Environmental Product Declaration

Environmental Product Declaration for various ready mix concrete products produced by Holcim México Operaciones S.A. de C.V. at their Arvide facility in Álvaro Obregón, Ciudad de México

ADMINISTRATIVE INFORMATION

International Certified Environmental Product Declaration

Declared Product:	This Environmental Product Declaration (EPD) covers concrete products produced by Holcim México Operaciones S.A. de C.V.. Declared unit: 1 m3 of concrete
Declaration Owner:	Holcim México Operaciones S.A. de C.V. Av. Prolongación Vasco de Quiroga #4800 Torre II Ofic. 101 Piso 1, Santa Fe Cuajimalpa de Morelos Ciudad de México, México www.holcim.com.mx
Program Operator:	Labeling Sustainability 11670 W Sunset Blvd. 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:	24 July 2023
Period of Validity:	5 years; valid until 24 July 2028
EPD Number:	ecd057d4-e2ba-41f1-a0b5-1d52eae3d45d

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COMPANY DESCRIPTION

Holcim Mexico produces and markets cement, ready-mix concrete, and other products and services for construction. The company has a nationwide presence through 7 cement plants with a current installed capacity to produce 12.6 million tons per year, 23 cement distribution centers, two maritime terminals, 1 Corporate Office, plus 35 ready-mix concrete plants, seven platforms, and a Geocycle transfer center, 26 commercial partners with more than 90 ready-mix concrete plants, more than 500 mixing pots, one aggregates plant and a Technological Innovation Center for Construction (CITEC).

Sustainable Development is an integral part of Lafarge Holcim's strategy around the world. Holcim Mexico has a clear vision of the future it wants for our country, which contributes to its development. Holcim Mexico's main objective is to create value. Creating value ensures long-term business success in covering the triple bottom line (i.e., social, economic, environmental values). Finally, good operating performance and a solid return on invested capital go hand in hand with sustainable development.

Holcim continues to invest in research and development. They have the Innovation and Development Center, located in Lyon (France), with satellite locations in various regions developing a comprehensive portfolio of innovators and sustainable solutions. These include different categories: inclusive business models, water management solutions, urban mining solutions (recycled aggregates), waste treatment services, energy-efficient solutions (insulating building materials), resource-efficient solutions (high recycled content, bags soluble cement), and low CO2 building materials.

Holcim operates with the belief that they can gain an advantage by developing knowledge and brand equity in the green building segment.

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 México Operaciones S.A. de C.V. 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 México Operaciones S.A. de C.V. 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 México Operaciones S.A. de C.V.'s license to operate in the community. The intended audience for this LCA report is Holcim México Operaciones S.A. de C.V.'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 65 concrete mixes manufactured at the Holcim Mexico Operaciones S.A. de C.V. Arvide concrete facility in Ciudad de México, México.

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 ready mix concrete products considered in this EPD along with key performance parameters.

Mix designs: 0 to 15 MPa

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	H2O to cement ratio
1	37.40ND2012	0.04 MPa 28d strength Ready mix concrete	Ready mix concrete	0.04	0.37
2	37.42ND2012	0.04 MPa 28d strength Ready mix concrete	Ready mix concrete	0.04	0.38
3	37.45ND2012	0.04 MPa 28d strength Ready mix concrete	Ready mix concrete	0.04	0.41
4	37.50ND2012	0.05 MPa 28d strength Ready mix concrete	Ready mix concrete	0.05	0.45
5	37.55ND2012	0.05 MPa 28d strength Ready mix concrete	Ready mix concrete	0.05	0.49
6	24005NB0520	0.49 MPa 28d strength mortars and fillers	Mortars and fillers	0.49	3.46
7	24007NB0520	0.69 MPa 28d strength mortars and fillers	Mortars and fillers	0.69	3.46
8	24010NB0520	0.98 MPa 28d strength mortars and fillers	Mortars and fillers	0.98	3.12
9	24015NB0514	1.47 MPa 28d strength mortars and fillers	Mortars and fillers	1.47	2.70
10	24020NB0518	1.96 MPa 28d strength mortars and fillers	Mortars and fillers	1.96	2.45

11	68025NB0514	2.45 MPa 28d strength special concrete	Special concrete	2.45	2.75
12	24025NB0514	2.45 MPa 28d strength mortars and fillers	Mortars and fillers	2.45	2.25
13	24030NB0520	2.94 MPa 28d strength mortars and fillers	Mortars and fillers	2.94	2.09
14	77035ND2010	3.43 MPa 28d strength Ready mix concrete	Ready mix concrete	3.43	0.85
15	68035NB0514	3.43 MPa 28d strength special concrete	Special concrete	3.43	2.31
16	24035NB0518	3.43 MPa 28d strength mortars and fillers	Mortars and fillers	3.43	1.94
17	39036ND2006	3.53 MPa 28d strength Ready mix concrete	Ready mix concrete	3.53	0.68
18	39038ND2010	3.73 MPa 28d strength Ready mix concrete	Ready mix concrete	3.73	0.64
19	39040ND2010	3.93 MPa 28d strength Ready mix concrete	Ready mix concrete	3.93	0.60
20	24040NB0520	3.93 MPa 28d strength mortars and fillers	Mortars and fillers	3.93	1.87
21	77042ND4014	4.12 MPa 28d strength Ready mix concrete	Ready mix concrete	4.12	0.66
22	77045NB4014	4.42 MPa 28d strength Ready mix concrete	Ready mix concrete	4.42	0.63
23	77048ND4014	4.71 MPa 28d strength Ready mix concrete	Ready mix concrete	4.71	0.61
24	77050ND4014	4.91 MPa 28d strength Ready mix concrete	Ready mix concrete	4.91	0.59
25	76050ND1218	4.91 MPa 28d strength special concrete	Special concrete	4.91	1.06
26	24050NB0514	4.91 MPa 28d strength mortars and fillers	Mortars and fillers	4.91	1.73
27	24075NB0518	7.36 MPa 28d strength mortars and fillers	Mortars and fillers	7.36	1.86
28	01100NB2018	9.81 MPa 28d strength Ready mix concrete	Ready mix concrete	9.81	1.59
29	76100ND1218	9.81 MPa 28d strength special concrete	Special concrete	9.81	0.95
30	73100NB0514	9.81 MPa 28d strength mortars and fillers	Mortars and fillers	9.81	1.59
31	71150ND1210	14.72 MPa 28d strength Ready mix concrete	Ready mix concrete	14.72	1.23
32	40150NB1214	14.72 MPa 28d strength special concrete	Special concrete	14.72	0.98
33	73150NB0514	14.72 MPa 28d strength mortars and fillers	Mortars and fillers	14.72	1.26

Mix designs: 15 to 20 MPa

Table 2: **Declared products with Mix designs: 15 to 20MPa considered in this environmental product declaration**

Mix#	Unique name/ID	Short description	Product type	28 day strength, MPa	H2O to cement ratio
34	71175ND1214	17.17 MPa 28d strength Ready mix concrete	Ready mix concrete	17.17	1.14
35	71200ND1214	19.63 MPa 28d strength Ready mix concrete	Ready mix concrete	19.63	1.06
36	76200ND1218	19.63 MPa 28d strength special concrete	Special concrete	19.63	0.78
37	73200NB0518	19.63 MPa 28d strength mortars and fillers	Mortars and fillers	19.63	1.04

Mix designs: 21 to 25 MPa

Table 3: **Declared products with Mix designs: 21 to 25MPa considered in this environmental product declaration**

Mix#	Unique name/ID	Short description	Product type	28 day strength, MPa	H2O to cement ratio
38	71210ND1214	20.61 MPa 28d strength Ready mix concrete	Ready mix concrete	20.61	1.03
39	70250ND2014	24.53 MPa 28d strength Ready mix concrete	Ready mix concrete	24.53	0.96
40	40250NB1210	24.53 MPa 28d strength special concrete	Special concrete	24.53	0.79
41	73250NB0514	24.53 MPa 28d strength mortars and fillers	Mortars and fillers	24.53	0.90

Mix designs: 26 to 30 MPa

Table 4: **Declared products with Mix designs: 26 to 30MPa considered in this environmental product declaration**

Mix#	Unique name/ID	Short description	Product type	28 day strength, MPa	H2O to cement ratio
42	71280ND1214	27.48 MPa 28d strength Ready mix concrete	Ready mix concrete	27.48	0.84
43	71300NB1218	29.44 MPa 28d strength Ready mix concrete	Ready mix concrete	29.44	0.81
44	56300NB1265	29.44 MPa 28d strength special concrete	Special concrete	29.44	0.39
45	73300NB0518	29.44 MPa 28d strength mortars and fillers	Mortars and fillers	29.44	0.81

Mix designs: 31 to 35 MPa

Table 5: **Declared products with Mix designs: 31 to 35MPa considered in this environmental product declaration**

Mix#	Unique name/ID	Short description	Product type	28 day strength, MPa	H2O to cement ratio
46	70320ND2010	31.4 MPa 28d strength Ready mix concrete	Ready mix concrete	31.40	0.76
47	70350ND2010	34.35 MPa 28d strength Ready mix concrete	Ready mix concrete	34.35	0.70
48	40350NB1010	34.35 MPa 28d strength special concrete	Special concrete	34.35	0.65
49	73350NB0518	34.35 MPa 28d strength mortars and fillers	Mortars and fillers	34.35	0.73

Mix designs: 36 to 40 MPa

Table 6: **Declared products with Mix designs: 36 to 40MPa considered in this environmental product declaration**

Mix#	Unique name/ID	Short description	Product type	28 day strength, MPa	H2O to cement ratio
50	71360NB1214	35.33 MPa 28d strength Ready mix concrete	Ready mix concrete	35.33	0.68
51	13400ND2012	39.25 MPa 28d strength Ready mix concrete	Ready mix concrete	39.25	0.40
52	40400NB1218	39.25 MPa 28d strength special concrete	Special concrete	39.25	0.46

Mix designs: 41 to 45 MPa

Table 7: **Declared products with Mix designs: 41 to 45MPa considered in this environmental product declaration**

Mix#	Unique name/ID	Short description	Product type	28 day strength, MPa	H2O to cement ratio
53	60420NB1212	41.22 MPa 28d strength special concrete	Special concrete	41.22	0.42
54	13450ND2010	44.16 MPa 28d strength Ready mix concrete	Ready mix concrete	44.16	0.36
55	56450NB1265	44.16 MPa 28d strength special concrete	Special concrete	44.16	0.32

Mix designs: 46 to 50 MPa

Table 8: **Declared products with Mix designs: 46 to 50MPa considered in this environmental product declaration**

Mix#	Unique name/ID	Short description	Product type	28 day strength, MPa	H2O to cement ratio
56	13500ND2012	49.07 MPa 28d strength Ready mix concrete	Ready mix concrete	49.07	0.34
57	56500NB1265	49.07 MPa 28d strength special concrete	Special concrete	49.07	0.30

Mix designs: 51 to 55 MPa

Table 9: **Declared products with Mix designs: 51 to 55MPa considered in this environmental product declaration**

Mix#	Unique name/ID	Short description	Product type	28 day strength, MPa	H2O to cement ratio
58	13550ND2010	53.97 MPa 28d strength Ready mix concrete	Ready mix concrete	53.97	0.31
59	56550NB1275	53.97 MPa 28d strength special concrete	Special concrete	53.97	0.30

Mix designs: 56 to 60 MPa

Table 10: **Declared products with Mix designs: 56 to 60MPa considered in this environmental product declaration**

Mix#	Unique name/ID	Short description	Product type	28 day strength, MPa	H2O to cement ratio
60	13600ND2012	58.88 MPa 28d strength Ready mix concrete	Ready mix concrete	58.88	0.28
61	60600NB1275	58.88 MPa 28d strength special concrete	Special concrete	58.88	0.36

Mix designs: >60 MPa

Table 11: **Declared products with Mix designs: >60MPa considered in this environmental product declaration**

Mix#	Unique name/ID	Short description	Product type	28 day strength, MPa	H2O to cement ratio
62	14650NB2022	63.79 MPa 28d strength Ready mix concrete	Ready mix concrete	63.79	0.30
63	14700NB2022	68.69 MPa 28d strength Ready mix concrete	Ready mix concrete	68.69	0.30
64	60700NB2024	68.69 MPa 28d strength special concrete	Special concrete	68.69	0.29

65	14750NB2022	73.6 MPa 28d strength Ready mix concrete	Ready mix concrete	73.60	0.30

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 12: **Design composition**

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

SYSTEM BOUNDARIES

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

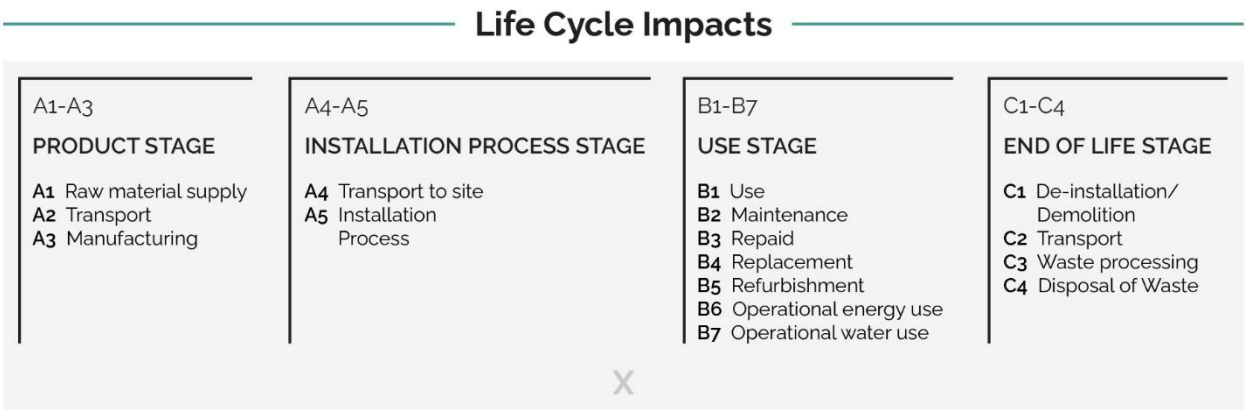

Figure 12: **General life cycle phases for consideration in a construction works system**

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 ready mix concrete products and is not necessarily exhaustive.

System Boundary

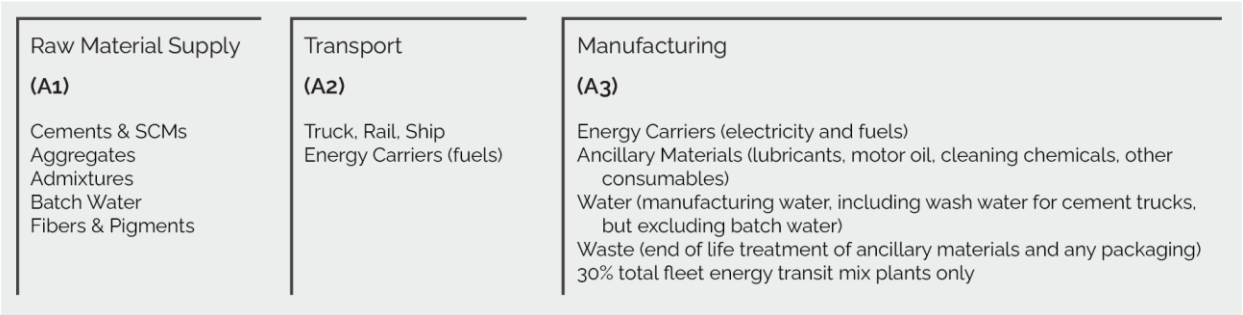

Figure 13: **General system inputs considered in the product system and categorized by modules in scope**

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 México Operaciones S.A. de C.V., is located at their Planta Arvide facility in México. All operating data is formulated using the actual data from Holcim México Operaciones S.A. de C.V.'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 México Operaciones S.A. de C.V. 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

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: Electricity consumption values are for Holcim Mexico in calendar year 2022. These values were direct reported from Holcim records. The unit process "market for electricity, medium voltage/electricity, medium voltage/MX/kWh" was used to represent the Mexico grid electricity used by the concrete 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.

Waste generation: Waste generation values are directly reported from Holcim operations for both bulk waste and hazardous waste. No High-level radioactive waste is generated on-site at this facility. Wash water values are direct reported water use from Holcim México 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 are modeled using fuel and technology appropriate ecoinvent activities. See LCI input tables for details.

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 México records for the year 2022. The concrete PCR allots 30% of the overall mixing truck total for stage A3 (manufacturing) for mixing the materials.

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 13: **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
Andesite sand	basalt quarry operation/basalt/RoW/kg; Note: modifications made (see ecoinvent activity changes table)	ecoinvent v3.8	Edo de Mexico	v3.8 in 2021	2	3	1	3	3
Water	tap water production, conventional with biological treatment/tap water/RoW/kg	ecoinvent v3.8	Edo de Mexico	v3.8 in 2021	2	3	1	3	3
Limestone Gravel	limestone quarry operation/limestone, unprocessed/RoW/kg ; Note: modifications made (see ecoinvent activity changes table)	ecoinvent v3.8	Estado de México	v3.8 in 2021	2	3	1	3	3
Additives	market for chemical, organic/chemical, organic/GLO/kg	ecoinvent v3.8	Edo de Mexico	v3.8 in 2021	2	3	1	3	3
CPC 40R CEMENTO PORTLAND GRANEL: Apaxco	CPC 40R	Progam Operator: Labeling Sustainability- EPD ID: e38f688d-1fa5-41b0-a9b1-e5b1422ea654	Estado de México	very good, 3rd party verfied facility - specific EPD dataset	3	NA	3	3	3
Silica fume	Waste input produced off-site	See A3 inputs	Texcoco	See A3 inputs	3	A3	3	A3	A3
Natural River sand	sand quarry operation, extraction from river bed/sand/BR/kg; Note: modifications made (see ecoinvent activity changes table)	ecoinvent v3.8	Morelos	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 Ready Mix Concrete 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).

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.

TOTAL IMPACT SUMMARY

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

Mix designs: 0 to 15 MPa

Table 14: **Total life cycle (across modules in scope) impact results for Mix designs: 0 to 15MPa, 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	112	0.125	126	7.1e-06	2.58	0.000496	642
Maximum	604	0.657	584	1.73e-05	14.3	0.00222	1590
Mean	282	0.309	284	1.07e-05	6.62	0.00109	957
Median	282	0.308	280	9.58e-06	6.63	0.00105	862
37.40ND2012	604	0.657	584	1.73e-05	14.3	0.00222	1590
37.42ND2012	544	0.593	531	1.68e-05	12.8	0.00203	1520
37.45ND2012	489	0.534	483	1.64e-05	11.5	0.00186	1460
37.50ND2012	437	0.479	437	1.6e-05	10.3	0.00169	1410

37.55ND2012	387	0.424	389	1.5e-05	9.1	0.00148	1210
24005NB0520	112	0.125	126	7.1e-06	2.58	0.000496	642
24007NB0520	112	0.125	126	7.1e-06	2.58	0.000496	642
24010NB0520	123	0.136	136	7.23e-06	2.83	0.00053	655
24015NB0514	133	0.147	146	7.57e-06	3.08	0.000568	686
24020NB0518	149	0.164	160	7.61e-06	3.46	0.000616	695
68025NB0514	133	0.148	146	7.64e-06	3.08	0.000569	690
24025NB0514	155	0.171	166	7.84e-06	3.6	0.00064	716
24030NB0520	173	0.19	181	7.83e-06	4.03	0.000692	719
77035ND2010	295	0.323	298	1.17e-05	6.91	0.00116	1020
68035NB0514	155	0.171	166	7.89e-06	3.61	0.000639	715
24035NB0518	182	0.2	189	8e-06	4.25	0.000722	735
39036ND2006	308	0.34	321	1.44e-05	7.22	0.00126	1200
39038ND2010	337	0.372	346	1.45e-05	7.92	0.00135	1220
39040ND2010	352	0.387	358	1.46e-05	8.26	0.0014	1240
24040NB0520	191	0.209	197	8.04e-06	4.45	0.000749	741
77042ND4014	373	0.408	369	1.26e-05	8.79	0.00141	1110
77045NB4014	394	0.43	387	1.28e-05	9.28	0.00147	1130
77048ND4014	406	0.443	398	1.3e-05	9.57	0.00151	1150
77050ND4014	423	0.461	413	1.32e-05	9.97	0.00157	1170
76050ND1218	334	0.361	318	8.2e-06	7.88	0.00117	787
24050NB0514	197	0.216	203	8.33e-06	4.6	0.000775	767
24075NB0518	192	0.21	199	8.27e-06	4.48	0.000756	756
01100NB2018	191	0.211	203	9.97e-06	4.43	0.000806	862
76100ND1218	369	0.399	349	8.57e-06	8.72	0.00128	827
73100NB0514	227	0.248	231	8.98e-06	5.31	0.000874	819
71150ND1210	233	0.255	239	9.6e-06	5.45	0.000909	882
40150NB1214	318	0.346	313	1.01e-05	7.47	0.00117	948
73150NB0514	282	0.308	280	9.58e-06	6.63	0.00105	883

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	709	32.7	681	19.3	0.00155	0.524	15.8	0.00134	0.212	2.6e-05	0.0787	0.0299
Maximum	1810	107	1700	48.6	0.00768	7.51	44.2	0.00327	0.369	2.6e-05	0.0787	0.0299
Mean	1080	58.4	1020	29.1	0.00372	2.08	26.1	0.00204	0.307	2.6e-05	0.0787	0.0299
Median	957	59.9	914	26.4	0.00366	0.61	21.9	0.00179	0.341	2.6e-05	0.0787	0.0299
37.40ND2012	1810	107	1700	48.6	0.00768	5.88	44.2	0.00327	0.242	2.6e-05	0.0787	0.0299
37.42ND2012	1730	97.5	1620	46.1	0.00704	6.28	43.1	0.0032	0.23	2.6e-05	0.0787	0.0299
37.45ND2012	1650	89.4	1560	44.2	0.00637	6.69	42.1	0.00314	0.221	2.6e-05	0.0787	0.0299

37.50ND2012	1580	81.2	1500	42.3	0.00562	7.09	41	0.00307	0.218	2.6e-05	0.0787	0.0299
37.55ND2012	1360	70.1	1280	36.4	0.00496	7.51	39.5	0.00296	0.212	2.6e-05	0.0787	0.0299
24005NB0520	712	32.7	683	19.3	0.00158	0.534	15.8	0.00134	0.369	2.6e-05	0.0787	0.0299
24007NB0520	709	33	681	19.4	0.00155	0.534	15.8	0.00134	0.369	2.6e-05	0.0787	0.0299
24010NB0520	726	34.7	693	19.9	0.00171	0.539	16.2	0.00137	0.367	2.6e-05	0.0787	0.0299
24015NB0514	766	36.7	729	20.6	0.00189	0.531	17	0.00143	0.349	2.6e-05	0.0787	0.0299
24020NB0518	775	39.1	734	21.1	0.00204	0.55	17.2	0.00143	0.357	2.6e-05	0.0787	0.0299
68025NB0514	767	37.2	729	21	0.00185	0.539	17.2	0.00145	0.355	2.6e-05	0.0787	0.0299
24025NB0514	798	40.6	760	21.8	0.0021	0.543	17.7	0.00148	0.344	2.6e-05	0.0787	0.0299
24030NB0520	805	42.7	759	22	0.00231	0.567	17.8	0.00147	0.358	2.6e-05	0.0787	0.0299
77035ND2010	1140	59.9	1080	30.7	0.00386	0.559	29.1	0.00224	0.266	2.6e-05	0.0787	0.0299
68035NB0514	796	40.6	754	21.6	0.00216	0.551	17.8	0.00149	0.352	2.6e-05	0.0787	0.0299
24035NB0518	825	43.8	781	22.5	0.00247	0.569	18.2	0.0015	0.352	2.6e-05	0.0787	0.0299
39036ND2006	1340	60.9	1270	35.5	0.00407	7.08	37.4	0.00283	0.227	2.6e-05	0.0787	0.0299
39038ND2010	1370	65	1300	36.2	0.00438	6.81	37.7	0.00284	0.234	2.6e-05	0.0787	0.0299
39040ND2010	1380	66.7	1310	36.7	0.00473	6.65	38	0.00285	0.231	2.6e-05	0.0787	0.0299
24040NB0520	833	44.9	784	22.7	0.00255	0.578	18.3	0.00151	0.356	2.6e-05	0.0787	0.0299
77042ND4014	1260	71	1180	34	0.0049	0.61	31.8	0.00241	0.262	2.6e-05	0.0787	0.0299
77045NB4014	1280	74.5	1200	34.7	0.00516	0.629	32.1	0.00243	0.267	2.6e-05	0.0787	0.0299
77048ND4014	1310	77.6	1220	35.3	0.00521	0.635	32.8	0.00247	0.265	2.6e-05	0.0787	0.0299
77050ND4014	1330	80	1240	35.8	0.00554	0.647	33.3	0.0025	0.266	2.6e-05	0.0787	0.0299
76050ND1218	906	63.5	842	25.1	0.00435	0.673	19.4	0.00151	0.365	2.6e-05	0.0787	0.0299
24050NB0514	861	46.3	813	23.6	0.00263	0.571	19	0.00156	0.341	2.6e-05	0.0787	0.0299
24075NB0518	845	46.3	799	23.2	0.00261	0.582	18.9	0.00156	0.356	2.6e-05	0.0787	0.0299
01100NB2018	957	44.4	914	25.6	0.0026	0.524	24.3	0.00192	0.305	2.6e-05	0.0787	0.0299
76100ND1218	953	67.9	885	26.4	0.00475	0.695	20.4	0.00157	0.362	2.6e-05	0.0787	0.0299

73100NB0514	919	51.1	872	25.2	0.00298	0.617	20.6	0.00169	0.362	2.6e-05	0.0787	0.0299
71150ND1210	992	54.8	940	27.2	0.00311	0.558	21.9	0.0018	0.294	2.6e-05	0.0787	0.0299
40150NB1214	1080	65	1010	29.6	0.00424	0.642	23.3	0.00187	0.322	2.6e-05	0.0787	0.0299
73150NB0514	1000	60.2	940	27.5	0.00366	0.653	22.2	0.00179	0.359	2.6e-05	0.0787	0.0299

Mix designs: 15 to 20 MPa

Table 15: **Total life cycle (across modules in scope) impact results for Mix designs: 15 to 20MPa, assuming the geometric mean point values on a per 1 m3 of concrete basis**

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	254	0.278	258	9.3e-06	5.95	0.000976	904
Maximum	445	0.48	416	1.02e-05	10.5	0.00152	948
Mean	329	0.357	321	9.82e-06	7.73	0.00119	920
Median	308	0.336	304	9.89e-06	7.24	0.00114	915
71175ND1214	254	0.278	258	9.8e-06	5.95	0.000976	905
71200ND1214	270	0.295	272	9.99e-06	6.33	0.00103	925
76200ND1218	445	0.48	416	9.3e-06	10.5	0.00152	904
73200NB0518	346	0.376	337	1.02e-05	8.14	0.00125	948

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	1020	57.3	961	27.9	0.0034	0.577	22.4	0.0017	0.296	2.6e-05	0.0787	0.0299
Maximum	1080	81	1010	29.8	0.00577	0.746	23.8	0.00189	0.366	2.6e-05	0.0787	0.0299
Mean	1050	67.1	980	28.9	0.00432	0.654	22.9	0.00182	0.33	2.6e-05	0.0787	0.0299
Median	1050	65	974	28.9	0.00404	0.646	22.6	0.00186	0.33	2.6e-05	0.0787	0.0299
71175ND1214	1020	57.3	961	27.9	0.0034	0.577	22.4	0.00184	0.298	2.6e-05	0.0787	0.0299
71200ND1214	1050	59.9	981	28.6	0.00363	0.587	22.9	0.00187	0.296	2.6e-05	0.0787	0.0299
76200ND1218	1050	81	968	29.2	0.00577	0.746	22.4	0.0017	0.361	2.6e-05	0.0787	0.0299
73200NB0518	1080	70.2	1010	29.8	0.00446	0.705	23.8	0.00189	0.366	2.6e-05	0.0787	0.0299

Mix designs: 21 to 25 MPa

Table 16: **Total life cycle (across modules in scope) impact results for Mix designs: 21 to 25MPa, assuming the geometric mean point values on a per 1 m3 of concrete basis**

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	277	0.303	279	1.01e-05	6.5	0.00105	933
Maximum	387	0.42	374	1.15e-05	9.12	0.00138	1020
Mean	332	0.362	328	1.08e-05	7.81	0.00123	988
Median	332	0.362	328	1.08e-05	7.81	0.00124	1000
71210ND1214	277	0.303	279	1.01e-05	6.5	0.00105	933
70250ND2014	287	0.315	291	1.15e-05	6.73	0.00113	1000
40250NB1210	377	0.409	366	1.08e-05	8.88	0.00136	1020
73250NB0514	387	0.42	374	1.07e-05	9.12	0.00138	1000

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	1050	59.7	993	28.8	0.0036	0.574	23.2	0.00188	0.288	2.6e-05	0.0787	0.0299
Maximum	1170	76.1	1090	32	0.00504	0.726	28.6	0.00219	0.358	2.6e-05	0.0787	0.0299
Mean	1120	67.8	1050	30.7	0.00431	0.641	25.5	0.00201	0.313	2.6e-05	0.0787	0.0299
Median	1140	67.8	1060	31	0.0043	0.633	25.2	0.00199	0.304	2.6e-05	0.0787	0.0299
71210ND1214	1050	60.9	993	28.8	0.0036	0.591	23.2	0.00188	0.296	2.6e-05	0.0787	0.0299
70250ND2014	1130	59.7	1060	30.2	0.00375	0.574	28.6	0.00219	0.288	2.6e-05	0.0787	0.0299
40250NB1210	1170	74.7	1090	32	0.00504	0.674	25.2	0.002	0.311	2.6e-05	0.0787	0.0299
73250NB0514	1150	76.1	1060	31.7	0.00486	0.726	25.1	0.00198	0.358	2.6e-05	0.0787	0.0299

Mix designs: 26 to 30 MPa

Table 17: **Total life cycle (across modules in scope) impact results for Mix designs: 26 to 30MPa, 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	335	0.365	330	1.07e-05	7.88	0.00123	997
Maximum	547	0.597	539	1.74e-05	12.9	0.00209	1680
Mean	425	0.462	414	1.26e-05	10	0.00156	1190
Median	408	0.443	394	1.11e-05	9.62	0.00146	1040
71280ND1214	335	0.365	330	1.07e-05	7.88	0.00123	997
71300NB1218	372	0.404	362	1.09e-05	8.75	0.00135	1030
56300NB1265	547	0.597	539	1.74e-05	12.9	0.00209	1680
73300NB0518	445	0.482	425	1.12e-05	10.5	0.00156	1060

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	1130	69.9	1060	31.2	0.00431	0.631	24.8	0.00199	0.234	2.6e-05	0.0787	0.0299
Maximum	1900	101	1790	50.6	0.00701	7.91	43.7	0.00327	0.37	2.6e-05	0.0787	0.0299
Mean	1360	82.7	1270	37	0.00546	2.5	30.1	0.00234	0.303	2.6e-05	0.0787	0.0299
Median	1200	80	1110	33	0.00526	0.726	26	0.00205	0.304	2.6e-05	0.0787	0.0299
71280ND1214	1130	69.9	1060	31.2	0.00431	0.631	24.8	0.00199	0.295	2.6e-05	0.0787	0.0299
71300NB1218	1180	75.7	1090	32.3	0.00483	0.673	25.5	0.00203	0.312	2.6e-05	0.0787	0.0299
56300NB1265	1900	101	1790	50.6	0.00701	7.91	43.7	0.00327	0.234	2.6e-05	0.0787	0.0299
73300NB0518	1210	84.3	1130	33.8	0.00569	0.778	26.5	0.00207	0.37	2.6e-05	0.0787	0.0299

Mix designs: 31 to 35 MPa

Table 18: **Total life cycle (across modules in scope) impact results for Mix designs: 31 to 35MPa, 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	350	0.382	347	1.16e-05	8.22	0.00133	1080
Maximum	494	0.535	469	1.26e-05	11.7	0.00172	1120
Mean	422	0.459	408	1.2e-05	9.96	0.00153	1100
Median	422	0.459	409	1.19e-05	9.96	0.00154	1110
70320ND2010	350	0.382	347	1.22e-05	8.22	0.00133	1080
70350ND2010	383	0.418	377	1.26e-05	9.01	0.00144	1120
40350NB1010	462	0.5	441	1.16e-05	10.9	0.00163	1110
73350NB0518	494	0.535	469	1.17e-05	11.7	0.00172	1110

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	1220	68.3	1150	32.9	0.00467	0.611	27.5	0.00215	0.28	2.6e-05	0.0787	0.0299
Maximum	1280	91.6	1190	35.5	0.00638	0.815	31.6	0.00239	0.372	2.6e-05	0.0787	0.0299
Mean	1260	80.3	1180	34.4	0.00554	0.7	29.4	0.00226	0.312	2.6e-05	0.0787	0.0299
Median	1280	80.6	1190	34.7	0.00555	0.686	29.3	0.00224	0.298	2.6e-05	0.0787	0.0299
70320ND2010	1220	68.3	1150	32.9	0.00467	0.611	30.7	0.00233	0.28	2.6e-05	0.0787	0.0299
70350ND2010	1270	73	1190	34.1	0.00502	0.635	31.6	0.00239	0.281	2.6e-05	0.0787	0.0299
40350NB1010	1280	88.3	1190	35.2	0.00608	0.737	27.5	0.00215	0.315	2.6e-05	0.0787	0.0299
73350NB0518	1280	91.6	1190	35.5	0.00638	0.815	27.9	0.00216	0.372	2.6e-05	0.0787	0.0299

Mix designs: 36 to 40 MPa

Table 19: **Total life cycle (across modules in scope) impact results for Mix designs: 41 to 45MPa, 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	425	0.461	410	1.15e-05	10	0.00151	1090
Maximum	570	0.617	539	1.67e-05	13.5	0.00199	1540
Mean	506	0.55	488	1.39e-05	12	0.00183	1300
Median	524	0.572	515	1.36e-05	12.4	0.00198	1260
71360NB1214	425	0.461	410	1.15e-05	10	0.00151	1090
13400ND2012	524	0.572	515	1.67e-05	12.4	0.00198	1540
40400NB1218	570	0.617	539	1.36e-05	13.5	0.00199	1260

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	1250	83.4	1160	34.3	0.00543	0.704	27.1	0.00214	0.229	2.6e-05	0.0787	0.0299
Maximum	1740	103	1640	46.6	0.00736	6.49	42.7	0.00318	0.305	2.6e-05	0.0787	0.0299
Mean	1480	93.4	1380	40.3	0.0065	2.65	34.4	0.00261	0.271	2.6e-05	0.0787	0.0299
Median	1460	93.8	1350	40.1	0.00672	0.77	33.4	0.00252	0.279	2.6e-05	0.0787	0.0299
71360NB1214	1250	83.4	1160	34.3	0.00543	0.704	27.1	0.00214	0.305	2.6e-05	0.0787	0.0299
13400ND2012	1740	93.8	1640	46.6	0.00672	6.49	42.7	0.00318	0.229	2.6e-05	0.0787	0.0299
40400NB1218	1460	103	1350	40.1	0.00736	0.77	33.4	0.00252	0.279	2.6e-05	0.0787	0.0299

Mix designs: 41 to 45 MPa

Table 20: **Total life cycle (across modules in scope) impact results for Mix designs: 41 to 45MPa, 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	545	0.592	518	1.43e-05	12.9	0.00193	1180
Maximum	691	0.751	666	1.87e-05	16.3	0.00255	1860
Mean	601	0.653	579	1.67e-05	14.2	0.0022	1550
Median	566	0.617	552	1.72e-05	13.4	0.00212	1600
60420NB1212	545	0.592	518	1.43e-05	12.9	0.00193	1180
13450ND2010	566	0.617	552	1.72e-05	13.4	0.00212	1600
56450NB1265	691	0.751	666	1.87e-05	16.3	0.00255	1860

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	1360	91.3	1260	36.8	0.00672	0.694	38.3	0.00276	0.228	2.6e-05	0.0787	0.0299
Maximum	2110	125	1990	56.9	0.00893	6.86	46.6	0.00346	0.249	2.6e-05	0.0787	0.0299
Mean	1760	106	1650	47.4	0.00759	4.6	42.9	0.00316	0.239	2.6e-05	0.0787	0.0299
Median	1820	102	1700	48.5	0.00712	6.24	43.7	0.00325	0.24	2.6e-05	0.0787	0.0299
60420NB1212	1360	91.3	1260	36.8	0.00672	0.694	38.3	0.00276	0.249	2.6e-05	0.0787	0.0299
13450ND2010	1820	102	1700	48.5	0.00712	6.24	43.7	0.00325	0.228	2.6e-05	0.0787	0.0299
56450NB1265	2110	125	1990	56.9	0.00893	6.86	46.6	0.00346	0.24	2.6e-05	0.0787	0.0299

Mix designs: 46 to 50 MPa

Table 21: **Total life cycle (across modules in scope) impact results for Mix designs: 46 to 50MPa, 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	624	0.678	602	1.76e-05	14.7	0.0023	1650
Maximum	740	0.804	710	1.91e-05	17.5	0.00271	1930
Mean	682	0.741	656	1.84e-05	16.1	0.00251	1790
Median	682	0.741	656	1.84e-05	16.1	0.00251	1790
13500ND2012	624	0.678	602	1.76e-05	14.7	0.0023	1650
56500NB1265	740	0.804	710	1.91e-05	17.5	0.00271	1930

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	1880	110	1760	50.6	0.00812	5.89	44.7	0.00331	0.236	2.6e-05	0.0787	0.0299
Maximum	2200	131	2050	59	0.00985	6.49	47.6	0.00352	0.243	2.6e-05	0.0787	0.0299
Mean	2040	120	1900	54.8	0.00898	6.19	46.2	0.00342	0.24	2.6e-05	0.0787	0.0299
Median	2040	120	1900	54.8	0.00898	6.19	46.2	0.00342	0.24	2.6e-05	0.0787	0.0299
13500ND2012	1880	110	1760	50.6	0.00812	5.89	44.7	0.00331	0.236	2.6e-05	0.0787	0.0299
56500NB1265	2200	131	2050	59	0.00985	6.49	47.6	0.00352	0.243	2.6e-05	0.0787	0.0299

Mix designs: 51 to 55 MPa

Table 22: **Total life cycle (across modules in scope) impact results for Mix designs: 51 to 55MPa, 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	660	0.717	636	1.81e-05	15.6	0.00242	1730
Maximum	750	0.814	718	1.92e-05	17.7	0.00274	1940
Mean	705	0.766	677	1.86e-05	16.6	0.00258	1840
Median	705	0.766	677	1.86e-05	16.6	0.00258	1840
13550ND2010	660	0.717	636	1.81e-05	15.6	0.00242	1730
56550NB1275	750	0.814	718	1.92e-05	17.7	0.00274	1940

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	1970	116	1840	52.7	0.0086	5.68	45.8	0.00338	0.226	2.6e-05	0.0787	0.0299
Maximum	2210	133	2070	59.3	0.00959	6.44	47.7	0.00353	0.247	2.6e-05	0.0787	0.0299
Mean	2090	124	1960	56	0.00909	6.06	46.8	0.00346	0.236	2.6e-05	0.0787	0.0299
Median	2090	124	1960	56	0.00909	6.06	46.8	0.00346	0.236	2.6e-05	0.0787	0.0299
13550ND2010	1970	116	1840	52.7	0.0086	5.68	45.8	0.00338	0.226	2.6e-05	0.0787	0.0299
56550NB1275	2210	133	2070	59.3	0.00959	6.44	47.7	0.00353	0.247	2.6e-05	0.0787	0.0299

Mix designs: 56 to 60 MPa

Table 23: **Total life cycle (across modules in scope) impact results for Mix designs: 56 to 60MPa, 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	658	0.715	628	1.75e-05	15.6	0.00231	1450
Maximum	729	0.791	697	1.87e-05	17.2	0.00264	1810
Mean	694	0.753	662	1.81e-05	16.4	0.00247	1630
Median	694	0.753	662	1.81e-05	16.4	0.00247	1630
13600ND2012	729	0.791	697	1.87e-05	17.2	0.00264	1810
60600NB1275	658	0.715	628	1.75e-05	15.6	0.00231	1450

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	1660	113	1540	45.5	0.0082	5.35	46.1	0.00338	0.226	2.6e-05	0.0787	0.0299
Maximum	2070	129	1930	55.9	0.00943	7.98	47.2	0.00348	0.255	2.6e-05	0.0787	0.0299
Mean	1860	121	1740	50.7	0.00882	6.66	46.7	0.00343	0.24	2.6e-05	0.0787	0.0299
Median	1860	121	1740	50.7	0.00882	6.66	46.7	0.00343	0.24	2.6e-05	0.0787	0.0299
13600ND2012	2070	129	1930	55.9	0.00943	5.35	47.2	0.00348	0.226	2.6e-05	0.0787	0.0299
60600NB1275	1660	113	1540	45.5	0.0082	7.98	46.1	0.00338	0.255	2.6e-05	0.0787	0.0299

Mix designs: >60 MPa

Table 24: **Total life cycle (across modules in scope) impact results for Mix designs: >60MPa, assuming the geometric mean point values on a per 1 m3 of concrete basis**

a) Midpoint Impact Categories:

b) 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	700	0.76	669	1.79e-05	16.6	0.00255	1760
Maximum	733	0.795	701	1.87e-05	17.3	0.00266	1840
Mean	713	0.774	682	1.82e-05	16.8	0.0026	1810
Median	710	0.77	679	1.8e-05	16.8	0.0026	1820
14650NB2022	700	0.76	669	1.79e-05	16.6	0.00255	1760
14700NB2022	708	0.768	677	1.8e-05	16.7	0.00259	1800
60700NB2024	733	0.795	701	1.87e-05	17.3	0.00266	1830
14750NB2022	711	0.772	681	1.81e-05	16.8	0.00261	1840

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	2010	124	1890	54.2	0.00886	3.3	45.2	0.00332	0.232	2.6e-05	0.0787	0.0299
Maximum	2100	127	1970	56.3	0.00949	5.64	47.3	0.00348	0.237	2.6e-05	0.0787	0.0299
Mean	2060	125	1940	55.5	0.00921	4	45.9	0.00336	0.234	2.6e-05	0.0787	0.0299
Median	2070	125	1940	55.8	0.00925	3.53	45.5	0.00333	0.234	2.6e-05	0.0787	0.0299
14650NB2022	2010	124	1890	54.2	0.00886	3.6	45.2	0.00332	0.232	2.6e-05	0.0787	0.0299
14700NB2022	2060	124	1930	55.4	0.00919	3.45	45.4	0.00333	0.237	2.6e-05	0.0787	0.0299
60700NB2024	2080	127	1950	56.3	0.00949	5.64	47.3	0.00348	0.234	2.6e-05	0.0787	0.0299
14750NB2022	2100	126	1970	56.2	0.00931	3.3	45.6	0.00333	0.235	2.6e-05	0.0787	0.0299

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.