d strength ready mix concrete.	Ready Mix	27.45862	0.5000000
52	I28-M46B28	27.45862 MPa 28d strength ready mix concrete.	Ready Mix	27.45862	0.6000000
53	F32-M46B28	31.38128 MPa 28d strength ready mix concrete.	Ready Mix	31.38128	0.5939394
54	A32-L46D07	31.38128 MPa 28d strength ready mix concrete.	Ready Mix	31.38128	0.5123967
55	F35-M46B28	34.323275 MPa 28d strength ready mix concrete.	Ready Mix	34.32328	0.5823529
56	F35-M44B28	34.323275 MPa 28d strength ready mix concrete.	Ready Mix	34.32328	0.6177285
57	A35-M46B03	34.323275 MPa 28d strength ready mix concrete.	Ready Mix	34.32328	0.4500000
58	A35-L46D07	34.323275 MPa 28d strength ready mix concrete.	Ready Mix	34.32328	0.5040214
59	A35-M44B07	34.323275 MPa 28d strength ready mix concrete.	Ready Mix	34.32328	0.5425791
60	A35-M46B14	34.323275 MPa 28d strength ready mix concrete.	Ready Mix	34.32328	0.5424658
61	AC35-M46B07	34.323275 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 Nicragua	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:

Life Cycle Impacts

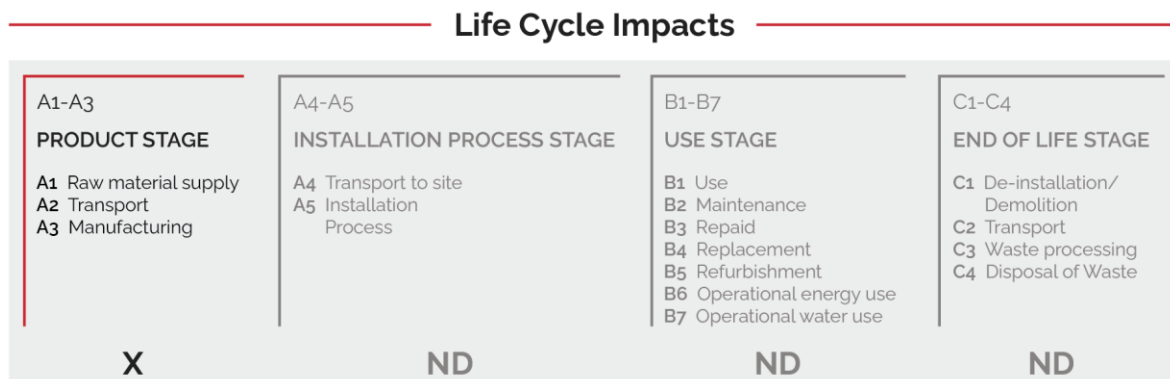| A1-A3	A4-A5	B1-B7	C1-C4
PRODUCT STAGE	**INSTALLATION PROCESS STAGE**	**USE STAGE**	**END OF LIFE STAGE**
A1 Raw material supply A2 Transport A3 Manufacturing	A4 Transport to site A5 Installation Process	B1 Use B2 Maintenance B3 Repaid B4 Replacement B5 Refurbishment B6 Operational energy use B7 Operational water use	C1 De-installation/ Demolition C2 Transport C3 Waste processing C4 Disposal of Waste
X	ND	ND	ND

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

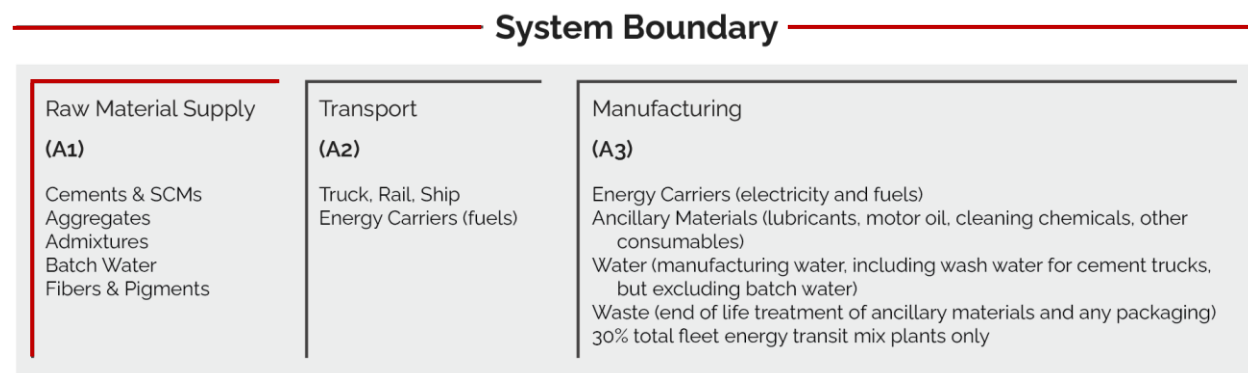| Raw Material Supply (A1)	Transport (A2)	Manufacturing (A3)
Cements & SCMs Aggregates Admixtures Batch Water Fibers & Pigments	Truck, Rail, Ship Energy Carriers (fuels)	Energy Carriers (electricity and fuels) Ancillary Materials (lubricants, motor oil, cleaning chemicals, other consumables) Water (manufacturing 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 KM15 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 2022-01-01 to 2022-12-31 (364 days) to produce 5042 m3 of concrete**

Activity	Value	Units
Electricity consumption and on-site generation or off-site contractual procurement (if applicable)		
Gross grid electricity:	20668.3	kWh
Fuel requirements for machinery		
Diesel	10099.2	L
Waste generation		
Wash water	687.96	m3
Hazardous waste	12000	kg
Non-hazardous waste	12000	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	7.56	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	Multiple Locations	v3.8 in 2021	2	3	2	3	3

					Technology	Time	Geography	Reliability	Completeness
Gravel	limestone quarry operation/limestone, unprocessed/RoW/kg	ecoinvent v3.8	Multiple Locations	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	Multiple Locations	v3.8 in 2021	2	3	2	3	3
Cement HE Nicragua	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	ecoinvent v3.8	RoW	v3.8 in 2021	2	3	1	3	3

	metric ton, EURO6/RoW/tkm							

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 metric ton, EURO6/RoW/tkm	ecoinvent v3.8	RoW	v3.8 in 2021	2	3	2	3	3
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 2022-01-01 to 2022-12-31.
- 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 9: **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 CO2-Eq
4	environmental impact: ozone depletion	ODP	kg CFC-11-Eq
5	environmental impact: photochemical oxidation	PCOP	kg NOx-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	m3
13	water depletion: WDP	WDP	m3
14	land filling: bulk waste	LFW	kg waste
15	land filling: hazardous waste	LFHW	kg waste
16	Concrete batching water consumption	CBWC	m3
17	Concrete washing water consumption	CWWC	m3
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 (GWP100), measured in the reference unit, kg CO2 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 (SO2) 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 SO2 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 SO2 and NOx. 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 PO4 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 (SO2), 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 (C2H4) equivalent.
Abiotic Depletion Potential (ADPel 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. ADPel) 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/utilized/wasted in the life cycle system considered.
Water Depletion Potential (WDP) (m3)	This indicator considers the cumulative life cycle consumption of water required to produced 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 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 CO2-Eq	kg CFC-11-Eq	kg NOx-Eq	kg Sb-Eq	MJ, net calorific value
Minimum	18.5	0.0324	98.3	1.11E-05	0.291	0.000402	846
Maximum	62	0.0814	420	2.51E-05	0.949	0.00183	2430
Mean	49.1	0.1	324.3	2.08E-05	0.8	0.00141	1951.1
Median	49	0.0666	324	2.08E-05	0.751	0.00141	1950
F05-H44B28	18.5	0.0324	98.3	1.11e-05	0.291	0.000402	846
R03-H00B28 RF	27.4	0.0425	165	1.41e-05	0.427	0.000696	1180
M36-L68D14	47	0.064	311	1.99e-05	0.72	0.00135	1870
M42-L68D28	47.3	0.0645	311	2.01e-05	0.724	0.00135	1880
M42-L68D03	55.2	0.0733	372	2.26e-05	0.844	0.00162	2170
M42-L68D07	51	0.0687	340	2.13e-05	0.781	0.00148	2020
M42-M46B28	49.4	0.0669	328	2.08e-05	0.756	0.00143	1960
M45-L68D28	48.6	0.066	320	2.06e-05	0.744	0.00139	1930
M45-L67D28	48.4	0.0657	320	2.05e-05	0.741	0.00139	1920
M45-L68D03	57.3	0.0755	388	2.32e-05	0.875	0.00169	2240
M48-M68D03	61.2	0.0799	417	2.44e-05	0.934	0.00182	2390
F18-M46B28	41.2	0.0581	264	1.85e-05	0.634	0.00114	1670
F18-M44B28	42.1	0.0589	272	1.86e-05	0.646	0.00118	1700
Q18-L44D28 ARQUI	62	0.0814	420	2.51e-05	0.949	0.00183	2430
F21-L68D28	39.4	0.0538	270	1.65e-05	0.604	0.00116	1570
F21-L46D28	41.4	0.0584	265	1.86e-05	0.637	0.00115	1680
F21-M46B28	42.9	0.0599	277	1.9e-05	0.659	0.0012	1730
F21-H46B28	44.4	0.0615	288	1.94e-05	0.681	0.00125	1780
F21-L44D28	42.4	0.0593	274	1.88e-05	0.651	0.00118	1710
F21-M44B28	43.8	0.0607	284	1.91e-05	0.671	0.00123	1760
A21-L46D03	52.7	0.0712	348	2.23e-05	0.808	0.00151	2090
A21-M46B03	48.6	0.0664	318	2.08e-05	0.745	0.00138	1940
A21-M44B03	54.8	0.0732	367	2.27e-05	0.839	0.0016	2160
A21-M46B07	48.3	0.0659	317	2.06e-05	0.74	0.00138	1920
A21-L46D14	44.1	0.0614	285	1.94e-05	0.678	0.00124	1780
A21-L44D14	45.1	0.0623	294	1.96e-05	0.692	0.00127	1810
A21-M44B14	46.4	0.0637	305	2e-05	0.712	0.00132	1850
F24-M46B28	45	0.0623	293	1.96e-05	0.691	0.00127	1810
F24-M44B28	46.5	0.0638	305	2e-05	0.713	0.00132	1860
A24-L46D03	54.2	0.0725	361	2.25e-05	0.829	0.00157	2140
A24-M46B03	55.8	0.0742	374	2.29e-05	0.853	0.00163	2190
A24-M44B03	57.1	0.0755	386	2.32e-05	0.873	0.00168	2240
A24-M46B07	50.4	0.0683	333	2.13e-05	0.772	0.00145	2000
L24-M68B28	43.7	0.0605	283	1.89e-05	0.668	0.00123	1740
F28-L46D28	45	0.0623	292	1.96e-05	0.691	0.00127	1810
F28-M46B28	46.6	0.064	305	2.01e-05	0.714	0.00132	1860
F28-H46B28	48.2	0.0656	317	2.05e-05	0.738	0.00138	1920
F28-L68D28	47.3	0.0649	310	2.04e-05	0.726	0.00135	1890
F28-M68D28	48.8	0.0664	322	2.08e-05	0.748	0.0014	1940
F28-M44B28	48.8	0.0664	322	2.08e-05	0.748	0.0014	1940
F28-H44B28	50.3	0.068	333	2.12e-05	0.77	0.00145	1990

A28-L46D03	55.8	0.0743	373	2.3e-05	0.853	0.00163	2200
A28-M46B03	57.3	0.0759	386	2.34e-05	0.877	0.00168	2250
A28-M44B03	59.3	0.0779	402	2.39e-05	0.906	0.00175	2320
A28-L46D07	50.4	0.0683	333	2.13e-05	0.772	0.00145	2000
A28-M46B07	52	0.07	345	2.17e-05	0.796	0.0015	2060
A28-H46B07	53.6	0.0716	358	2.22e-05	0.819	0.00156	2110
A28-H44B07	55.6	0.074	374	2.28e-05	0.851	0.00163	2190
A28-M46B14	49.3	0.067	325	2.09e-05	0.755	0.00141	1960
R50-X28-M46B28 REL A/C 0.50	49	0.0666	324	2.08e-05	0.751	0.00141	1950
R48-X28-M46B28 REL A/C 0.48	49.5	0.0674	326	2.11e-05	0.759	0.00142	1970
I28-M46B28	47.3	0.0646	312	2.02e-05	0.725	0.00135	1890
F32-M46B28	48.2	0.0657	317	2.05e-05	0.738	0.00138	1920
A32-L46D07	51.9	0.0699	344	2.18e-05	0.794	0.0015	2050
F35-M46B28	49.2	0.0669	325	2.08e-05	0.754	0.00141	1950
F35-M44B28	51.5	0.0695	342	2.16e-05	0.789	0.00149	2040
A35-M46B03	60	0.0788	406	2.42e-05	0.916	0.00177	2350
A35-L46D07	52.9	0.0711	352	2.21e-05	0.81	0.00153	2090
A35-M44B07	56.9	0.0755	383	2.33e-05	0.87	0.00167	2240
A35-M46B14	51.9	0.0699	345	2.17e-05	0.794	0.0015	2050
AC35-M46B07	53.4	0.0714	357	2.21e-05	0.817	0.00155	2110

b) Inventory Metrics:

Indicator/ LCI Metric	TPE	RE	NRE	NRR	RR	WDP	LFW	LFHW	CBWC	CWWC	CHW	CNHW
Unit	MJ-Eq	MJ-Eq	MJ-Eq	kg	m3	m3	kg waste	kg waste	m3	m3	kg	kg
Minimum	940	42.1	893	25	0.000525	8.61	28.3	0.00178	0.173	0.000136	2.38	2.38
Maximum	2710	160	2560	79.5	0.00221	14.8	46.5	0.003	0.262	0.000136	2.38	2.38
Mean	2175.41	124.78	2049.23	63.5	0.001659	10.02	40.8918	0.00260	0.211	0.000136	2.38	2.38
Median	2170	125	2050	63.2	0.00166	9.88	41	0.00261	0.21	0.000136	2.38	2.38
F05-H44B28	940	42.1	893	25	0.000525	14.8	28.3	0.00178	0.262	0.000136	2.38	2.38
R03-H00B28 RF	1300	66.2	1230	36.4	0.000842	14.8	32	0.00204	0.252	0.000136	2.38	2.38
M36-L68D14	2090	119	1970	60.8	0.00156	9.61	39.3	0.0025	0.215	0.000136	2.38	2.38
M42-L68D28	2100	120	1970	61	0.00159	9.08	39.9	0.00252	0.21	0.000136	2.38	2.38
M42-L68D03	2410	142	2270	71.7	0.00192	9.13	42.6	0.00272	0.215	0.000136	2.38	2.38
M42-L68D07	2260	130	2120	66.1	0.00175	9.08	41.2	0.00262	0.21	0.000136	2.38	2.38

M42-M46B28	2200	126	2070	63.5	0.00168	9.72	40.6	0.00259	0.226	0.000136	2.38	2.38
M45-L68D28	2140	123	2030	62.8	0.00164	9.36	40.7	0.00258	0.194	0.000136	2.38	2.38
M45-L67D28	2150	122	2010	62.5	0.00162	9.47	40.3	0.00256	0.2	0.000136	2.38	2.38
M45-L68D03	2510	148	2350	73.9	0.00199	9.07	43.1	0.00277	0.215	0.000136	2.38	2.38
M48-M68D03	2660	160	2510	78.6	0.00205	8.75	44.7	0.00287	0.215	0.000136	2.38	2.38
F18-M46B28	1870	103	1750	53.6	0.00137	10.9	38.5	0.00244	0.197	0.000136	2.38	2.38
F18-M44B28	1890	105	1790	54.8	0.00139	11	38.3	0.00243	0.224	0.000136	2.38	2.38
Q18-L44D28 ARQUI	2710	159	2560	79.5	0.00221	10.4	46.5	0.003	0.215	0.000136	2.38	2.38
F21-L68D28	1750	106	1650	51.6	0.00135	10.7	30.7	0.00198	0.234	0.000136	2.38	2.38
F21-L46D28	1870	103	1760	53.9	0.0014	10.8	38.8	0.00245	0.189	0.000136	2.38	2.38
F21-M46B28	1930	106	1820	55.5	0.00145	10.4	39.1	0.00247	0.2	0.000136	2.38	2.38
F21-H46B28	1980	111	1870	57.6	0.00148	10.1	39.4	0.00249	0.21	0.000136	2.38	2.38
F21-L44D28	1910	106	1790	55.1	0.0014	10.8	38.6	0.00244	0.215	0.000136	2.38	2.38
F21-M44B28	1970	111	1840	56.4	0.00145	10.4	38.8	0.00246	0.226	0.000136	2.38	2.38
A21-L46D03	2320	134	2210	67.9	0.0018	10.5	43.7	0.00279	0.189	0.000136	2.38	2.38
A21-M46B03	2150	122	2040	62.4	0.00161	10.1	41.6	0.00264	0.2	0.000136	2.38	2.38
A21-M44B03	2410	141	2280	71.3	0.00183	9.97	43.3	0.00277	0.226	0.000136	2.38	2.38
A21-M46B07	2160	122	2010	62.1	0.00164	10.3	41	0.00261	0.2	0.000136	2.38	2.38
A21-L46D14	1980	111	1870	57.2	0.00144	10.7	39.8	0.00252	0.189	0.000136	2.38	2.38
A21-L44D14	2010	113	1900	58.7	0.00151	10.7	39.6	0.00251	0.215	0.000136	2.38	2.38
A21-M44B14	2060	118	1940	60.3	0.00158	10.3	39.8	0.00253	0.226	0.000136	2.38	2.38
F24-M46B28	2010	113	1900	57.9	0.0015	10.3	39.8	0.00252	0.202	0.000136	2.38	2.38
F24-M44B28	2060	118	1950	60.3	0.00156	10.3	39.9	0.00254	0.228	0.000136	2.38	2.38
A24-L46D03	2380	138	2240	70.4	0.00186	9.46	43.3	0.00276	0.191	0.000136	2.38	2.38
A24-M46B03	2440	143	2300	72.4	0.00189	9.29	43.6	0.00279	0.202	0.000136	2.38	2.38

A24-M44B03	2500	147	2360	74.1	0.00199	9.28	43.6	0.00279	0.228	0.000136	2.38	2.38
A24-M46B07	2230	129	2120	65.2	0.00171	10.2	41.8	0.00266	0.202	0.000136	2.38	2.38
L24-M68B28	1940	110	1830	56.4	0.00147	8.61	38.8	0.00243	0.2	0.000136	2.38	2.38
F28-L46D28	2020	113	1900	58	0.00149	10.1	40	0.00253	0.193	0.000136	2.38	2.38
F28-M46B28	2070	118	1950	60.4	0.00157	9.72	40.3	0.00255	0.204	0.000136	2.38	2.38
F28-H46B28	2130	122	2010	62.5	0.00165	9.38	40.6	0.00257	0.214	0.000136	2.38	2.38
F28-L68D28	2110	119	1990	61.4	0.00161	10.6	40.8	0.00259	0.219	0.000136	2.38	2.38
F28-M68D28	2170	124	2060	62.7	0.00162	10.2	41	0.00261	0.23	0.000136	2.38	2.38
F28-M44B28	2160	123	2030	63.4	0.00166	10.2	41	0.00261	0.23	0.000136	2.38	2.38
F28-H44B28	2220	129	2100	65.5	0.00166	9.85	41.3	0.00263	0.24	0.000136	2.38	2.38
A28-L46D03	2450	143	2310	71.8	0.00189	9.39	43.8	0.0028	0.193	0.000136	2.38	2.38
A28-M46B03	2500	146	2360	74.2	0.00198	9.22	44.2	0.00283	0.204	0.000136	2.38	2.38
A28-M44B03	2590	153	2440	76.2	0.00203	9.18	44.3	0.00285	0.23	0.000136	2.38	2.38
A28-L46D07	2230	128	2100	65.6	0.00167	9.91	41.9	0.00267	0.193	0.000136	2.38	2.38
A28-M46B07	2290	133	2150	67	0.00173	9.56	42.2	0.00269	0.204	0.000136	2.38	2.38
A28-H46B07	2360	138	2210	69	0.00178	9.21	42.6	0.00271	0.214	0.000136	2.38	2.38
A28-H44B07	2440	142	2310	71.8	0.00194	9.67	43.2	0.00277	0.24	0.000136	2.38	2.38
A28-M46B14	2180	125	2060	63.4	0.00169	9.63	41.3	0.00262	0.204	0.000136	2.38	2.38
R50-X28-M46B28 REL A/C 0.50	2170	125	2040	63.1	0.00164	10	40.7	0.0026	0.173	0.000136	2.38	2.38
R48-X28-M46B28 REL A/C 0.48	2200	125	2060	64	0.00167	10.1	41.7	0.00266	0.178	0.000136	2.38	2.38
I28-M46B28	2100	121	1990	61.4	0.0016	10.2	40	0.00254	0.205	0.000136	2.38	2.38
F32-M46B28	2130	123	2020	62.5	0.00165	9.65	40.8	0.00259	0.206	0.000136	2.38	2.38
A32-L46D07	2300	132	2150	66.9	0.00179	9.83	42.4	0.0027	0.195	0.000136	2.38	2.38
F35-M46B28	2190	125	2050	63.2	0.00167	9.41	41.1	0.00261	0.208	0.000136	2.38	2.38

F35-M44B28	2290	131	2140	66.5	0.00173	10.1	42	0.00268	0.234	0.000136	2.38	2.38
A35-M46B03	2620	154	2460	77.6	0.0021	8.93	45	0.00289	0.208	0.000136	2.38	2.38
A35-L46D07	2330	136	2190	68.5	0.00184	9.6	42.7	0.00272	0.197	0.000136	2.38	2.38
A35-M44B07	2510	146	2360	73.5	0.00193	9.88	44	0.00282	0.234	0.000136	2.38	2.38
A35-M46B14	2280	133	2150	66.8	0.00175	9.34	42.1	0.00268	0.208	0.000136	2.38	2.38
AC35-M46B07	2370	137	2210	69.2	0.00179	9.7	42.4	0.00271	0.21	0.000136	2.38	2.38

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/
- NSF International (February 2019). Product Category Rules (PCR) for ISO 14025 Type III Environmental Product Declarations (EPDs) of Concrete v1.2.
- 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.