Environmental Product Declaration

Environmental Product Declaration for various ready mix concrete products produced by Holcim México Operaciones S.A. de C.V. at their Cuautitlan facility in Alvaro Obregon

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:	29 July 2023
Period of Validity:	5 years; valid until 29 July 2028
EPD Number:	64cd99cd-7c7c-441d-aa8a-680a36e75e69

TABLE OF CONTENTS

ADMINISTRATIVE INFORMATION 1
COMPANY DESCRIPTION 3
STUDY GOAL 3
DESCRIPTION OF PRODUCT AND SCOPE 4
READY MIX CONCRETE DESIGN SUMMARY 4
READY MIX CONCRETE DESIGN COMPOSITION 8
SYSTEM BOUNDARIES 9
CUT-OFF CRITERIA 10
DATA SOURCES AND DATA QUALITY ASSESSMENT 10
Raw material transport: 10
Electricity: 10
Process/space heating: 10
Fuel required for machinery: 10
Waste generation: 11
Recovered energy: 11
Recycled/reused material/components: 11
Module A1 material losses: 11
Direct A3 emissions accounting: 11
Waste transport requirements: 11
Product transport requirements: 11
DATA QUALITY ASSESSMENT 12
ENVIRONMENTAL INDICATORS AND INVENTORY METRICS 13
LIMITATIONS 14
TOTAL IMPACT SUMMARY 14
ADDITIONAL ENVIRONMENTAL INFO 24
REFERENCES 25
ASTM Standards: 25
CSA Standards: 26
ISO Standards: 27
EN Standards: 27
Other References: 27

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 55 concrete mixes manufactured at the Holcim Mexico Operaciones S.A. de C.V. Cuautitlan concrete facility in Ciudad de Mexico, 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	3745NB2012	0.04 MPa 28d strength Ready mix concrete	Ready mix concrete	0.04	0.47
2	24005NB0524	0.49 MPa 28d strength mortars and fillers	mortars and fillers	0.49	4.66
3	24007NB0524	0.69 MPa 28d strength mortars and fillers	mortars and fillers	0.69	4.66
4	24010NB0524	0.98 MPa 28d strength mortars and fillers	mortars and fillers	0.98	4.08
5	24015NB0524	1.47 MPa 28d strength mortars and fillers	mortars and fillers	1.47	3.37
6	24020NB0524	1.96 MPa 28d strength mortars and fillers	mortars and fillers	1.96	3.03
7	24025NB0524	2.45 MPa 28d strength mortars and fillers	mortars and fillers	2.45	2.75
8	24030NB0524	2.94 MPa 28d strength mortars and fillers	mortars and fillers	2.94	2.51
9	39035ND4010	3.43 MPa 28d strength Ready mix concrete	Ready mix concrete	3.43	0.74
10	68035ND4010	3.43 MPa 28d strength special concrete	special concrete	3.43	0.89

11	24035NB0524	3.43 MPa 28d strength mortars and fillers	mortars and fillers	3.43	2.31
12	39036ND4012	3.53 MPa 28d strength Ready mix concrete	Ready mix concrete	3.53	0.72
13	77038ND4010	3.73 MPa 28d strength Ready mix concrete	Ready mix concrete	3.73	0.78
14	77040ND4010	3.93 MPa 28d strength Ready mix concrete	Ready mix concrete	3.93	0.74
15	24040NB0524	3.93 MPa 28d strength mortars and fillers	mortars and fillers	3.93	2.22
16	77042ND4010	4.12 MPa 28d strength Ready mix concrete	Ready mix concrete	4.12	0.70
17	60042ND4014	4.12 MPa 28d strength special concrete	special concrete	4.12	0.54
18	39045ND2012	4.42 MPa 28d strength Ready mix concrete	Ready mix concrete	4.42	0.61
19	68045ND4010	4.42 MPa 28d strength special concrete	special concrete	4.42	0.67
20	39048ND2012	4.71 MPa 28d strength Ready mix concrete	Ready mix concrete	4.71	0.62
21	68048ND4014	4.71 MPa 28d strength special concrete	special concrete	4.71	0.62
22	77050ND4010	4.91 MPa 28d strength Ready mix concrete	Ready mix concrete	4.91	0.61
23	24050NB0514	4.91 MPa 28d strength mortars and fillers	mortars and fillers	4.91	2.01
24	24075NB0518	7.36 MPa 28d strength mortars and fillers	mortars and fillers	7.36	1.37
25	70100ND2010	9.81 MPa 28d strength Ready mix concrete	Ready mix concrete	9.81	1.21
26	76100NB1218	9.81 MPa 28d strength special concrete	special concrete	9.81	0.84
27	73100NB0518	9.81 MPa 28d strength mortars and fillers	mortars and fillers	9.81	1.48
28	71150ND1210	14.72 MPa 28d strength Ready mix concrete	Ready mix concrete	14.72	0.94
29	27150NB1200	14.72 MPa 28d strength special concrete ,dry mix only	special concrete	14.72	0.00
30	73150NB0518	14.72 MPa 28d strength mortars and fillers	mortars and fillers	14.72	1.18

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
31	70175ND2014	17.17 MPa 28d strength Ready mix concrete	Ready mix concrete	17.17	0.97

32	70200NB2014	19.63 MPa 28d strength Ready mix concrete	Ready mix concrete	19.63	0.91
33	27200NB1200	19.63 MPa 28d strength special concrete, dry mix only	special concrete	19.63	0.00
34	73200NB0518	19.63 MPa 28d strength mortars and fillers	mortars and fillers	19.63	0.98

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
35	71210ND1214	20.61 MPa 28d strength Ready mix concrete	Ready mix concrete	20.61	0.81
36	04250NB4012	24.53 MPa 28d strength Ready mix concrete	Ready mix concrete	24.53	0.67
37	68250NB1218	24.53 MPa 28d strength special concrete	special concrete	24.53	0.76
38	73250NB0518	24.53 MPa 28d strength mortars and fillers	mortars and fillers	24.53	0.85

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
39	04280ND2012	27.48 MPa 28d strength Ready mix concrete	Ready mix concrete	27.48	0.71
40	70300ND2010	29.44 MPa 28d strength Ready mix concrete	Ready mix concrete	29.44	0.68
41	27300NB1200	29.44 MPa 28d strength special concrete ,dry mix only	special concrete	29.44	0.00
42	73300NB0518	29.44 MPa 28d strength mortars and fillers	mortars and fillers	29.44	0.76

Mix designs: 31 to 35 MPa

Table 5: **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
43	70320ND2010	31.4 MPa 28d strength Ready mix concrete	Ready mix concrete	31.40	0.65
44	02350NB2018	34.35 MPa 28d strength Ready mix concrete	Ready mix concrete	34.35	0.62
45	56350NB1265	34.35 MPa 28d strength special concrete	special concrete	34.35	0.44
46	73350NB0518	34.35 MPa 28d strength mortars and fillers	mortars and fillers	34.35	0.69

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
47	70360NB2014	35.33 MPa 28d strength Ready mix concrete	Ready mix concrete	35.33	0.59
48	13400ND2010	39.25 MPa 28d strength Ready mix concrete	Ready mix concrete	39.25	0.41
49	56400NB1265	39.25 MPa 28d strength special concrete	special concrete	39.25	0.41

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
50	13450ND2012	44.16 MPa 28d strength Ready mix concrete	Ready mix concrete	44.16	0.38
51	56450NB1275	44.16 MPa 28d strength special concrete	special concrete	44.16	0.38

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
52	13500ND2012	49.07 MPa 28d strength Ready mix concrete	Ready mix concrete	49.07	0.36
53	56500NB1265	49.07 MPa 28d strength special concrete	special concrete	49.07	0.35

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
54	13550ND2012	53.97 MPa 28d strength Ready mix concrete	Ready mix concrete	53.97	0.32

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
33	14650NB2018	66.68 MPa 28d strength Ready mix concrete	Ready mix concrete	66.68	0.1860119

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 11: **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:

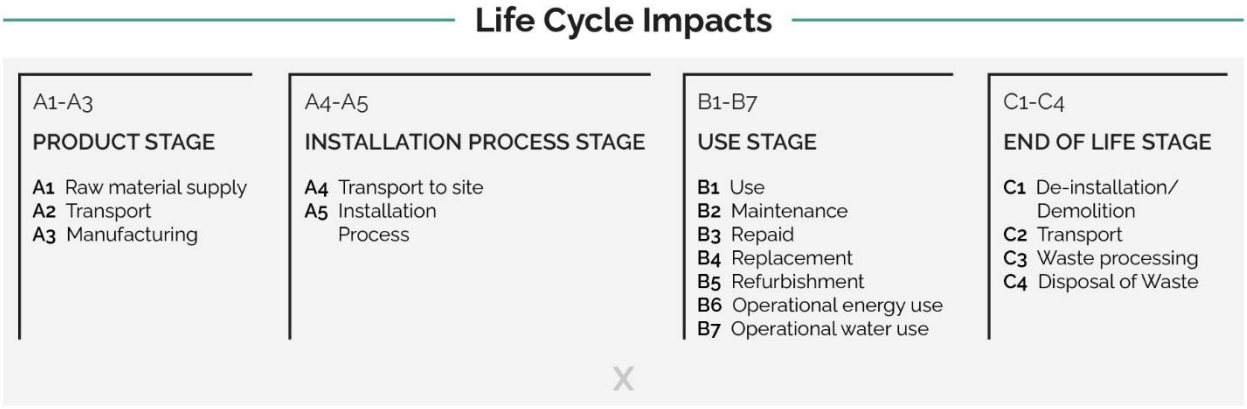

Figure 1: **General life cycle phases for consideration in a construction works system**

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 ready mix concrete products and is not necessarily exhaustive.

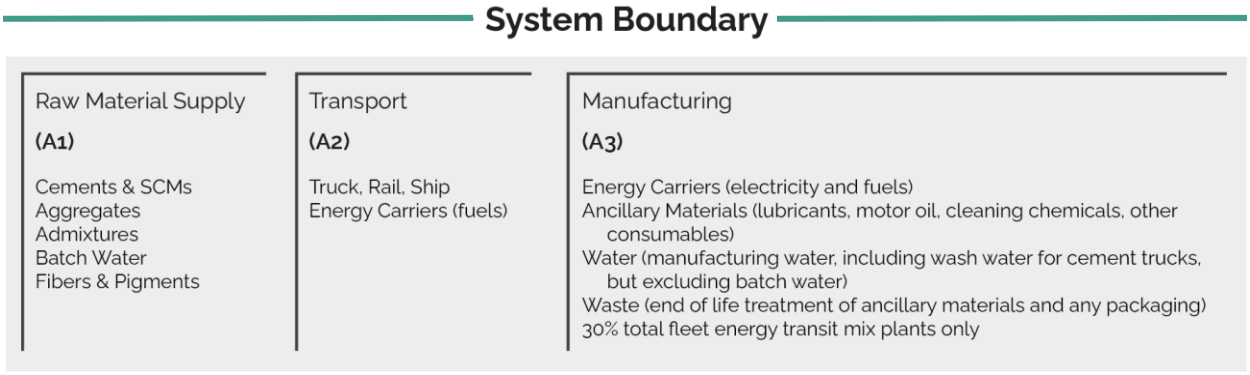

Figure 2: **General system inputs considered in the product system and categorized by modules in scope**

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 México Operaciones S.A. de C.V., is located at their Planta Cuautitlan 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 12: **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	Estado de México	v3.8 in 2021	2	3	1	3	3
Water	tap water production, conventional with biological treatment/tap water/RoW/kg	ecoinvent v3.8	Estado de Mexico	v3.8 in 2021	2	3	1	3	3
Limestone Gravel	limestone quarry operation/limestone, unprocessed/RoW/kg;	ecoinvent v3.8	Estado de Mexico	v3.8 in 2021	2	3	1	3	3

	Note: modifications made (see ecoinvent activity changes table)								
Additives	market for chemical, organic/chemical, organic/GLO/kg	ecoinvent v3.8	Estado de Mexico	v3.8 in 2021	2	3	1	3	3
Cement (CPC 40) Apaxco	CPC 40	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
Cement (CPO 30R R) PROVEEDOR: HOLCI Orizaba	CPC 30R	Progam Operator: Labeling Sustainability - EPD ID: 565b7deb-ebd6-4cb3-9aa6-a585381c41f3	Veracruz	25 February 2023	3	3	3	3	3
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, Hidalgo	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.

LIMITATIONS

This EPD is a declaration of potential environmental impact and does not support or provide definitive comparisons of the environmental performance of specific products. Only EPDs prepared from cradle-to-grave life cycle results and based on the same function and reference service life and quantified by the same functional unit can be used to assist purchasers and users in making informed comparisons between products.

LCIA results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks. Further, LCA offers a wide array of environmental impact indicators, and this EPD reports a collection of those, as specified by the PCR.

In addition to the impact results, this EPD provides several metrics related to resource consumption and waste generation. While these data may be informational in other ways, they do not provide a measure of impact on the environment

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 13: **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	21.4	0.0365	101	6.79e-06	0.247	0.000357	608
Maximum	438	0.473	520	4.32e-05	10.4	0.00143	3290
Mean	193	0.216	267	1.42e-05	4.44	0.000812	1170
Median	162	0.178	270	9.72e-06	3.78	0.000667	872
3745NB2012	43.8	0.0766	520	4.32e-05	0.481	0.000779	3290
24005NB0524	87.3	0.0981	101	6.79e-06	1.99	0.000406	608
24007NB0524	87.3	0.0981	101	6.79e-06	1.99	0.000406	608
24010NB0524	97.6	0.109	110	6.9e-06	2.24	0.000438	620
24015NB0524	115	0.128	124	7.08e-06	2.65	0.00049	640
24020NB0524	126	0.139	134	7.2e-06	2.91	0.000524	653
24025NB0524	137	0.151	143	7.32e-06	3.17	0.000558	667

24030NB0524	148	0.163	152	7.43e-06	3.44	0.000591	678
39035ND4010	30.3	0.0525	324	2.85e-05	0.351	0.000537	2150
68035ND4010	275	0.3	258	9.16e-06	6.47	0.000989	795
24035NB0524	159	0.175	162	7.54e-06	3.7	0.000624	690
39036ND4012	31	0.0538	336	2.92e-05	0.357	0.000548	2210
77038ND4010	323	0.353	302	1.01e-05	7.62	0.00114	900
77040ND4010	340	0.37	316	1.02e-05	8.01	0.00119	915
24040NB0524	165	0.182	167	7.61e-06	3.86	0.000644	697
77042ND4010	356	0.388	329	1.03e-05	8.41	0.00124	923
60042ND4014	38.7	0.067	454	3.72e-05	0.428	0.000667	2820
39045ND2012	35.2	0.0608	404	3.36e-05	0.393	0.000608	2540
68045ND4010	357	0.388	327	9.87e-06	8.44	0.00123	874
39048ND2012	34.9	0.0606	397	3.34e-05	0.392	0.00061	2530
68048ND4014	403	0.438	366	1.02e-05	9.54	0.00137	915
77050ND4010	411	0.446	375	1.07e-05	9.71	0.0014	972
24050NB0514	169	0.186	173	8.15e-06	3.94	0.000668	745
24075NB0518	21.4	0.0365	232	1.94e-05	0.247	0.000357	1460
70100ND2010	219	0.241	215	9.09e-06	5.13	0.000833	806
76100NB1218	438	0.473	390	8.72e-06	10.4	0.00143	860
73100NB0518	236	0.259	231	9.21e-06	5.54	0.000876	843
71150ND1210	275	0.301	262	9.73e-06	6.47	0.001	871
27150NB1200	343	0.373	319	1.03e-05	8.09	0.00118	892
73150NB0518	291	0.318	277	9.71e-06	6.85	0.00104	899

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	670	28.4	640	18	0.00038	0.426	16	0.00131	0	2.2e-05	0.0603	0.0264
Maximum	3600	77.3	3530	86.9	0.00556	6.43	54.6	0.00433	0.381	2.2e-05	0.0603	0.0264
Mean	1300	50.1	1250	33.3	0.0026	1.32	25.9	0.00204	0.298	2.2e-05	0.0603	0.0264
Median	997	50.3	929	27.2	0.00223	0.656	23.8	0.00186	0.274	2.2e-05	0.0603	0.0264
3745NB2012	3600	65.1	3530	86.9	0.000861	6.43	54.6	0.00433	0.248	2.2e-05	0.0603	0.0264
24005NB0524	672	28.7	648	18	0.00128	0.545	16	0.00131	0.376	2.2e-05	0.0603	0.0264
24007NB0524	670	28.4	640	18	0.00127	0.545	16	0.00131	0.376	2.2e-05	0.0603	0.0264
24010NB0524	691	30.3	655	18.4	0.00135	0.555	16.3	0.00133	0.374	2.2e-05	0.0603	0.0264
24015NB0524	710	33.2	678	19	0.00163	0.57	16.8	0.00136	0.371	2.2e-05	0.0603	0.0264
24020NB0524	727	34.5	691	19.6	0.00176	0.58	17.1	0.00139	0.368	2.2e-05	0.0603	0.0264

24025NB0524	741	36	705	20	0.00189	0.589	17.5	0.00141	0.366	2.2e-05	0.0603	0.0264
24030NB0524	761	37.9	723	20.5	0.00204	0.6	17.7	0.00143	0.365	2.2e-05	0.0603	0.0264
39035ND4010	2330	42.2	2300	56.6	6e-04	3.81	38.8	0.00308	0.234	2.2e-05	0.0603	0.0264
68035ND4010	899	51.4	845	24	0.00362	0.604	23	0.00175	0.26	2.2e-05	0.0603	0.0264
24035NB0524	773	39.5	729	20.7	0.00218	0.61	18	0.00145	0.363	2.2e-05	0.0603	0.0264
39036ND4012	2420	43.2	2370	58.2	0.00061	3.75	39.3	0.00313	0.238	2.2e-05	0.0603	0.0264
77038ND4010	1020	61.9	961	27.6	0.00414	0.676	25	0.00191	0.269	2.2e-05	0.0603	0.0264
77040ND4010	1040	63.3	974	28	0.00436	0.692	25.3	0.00193	0.268	2.2e-05	0.0603	0.0264
24040NB0524	782	40.3	740	21.2	0.00228	0.617	18.2	0.00146	0.363	2.2e-05	0.0603	0.0264
77042ND4010	1050	66.4	983	28.4	0.00472	0.708	25.6	0.00195	0.268	2.2e-05	0.0603	0.0264
60042ND4014	3080	55.9	3040	74.3	0.00073	3.22	45.5	0.00364	0.25	2.2e-05	0.0603	0.0264
39045ND2012	2780	50.5	2720	67.1	0.000664	3.23	42.1	0.00336	0.249	2.2e-05	0.0603	0.0264
68045ND4010	994	63.6	930	26.8	0.00469	0.688	24.9	0.00187	0.258	2.2e-05	0.0603	0.0264
39048ND2012	2760	50.1	2720	66.8	0.000672	3.9	42.9	0.00342	0.248	2.2e-05	0.0603	0.0264
68048ND4014	1050	70.3	977	28.3	0.00516	0.748	25.8	0.00193	0.27	2.2e-05	0.0603	0.0264
77050ND4010	1120	74	1030	30.2	0.00532	0.767	26.8	0.00203	0.271	2.2e-05	0.0603	0.0264
24050NB0514	829	42.7	792	22.5	0.00233	0.601	19.5	0.00156	0.338	2.2e-05	0.0603	0.0264
24075NB0518	1590	29	1570	38.3	0.00038	0.483	24.5	0.00197	0.309	2.2e-05	0.0603	0.0264
70100ND2010	903	47	857	24.2	0.00292	0.577	22.2	0.00174	0.275	2.2e-05	0.0603	0.0264
76100NB1218	1000	77.3	922	27.5	0.00556	0.899	21.7	0.00162	0.381	2.2e-05	0.0603	0.0264
73100NB0518	953	53.3	893	25.9	0.00309	0.691	22.2	0.00176	0.353	2.2e-05	0.0603	0.0264
71150ND1210	988	56.2	928	26.4	0.00359	0.636	23.9	0.00186	0.273	2.2e-05	0.0603	0.0264
27150NB1200	1020	67.7	949	27.8	0.00441	0.426	25.6	0.00198	0	2.2e-05	0.0603	0.0264
73150NB0518	1030	61.7	952	27.7	0.00385	0.745	23.6	0.00185	0.35	2.2e-05	0.0603	0.0264

Mix designs: 15 to 20 MPa

Table 14: **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**

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	278	0.304	264	9.5e-06	6.55	0.00101	788
Maximum	372	0.404	336	1.02e-05	8.8	0.00124	948
Mean	323	0.352	301	9.73e-06	7.62	0.00113	868
Median	322	0.35	302	9.62e-06	7.58	0.00113	868
70175ND2014	278	0.304	264	9.52e-06	6.55	0.00101	856
70200NB2014	297	0.324	280	9.71e-06	6.99	0.00106	879
27200NB1200	372	0.404	336	9.5e-06	8.8	0.00124	788
73200NB0518	346	0.376	323	1.02e-05	8.16	0.0012	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	907	56.6	838	24.8	0.00364	0.425	23.5	0.00181	0	2.2e-05	0.0603	0.0264
Maximum	1080	70.4	1010	29.7	0.00488	0.8	24.9	0.00194	0.348	2.2e-05	0.0603	0.0264
Mean	988	63	924	26.8	0.00422	0.635	24.2	0.00186	0.229	2.2e-05	0.0603	0.0264
Median	982	62.5	924	26.4	0.00417	0.658	24.2	0.00184	0.284	2.2e-05	0.0603	0.0264
70175ND2014	966	56.6	913	26	0.00364	0.646	23.5	0.00181	0.283	2.2e-05	0.0603	0.0264
70200NB2014	999	59.4	934	26.8	0.0038	0.669	23.9	0.00185	0.286	2.2e-05	0.0603	0.0264
27200NB1200	907	65.6	838	24.8	0.00488	0.425	24.5	0.00183	0	2.2e-05	0.0603	0.0264
73200NB0518	1080	70.4	1010	29.7	0.00454	0.8	24.9	0.00194	0.348	2.2e-05	0.0603	0.0264

Mix designs: 21 to 25 MPa

Table 15: **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**

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	32.6	0.0557	300	9.42e-06	0.362	0.00053	816
Maximum	395	0.429	380	3.05e-05	9.34	0.00135	2280
Mean	270	0.299	337	1.52e-05	6.28	0.00104	1250
Median	326	0.356	334	1.04e-05	7.7	0.00115	954
71210ND1214	320	0.349	300	1.01e-05	7.55	0.00114	914
04250NB4012	332	0.362	304	9.42e-06	7.85	0.00116	816
68250NB1218	32.6	0.0557	380	3.05e-05	0.362	0.00053	2280
73250NB0518	395	0.429	365	1.06e-05	9.34	0.00135	995

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	930	45.8	867	24.7	0.000567	0.565	24	0.00179	0.244	2.2e-05	0.0603	0.0264
Maximum	2490	76.9	2450	59.9	0.00502	0.852	36	0.0029	0.349	2.2e-05	0.0603	0.0264
Mean	1400	60.6	1340	36	0.0035	0.684	27.7	0.00215	0.29	2.2e-05	0.0603	0.0264
Median	1090	60	1020	29.7	0.00421	0.661	25.4	0.00197	0.284	2.2e-05	0.0603	0.0264
71210ND1214	1040	62.4	973	28	0.00416	0.684	24.9	0.00192	0.275	2.2e-05	0.0603	0.0264
04250NB4012	930	57.5	867	24.7	0.00425	0.637	24	0.00179	0.244	2.2e-05	0.0603	0.0264
68250NB1218	2490	45.8	2450	59.9	0.000567	0.565	36	0.0029	0.293	2.2e-05	0.0603	0.0264
73250NB0518	1140	76.9	1060	31.4	0.00502	0.852	26	0.00201	0.349	2.2e-05	0.0603	0.0264

Mix designs: 26 to 30 MPa

Table 16: **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	368	0.4	339	1.04e-05	8.68	0.00128	948
Maximum	449	0.486	407	1.11e-05	10.6	0.00149	1030
Mean	409	0.444	374	1.07e-05	9.65	0.00139	974
Median	410	0.444	376	1.07e-05	9.67	0.00139	959
04280ND2012	368	0.4	339	1.04e-05	8.68	0.00128	948
70300ND2010	374	0.407	345	1.04e-05	8.84	0.0013	952
27300NB1200	449	0.486	407	1.11e-05	10.6	0.00148	966
73300NB0518	445	0.482	406	1.1e-05	10.5	0.00149	1030

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	1080	70.3	1010	29.3	0.00477	0.531	25.7	0.00196	0	2.2e-05	0.0603	0.0264
Maximum	1190	85.2	1100	32.8	0.00587	0.905	27.9	0.00212	0.351	2.2e-05	0.0603	0.0264
Mean	1120	77.1	1040	30.6	0.00531	0.726	26.6	0.00203	0.225	2.2e-05	0.0603	0.0264
Median	1100	76.5	1020	30	0.0053	0.734	26.4	0.00202	0.275	2.2e-05	0.0603	0.0264
04280ND2012	1080	70.3	1010	29.3	0.00477	0.732	25.7	0.00196	0.277	2.2e-05	0.0603	0.0264
70300ND2010	1090	70.5	1010	29.4	0.00486	0.735	25.8	0.00197	0.273	2.2e-05	0.0603	0.0264
27300NB1200	1110	82.5	1030	30.7	0.00587	0.531	27.9	0.00212	0	2.2e-05	0.0603	0.0264
73300NB0518	1190	85.2	1100	32.8	0.00575	0.905	27.1	0.00208	0.351	2.2e-05	0.0603	0.0264

Mix designs: 31 to 35 MPa

Table 17: **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	396	0.431	363	1.01e-05	9.37	0.00136	894
Maximum	502	0.549	474	1.64e-05	11.9	0.00183	1510
Mean	459	0.5	420	1.21e-05	10.9	0.00158	1110
Median	470	0.509	422	1.1e-05	11.1	0.00156	1030
70320ND2010	396	0.431	363	1.06e-05	9.37	0.00136	971
02350NB2018	445	0.483	398	1.01e-05	10.6	0.00148	894
56350NB1265	502	0.549	474	1.64e-05	11.9	0.00183	1510
73350NB0518	494	0.535	447	1.14e-05	11.7	0.00164	1080

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	1030	73.2	957	28	0.00521	0.758	25.8	0.0019	0.244	2.2e-05	0.0603	0.0264
Maximum	1710	93.3	1610	45.2	0.00658	7.79	42.4	0.00311	0.353	2.2e-05	0.0603	0.0264
Mean	1280	83.6	1190	34.5	0.00595	2.58	30.7	0.00229	0.292	2.2e-05	0.0603	0.0264
Median	1180	84	1090	32.4	0.006	0.883	27.2	0.00208	0.284	2.2e-05	0.0603	0.0264
70320ND2010	1110	73.2	1030	30.1	0.00521	0.758	26.3	0.002	0.274	2.2e-05	0.0603	0.0264
02350NB2018	1030	74.9	957	28	0.00568	0.807	25.8	0.0019	0.295	2.2e-05	0.0603	0.0264
56350NB1265	1710	93.3	1610	45.2	0.00658	7.79	42.4	0.00311	0.244	2.2e-05	0.0603	0.0264
73350NB0518	1250	93.1	1150	34.6	0.00632	0.958	28.2	0.00215	0.353	2.2e-05	0.0603	0.0264

Mix designs: 36 to 40 MPa

Table 18: **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	456	0.494	413	1.1e-05	10.8	0.00153	1020
Maximum	549	0.599	513	1.67e-05	13	0.00197	1560
Mean	549	0.599	513	1.67e-05	13	0.00197	1560
Median	522	0.565	466	1.14e-05	12.4	0.00175	1090
70360NB2014	456	0.494	413	1.1e-05	10.8	0.00153	1020
13400ND2010	522	0.565	466	1.14e-05	12.4	0.00175	1090
56400NB1265	549	0.599	513	1.67e-05	13	0.00197	1560

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	1180	82.9	1090	32.2	0.00593	0.834	27.5	0.00207	0.237	2.2e-05	0.0603	0.0264
Maximum	1770	102	1670	47.2	0.00719	7.45	42.9	0.00315	0.289	2.2e-05	0.0603	0.0264
Mean	1400	90.5	1310	37.8	0.00658	3.04	33	0.00245	0.257	2.2e-05	0.0603	0.0264
Median	1400	90.5	1310	37.8	0.00658	3.04	33	0.00245	0.257	2.2e-05	0.0603	0.0264
70360NB2014	1180	82.9	1090	32.2	0.00593	0.836	27.5	0.00207	0.289	2.2e-05	0.0603	0.0264
13400ND2010	1260	86.6	1160	33.9	0.00663	0.834	28.7	0.00212	0.237	2.2e-05	0.0603	0.0264
56400NB1265	1770	102	1670	47.2	0.00719	7.45	42.9	0.00315	0.246	2.2e-05	0.0603	0.0264

Mix designs: 41 to 45 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	590	0.638	524	1.21e-05	14	0.00195	1170
Maximum	607	0.661	561	1.69e-05	14.4	0.00214	1610
Mean	598	0.65	542	1.45e-05	14.2	0.00204	1390
Median	598	0.65	542	1.45e-05	14.2	0.00204	1390
13450ND2012	590	0.638	524	1.21e-05	14	0.00195	1170
56450NB1275	607	0.661	561	1.69e-05	14.4	0.00214	1610

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	101	1260	36.8	0.00751	0.916	30.3	0.00223	0.247	2.2e-05	0.0603	0.0264
Maximum	1840	110	1730	49	0.00793	7.03	43.3	0.00317	0.252	2.2e-05	0.0603	0.0264
Mean	1600	106	1500	42.9	0.00772	3.97	36.8	0.0027	0.25	2.2e-05	0.0603	0.0264
Median	1600	106	1500	42.9	0.00772	3.97	36.8	0.0027	0.25	2.2e-05	0.0603	0.0264
13450ND2012	1360	101	1260	36.8	0.00751	0.916	30.3	0.00223	0.247	2.2e-05	0.0603	0.0264
56450NB1275	1840	110	1730	49	0.00793	7.03	43.3	0.00317	0.252	2.2e-05	0.0603	0.0264

Mix designs: 46 to 50 MPa

Table 20: **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	634	0.685	561	1.25e-05	15	0.00208	1220
Maximum	649	0.706	595	1.71e-05	15.4	0.00227	1650
Mean	642	0.696	578	1.48e-05	15.2	0.00217	1440
Median	642	0.696	578	1.48e-05	15.2	0.00217	1440
13500ND2012	634	0.685	561	1.25e-05	15	0.00208	1220
56500NB1265	649	0.706	595	1.71e-05	15.4	0.00227	1650

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	1420	105	1310	38.4	0.00794	0.966	31.3	0.00231	0.25	2.2e-05	0.0603	0.0264
Maximum	1890	117	1770	50.4	0.00849	6.71	43.8	0.0032	0.25	2.2e-05	0.0603	0.0264
Mean	1660	111	1540	44.4	0.00822	3.84	37.6	0.00276	0.25	2.2e-05	0.0603	0.0264
Median	1660	111	1540	44.4	0.00822	3.84	37.6	0.00276	0.25	2.2e-05	0.0603	0.0264
13500ND2012	1420	105	1310	38.4	0.00794	0.966	31.3	0.00231	0.25	2.2e-05	0.0603	0.0264
56500NB1265	1890	117	1770	50.4	0.00849	6.71	43.8	0.0032	0.25	2.2e-05	0.0603	0.0264

Mix designs: 51 to 55 MPa

Table 21: **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	683	0.738	604	1.31e-05	16.2	0.00224	1300
Maximum	683	0.738	604	1.31e-05	16.2	0.00224	1300
Mean	683	0.738	604	1.31e-05	16.2	0.00224	1300
Median	683	0.738	604	1.31e-05	16.2	0.00224	1300
13550ND2012	683	0.738	604	1.31e-05	16.2	0.00224	1300

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	1520	115	1400	41.2	0.00868	1.01	32.7	0.00241	0.245	2.2e-05	0.0603	0.0264
Maximum	1520	115	1400	41.2	0.00868	1.01	32.7	0.00241	0.245	2.2e-05	0.0603	0.0264
Mean	1520	115	1400	41.2	0.00868	1.01	32.7	0.00241	0.245	2.2e-05	0.0603	0.0264
Median	1520	115	1400	41.2	0.00868	1.01	32.7	0.00241	0.245	2.2e-05	0.0603	0.0264
13550ND2012	1520	115	1400	41.2	0.00868	1.01	32.7	0.00241	0.245	2.2e-05	0.0603	0.0264

Mix designs: 56 to 60 MPa

Table 22: **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	738	0.798	651	1.36e-05	17.5	0.00241	1380
Maximum	738	0.798	651	1.36e-05	17.5	0.00241	1380
Mean	738	0.798	651	1.36e-05	17.5	0.00241	1380
Median	738	0.798	651	1.36e-05	17.5	0.00241	1380

13600ND2012	738	0.798	651	1.36e-05	17.5	0.00241	1380

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	1600	121	1480	43.8	0.00949	1.07	34	0.00251	0.239	2.2e-05	0.0603	0.0264
Maximum	1600	121	1480	43.8	0.00949	1.07	34	0.00251	0.239	2.2e-05	0.0603	0.0264
Mean	1600	121	1480	43.8	0.00949	1.07	34	0.00251	0.239	2.2e-05	0.0603	0.0264
Median	1600	121	1480	43.8	0.00949	1.07	34	0.00251	0.239	2.2e-05	0.0603	0.0264
13600ND2012	1600	121	1480	43.8	0.00949	1.07	34	0.00251	0.239	2.2e-05	0.0603	0.0264

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.