

Environmental Product Declaration



Environmental Product Declaration for various ready mix concrete products produced by Holcim México Operaciones S.A. de C.V. at their Vallejo facility in Azcapotzalco, 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 m ³ 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.labelinsustainability.com/
Product Category Rule:	Core PCR: ISO 21930:2017 Sustainability in buildings and civil engineering works – Core rules for environmental product declarations of construction products and services SubPCR: NSF International (March 2020). Product Category Rule (PCR) for Environmental Product Declarations (EPD) PCR for Concrete, v2.1
	Sub PCR Program Operator: NSF International
	Sub-category PCR review was conducted by: Thomas P. Gloria, Ph. D. of Industrial Ecology Consultants: 35 Bracebridge Rd., Newton, MA 02459-1728, t.gloria@industrial-ecology.com. Dr. Michael Overcash of Environmental Clarity: 2908 Chipmunk Lane, Raleigh, NC 27607-3117, mrovercash@earthlink.net. Mr. Bill Stough of Sustainable Research Group: PO Box 1684, Grand Rapids, MI 49501-1684, bstough@sustainableresearchgroup.com. Mr. Jack Geilbig, EcoForm: 2624 Abelia Way, Suite 611, Knoxville, TN 37931, jgeilbig@ecoform.com.
Independent LCA Reviewer and EPD Verifier:	This EPD was independently verified in accordance with ISO 14025 and ISO 21930. The life cycle assessment was independently reviewed in accordance ISO 14044 and the referenced PCR.
	Independent verification of the declaration, according to ISO 14025:2006
	Internal <input type="checkbox"/> ; External <input checked="" type="checkbox"/>
	Third Party Verifier Geoffrey Guest, Certified 3rd Party Verifier under the International EPD Program (www.environdec.com), CSA Group (www.csaregistry.ca)
Date of Issue:	29 July 2023
Period of Validity:	5 years; valid until 29 July 2028
EPD Number:	6bba49bf-03c5-4c3e-9a16—a9a95627aa31



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	9
SYSTEM BOUNDARIES	9
CUT-OFF CRITERIA	10
DATA SOURCES AND DATA QUALITY ASSESSMENT	11
Raw material transport:.....	11
Electricity:.....	11
Process/space heating:	11
Fuel required for machinery:.....	11
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	13
ENVIRONMENTAL INDICATORS AND INVENTORY METRICS	14
TOTAL IMPACT SUMMARY	14
ADDITIONAL ENVIRONMENTAL INFO	25
REFERENCES	25
ASTM Standards:.....	25
CSA Standards:.....	27
ISO Standards:	27
EN Standards:.....	27
Other References:.....	28



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 64 concrete mixes manufactured at the Holcim Mexico Operaciones S.A. de C.V. Vallejo 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	H ₂ O to cement ratio
1	37.40NB2012	0.039 MPa 28d strength Ready mix concrete	Ready mix concrete	0.039	0.36
2	37.42NB2012	0.041 MPa 28d strength Ready mix concrete	Ready mix concrete	0.041	0.39
3	37.45NB2012	0.044 MPa 28d strength Ready mix concrete	Ready mix concrete	0.044	0.43
4	37.50NB2012	0.049 MPa 28d strength Ready mix concrete	Ready mix concrete	0.049	0.48
5	37.55NB2012	0.054 MPa 28d strength Ready mix concrete	Ready mix concrete	0.054	0.53
6	24005NB0518	0.491 MPa 28d strength mortars and fillers	Mortars and fillers	0.491	4.45
7	60007NB1218	0.687 MPa 28d strength special concrete	Special concrete	0.687	3.02
8	24007NB0520	0.687 MPa 28d strength mortars and fillers	Mortars and fillers	0.687	4.40
9	24010NB0518	0.981 MPa 28d strength mortars and fillers	Mortars and fillers	0.981	3.89
10	24015NB0518	1.472 MPa 28d strength mortars and fillers	Mortars and fillers	1.472	3.21



11	24020NB0518	1.963 MPa 28d strength mortars and fillers	Mortars and fillers	1.963	2.88
12	60025NB1218	2.453 MPa 28d strength special concrete	Special concrete	2.453	2.04
13	24025NB0524	2.453 MPa 28d strength mortars and fillers	Mortars and fillers	2.453	2.61
14	24030NB0520	2.944 MPa 28d strength mortars and fillers	Mortars and fillers	2.944	2.39
15	77035NB4014	3.435 MPa 28d strength Ready mix concrete	Ready mix concrete	3.435	0.82
16	68035ND4010	3.435 MPa 28d strength special concrete	Special concrete	3.435	0.93
17	24035NB0518	3.435 MPa 28d strength mortars and fillers	Mortars and fillers	3.435	2.20
18	39036NB4012	3.533 MPa 28d strength Ready mix concrete	Ready mix concrete	3.533	0.71
19	39038NB4012	3.729 MPa 28d strength Ready mix concrete	Ready mix concrete	3.729	0.67
20	39040NB4012	3.925 MPa 28d strength Ready mix concrete	Ready mix concrete	3.925	0.63
21	24040NB0518	3.925 MPa 28d strength mortars and fillers	Mortars and fillers	3.925	2.11
22	39042ND4012	4.122 MPa 28d strength Ready mix concrete	Ready mix concrete	4.122	0.59
23	68042ND4010	4.122 MPa 28d strength special concrete	Special concrete	4.122	0.67
24	77045ND4010	4.416 MPa 28d strength Ready mix concrete	Ready mix concrete	4.416	0.61
25	68045ND4010	4.416 MPa 28d strength special concrete	Special concrete	4.416	0.70
26	77048ND4010	4.711 MPa 28d strength Ready mix concrete	Ready mix concrete	4.711	0.58
27	39050ND4010	4.907 MPa 28d strength Ready mix concrete	Ready mix concrete	4.907	0.51
28	76050ND1218	4.907 MPa 28d strength special concrete	Special concrete	4.907	1.06
29	24050NB0518	4.907 MPa 28d strength mortars and fillers	Mortars and fillers	4.907	1.94
30	24060NB0514	5.888 MPa 28d strength mortars and fillers	Mortars and fillers	5.888	1.93
31	70100ND2014	9.814 MPa 28d strength Ready mix concrete	Ready mix concrete	9.814	1.45
32	76100ND1218	9.814 MPa 28d strength special concrete	Special concrete	9.814	0.95
33	73100NB0514	9.814 MPa 28d strength mortars and fillers	Mortars and fillers	9.814	1.50
34	01150NB2018	14.72 MPa 28d strength Ready mix concrete	Ready mix concrete	14.720	1.18
35	27150NB1200	14.72 MPa 28d strength special concrete ,dry mix only	Special concrete	14.720	0.00



36	73150NB0514	14.72 MPa 28d strength mortars and fillers	Mortars and fillers	14.720	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	H ₂ O to cement ratio
37	70175NB2018	17.174 MPa 28d strength Ready mix concrete	Ready mix concrete	17.174	1.12
38	70200ND2014	19.627 MPa 28d strength Ready mix concrete	Ready mix concrete	19.627	1.03
39	27200NB1200	19.627 MPa 28d strength special concrete ,dry mix only	Special concrete	19.627	0.00
40	73200NB0518	19.627 MPa 28d strength mortars and fillers	Mortars and fillers	19.627	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	H ₂ O to cement ratio
41	70210NB2014	20.608 MPa 28d strength Ready mix concrete	Ready mix concrete	20.608	1.01
42	71250ND1210	24.534 MPa 28d strength Ready mix concrete	Ready mix concrete	24.534	0.93
43	27250NB1200	24.534 MPa 28d strength special concrete ,dry mix only	Special concrete	24.534	0.00
44	73250NB0518	24.534 MPa 28d strength mortars and fillers	Mortars and fillers	24.534	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	H ₂ O to cement ratio
45	70280ND2014	27.478 MPa 28d strength Ready mix concrete	Ready mix concrete	27.478	0.85
46	70300NB2014	29.441 MPa 28d strength Ready mix concrete	Ready mix concrete	29.441	0.80
47	56300NB1224	29.441 MPa 28d strength special concrete	Special concrete	29.441	0.48



48	73300NB0518	29.441 MPa 28d strength mortars and fillers	Mortars and fillers	29.441	0.76
----	-------------	---	---------------------	--------	------

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	H ₂ O to cement ratio
49	70320ND2010	31.403 MPa 28d strength Ready mix concrete	Ready mix concrete	31.403	0.74
50	70350NB2014	34.347 MPa 28d strength Ready mix concrete	Ready mix concrete	34.347	0.70
51	40350NB1214	34.347 MPa 28d strength special concrete	Special concrete	34.347	0.65
52	73350NB0518	34.347 MPa 28d strength mortars and fillers	Mortars and fillers	34.347	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	H ₂ O to cement ratio
53	70360ND2010	35.329 MPa 28d strength Ready mix concrete	Ready mix concrete	35.329	0.67
54	13400ND1210	39.254 MPa 28d strength Ready mix concrete	Ready mix concrete	39.254	0.47
55	40400NB1218	39.254 MPa 28d strength special concrete	Special concrete	39.254	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	H ₂ O to cement ratio
56	13450ND1212	44.161 MPa 28d strength Ready mix concrete	Ready mix concrete	44.161	0.42
57	56450NB1265	44.161 MPa 28d strength special concrete	Special concrete	44.161	0.37



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
58	13500ND1212	49.068 MPa 28d strength Ready mix concrete	Ready mix concrete	49.068	0.37
59	56500NB1265	49.068 MPa 28d strength special concrete	Special concrete	49.068	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
60	13550ND1212	53.974 MPa 28d strength Ready mix concrete	Ready mix concrete	53.974	0.34

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
61	13600NB2012	58.881 MPa 28d strength Ready mix concrete	Ready mix concrete	58.881	0.34

Mix designs: >60 MPa

Table 11: 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
62	14650NB2024	63.788 MPa 28d strength Ready mix concrete	Ready mix concrete	63.788	0.30
63	14700NB2024	68.695 MPa 28d strength Ready mix concrete	Ready mix concrete	68.695	0.31
64	14750NB2024	73.602 MPa 28d strength Ready mix concrete	Ready mix concrete	73.602	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:

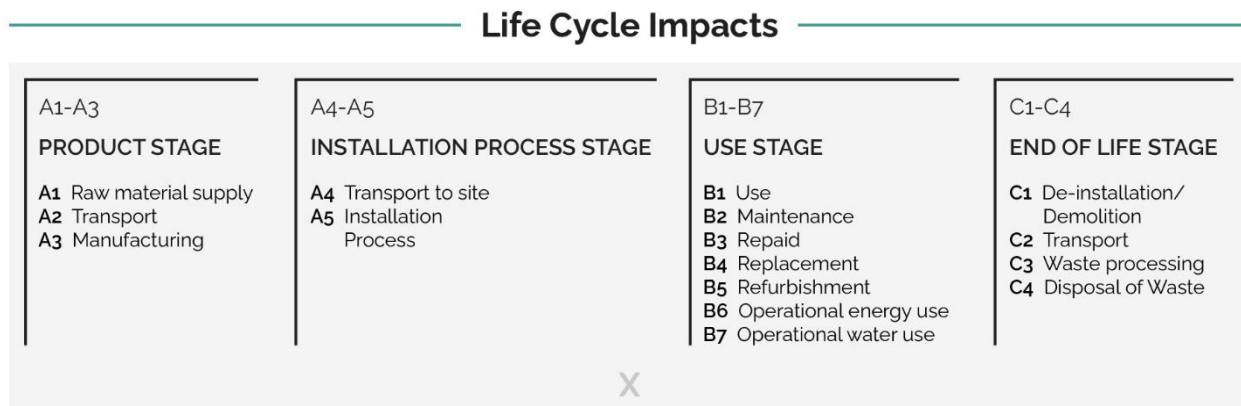


Figure 1: General life cycle phases for consideration in a construction works system

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.



System Boundary

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

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

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

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

For this LCA the manufacturing plant, owned and operated by Holcim México Operaciones S.A. de C.V., is located at their Planta Vallejo 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	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 ; Note: modifications made (see ecoinvent activity changes table)	ecoinvent v3.8	Estado de Mexico	v3.8 in 2021	2	3	1	3	3
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 verified facility - specific EPD dataset	3	NA	3	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 verified facility - specific EPD dataset	3	NA	3	3	3
Cement (CPO 30R R) PROVEEDOR	CPC 30R	Progam Operator: Labeling	Veracruz	25 Februa	3	3	3	3	3



: HOLCI Orizaba		Sustainability- EPD ID: 565b7deb- ebd6-4cb3- 9aa6- a585381c41f 3		ry 2023					
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
Silica fume	Waste input produced off-site	See A3 inputs	Texcoco	See A3 inputs	3	A3	3	A3	A3

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 basis1

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	0.0387	108	6.97e-06	0.266	0.000422	644
Maximum	369	0.399	651	5.12e-05	8.72	0.00135	4020
Mean	165	0.189	293	1.78e-05	3.71	0.000809	1460
Median	148	0.163	284	1.04e-05	3.41	0.000709	926
37.40NB2012	52.8	0.0922	651	5.12e-05	0.562	0.000924	4020
37.42NB2012	48.9	0.0856	593	4.73e-05	0.526	0.00086	3700
37.45NB2012	45.5	0.0798	539	4.39e-05	0.495	0.000807	3420
37.50NB2012	42.1	0.0741	489	4.05e-05	0.465	0.000753	3150
37.55NB2012	39	0.0688	440	3.73e-05	0.437	0.000704	2900
24005NB0518	88.4	0.0998	108	7.02e-06	2	0.000422	647
60007NB1218	21	0.0387	177	2.01e-05	0.266	0.00043	1540
24007NB0520	90	0.102	109	6.97e-06	2.04	0.000426	644
24010NB0518	98.7	0.111	117	7.14e-06	2.25	0.000456	660
24015NB0518	116	0.129	132	7.33e-06	2.66	0.000511	680
24020NB0518	127	0.141	142	7.46e-06	2.92	0.000546	694
60025NB1218	23.4	0.0427	222	2.27e-05	0.284	0.00046	1740
24025NB0524	144	0.159	156	7.43e-06	3.33	0.000595	695
24030NB0520	151	0.167	163	7.66e-06	3.49	0.000621	716
77035NB4014	284	0.312	285	1.05e-05	6.66	0.00109	927
68035ND4010	276	0.303	267	1.06e-05	6.47	0.00104	926
24035NB0518	160	0.177	171	7.82e-06	3.71	0.000652	731
39036NB4012	32.3	0.0574	338	3.06e-05	0.377	0.000591	2330
39038NB4012	33.2	0.0589	352	3.15e-05	0.385	0.000604	2400
39040NB4012	34.1	0.0604	365	3.23e-05	0.392	0.000617	2470
24040NB0518	167	0.184	177	7.89e-06	3.87	0.000673	739
39042ND4012	34.7	0.0613	374	3.28e-05	0.398	0.000626	2520
68042ND4010	359	0.392	351	1.13e-05	8.46	0.00133	1000
77045ND4010	348	0.381	342	1.13e-05	8.2	0.0013	1000
68045ND4010	358	0.392	336	1.13e-05	8.44	0.00128	1010
77048ND4010	365	0.399	357	1.14e-05	8.6	0.00135	1020
39050ND4010	37.7	0.0665	421	3.59e-05	0.425	0.000673	2760
76050ND1218	334	0.361	318	8.01e-06	7.88	0.00116	788
24050NB0518	180	0.198	189	8.03e-06	4.19	0.000714	754
24060NB0514	176	0.193	186	8.1e-06	4.08	0.000701	753
70100ND2014	208	0.23	217	9.45e-06	4.86	0.000844	846
76100ND1218	369	0.399	350	8.34e-06	8.72	0.00127	826
73100NB0514	228	0.25	233	8.86e-06	5.33	0.000873	832
01150NB2018	252	0.276	255	9.74e-06	5.9	0.000975	878
27150NB1200	333	0.363	328	1.04e-05	7.83	0.0012	938
73150NB0514	283	0.309	283	9.5e-06	6.65	0.00105	913



b) Inventory Metrics:

Indicator/L CI Metric	TPE	RE	NR E	NR R	RR	WD P	LFW	LFHW	CBW C	CWW C	CHW	CNH W
Unit	MJ- Eq	MJ- Eq	MJ- Eq	kg	m3	m3	kg waste	kg waste	m3	m3	kg	kg
Minimum	709	29.7	678	19.2	0.000529	0.323	17.3	0.00135	0	2.56e-05	0.0954	0.349
Maximum	4390	82.2	4330	106	0.00473	13.8	64.4	0.00485	0.365	2.56e-05	0.0954	0.349
Mean	1610	52.4	1560	40.9	0.00227	2.99	32.8	0.00243	0.29	2.56e-05	0.0954	0.349
Median	1040	52	984	28.2	0.00202	0.593	27.8	0.00201	0.306	2.56e-05	0.0954	0.349
37.40NB2012	4390	82.2	4330	106	0.00101	5.63	64.4	0.00485	0.243	2.56e-05	0.0954	0.349
37.42NB2012	4060	75.1	3970	98.1	0.000952	6.01	61.3	0.0046	0.24	2.56e-05	0.0954	0.349
37.45NB2012	3740	69.1	3660	90.4	0.000895	6.41	58.8	0.0044	0.236	2.56e-05	0.0954	0.349
37.50NB2012	3440	63.9	3380	83.5	0.000833	6.81	56.1	0.00418	0.234	2.56e-05	0.0954	0.349
37.55NB2012	3170	58.3	3100	77	0.00079	7.22	53.7	0.00399	0.233	2.56e-05	0.0954	0.349
24005NB0518	715	31	683	19.3	0.00127	0.514	17.4	0.00136	0.359	2.56e-05	0.0954	0.349
60007NB1218	1680	29.7	1640	41.8	0.000529	13.8	41.3	0.003	0.364	2.56e-05	0.0954	0.349
24007NB0520	709	31.3	678	19.2	0.0013	0.519	17.3	0.00135	0.363	2.56e-05	0.0954	0.349
24010NB0518	731	32.3	696	19.7	0.00142	0.52	17.7	0.00138	0.357	2.56e-05	0.0954	0.349
24015NB0518	755	35.3	718	20.3	0.00166	0.529	18.2	0.00141	0.354	2.56e-05	0.0954	0.349
24020NB0518	770	36.9	732	20.8	0.00172	0.535	18.6	0.00143	0.352	2.56e-05	0.0954	0.349
60025NB1218	1890	34.1	1850	46.8	0.000552	12.8	42.1	0.00307	0.355	2.56e-05	0.0954	0.349
24025NB0524	772	38.9	734	21.1	0.00195	0.557	18.6	0.00142	0.364	2.56e-05	0.0954	0.349
24030NB0520	798	40.8	758	21.7	0.00208	0.552	19.1	0.00147	0.352	2.56e-05	0.0954	0.349
77035NB4014	1050	56.9	989	28	0.00357	0.521	28.9	0.00203	0.248	2.56e-05	0.0954	0.349
68035ND4010	1040	55.8	980	27.7	0.00355	0.631	29.3	0.00206	0.271	2.56e-05	0.0954	0.349
24035NB0518	819	42.5	776	22.3	0.00217	0.553	19.6	0.0015	0.346	2.56e-05	0.0954	0.349
39036NB4012	2550	46.5	2510	62.3	0.000673	7.67	48.6	0.00358	0.227	2.56e-05	0.0954	0.349



39038NB4012	2620	47.8	2570	64.1	0.000683	7.49	49.2	0.00363	0.226	2.56e-05	0.0954	0.349
39040NB4012	2700	49.3	2650	65.5	0.000695	7.31	49.8	0.00368	0.225	2.56e-05	0.0954	0.349
24040NB0518	828	43.4	778	22.5	0.00233	0.558	19.7	0.00151	0.346	2.56e-05	0.0954	0.349
39042ND4012	2750	50.3	2690	66.8	0.000704	6.76	50	0.00369	0.217	2.56e-05	0.0954	0.349
68042ND4010	1140	67.9	1070	30.6	0.00473	0.583	30.9	0.00216	0.258	2.56e-05	0.0954	0.349
77045ND4010	1140	66.1	1060	30.4	0.00445	0.55	31	0.00216	0.232	2.56e-05	0.0954	0.349
68045ND4010	1150	67.7	1080	30.7	0.00467	0.715	31.5	0.0022	0.269	2.56e-05	0.0954	0.349
77048ND4010	1150	68.2	1080	31	0.00469	0.562	31.4	0.00219	0.233	2.56e-05	0.0954	0.349
39050ND4010	3020	55.4	2940	73.4	0.000749	6.16	52.2	0.00387	0.215	2.56e-05	0.0954	0.349
76050ND1218	907	64.8	842	25.1	0.00447	0.677	20.3	0.00148	0.365	2.56e-05	0.0954	0.349
24050NB0518	844	45.4	803	22.9	0.00243	0.567	20.1	0.00153	0.346	2.56e-05	0.0954	0.349
24060NB0514	846	44.5	797	22.9	0.00239	0.555	20.3	0.00155	0.336	2.56e-05	0.0954	0.349
70100ND2014	951	46.9	898	25.2	0.00284	0.538	25.1	0.00183	0.307	2.56e-05	0.0954	0.349
76100ND1218	958	70.1	882	26.4	0.00463	0.698	21.2	0.00154	0.362	2.56e-05	0.0954	0.349
73100NB0514	938	53.8	884	25.6	0.00303	0.603	22.3	0.00169	0.343	2.56e-05	0.0954	0.349
01150NB2018	992	53.6	933	26.5	0.00336	0.566	25.9	0.00187	0.305	2.56e-05	0.0954	0.349
27150NB1200	1070	68.5	993	29.6	0.00436	0.323	26.6	0.00199	0	2.56e-05	0.0954	0.349
73150NB0514	1030	62.1	971	28.3	0.00366	0.64	23.8	0.00179	0.34	2.56e-05	0.0954	0.349

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

a) Midpoint Impact Categories:

Indicator/LCI Metric	AP	EP	GWP	ODP	PCOP	ADPe	ADPf
Unit	moles of H ⁺ -Eq	kg N	kg CO ₂ -Eq	kg CFC-11-Eq	kg NO _x -Eq	kg Sb-Eq	MJ, net calorific value
Minimum	272	0.298	273	1e-05	6.37	0.00104	908
Maximum	365	0.397	356	1.07e-05	8.59	0.00129	972
Mean	316	0.345	312	1.02e-05	7.42	0.00116	943



Median	314	0.342	310	1.01e-05	7.37	0.00116	946
70175NB2018	272	0.298	273	1e-05	6.37	0.00104	908
70200ND2014	280	0.307	281	1.02e-05	6.57	0.00107	924
27200NB1200	365	0.397	356	1.07e-05	8.59	0.00129	967
73200NB0518	347	0.377	339	1e-05	8.17	0.00125	972

b) Inventory Metrics:

Indicator/LCI Metric	TPE	RE	NR E	NR R	RR	WD P	LFW	LFHW	CBW C	CWW C	CHW	CNH W
Unit	MJ-Eq	MJ-Eq	MJ-Eq	kg	m3	m3	kg waste	kg waste	m3	m3	kg	kg
Minimum	1020	57.1	965	27.6	0.00348	0.345	25.3	0.00188	0	2.56e-05	0.0954	0.349
Maximum	1110	74.8	1030	30.6	0.00464	0.691	27.4	0.00204	0.348	2.56e-05	0.0954	0.349
Mean	1070	65.2	1000	29.2	0.00407	0.551	26.6	0.00195	0.24	2.56e-05	0.0954	0.349
Median	1080	64.5	1010	29.3	0.00408	0.584	27	0.00194	0.306	2.56e-05	0.0954	0.349
70175NB2018	1020	57.1	965	27.6	0.00348	0.588	26.6	0.00192	0.312	2.56e-05	0.0954	0.349
70200ND2014	1040	57.7	987	28.1	0.00365	0.58	27.3	0.00196	0.299	2.56e-05	0.0954	0.349
27200NB1200	1110	74.8	1030	30.6	0.00464	0.345	27.4	0.00204	0	2.56e-05	0.0954	0.349
73200NB0518	1110	71.3	1030	30.5	0.00451	0.691	25.3	0.00188	0.348	2.56e-05	0.0954	0.349

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

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	287	0.315	288	1.01e-05	6.74	0.00109	931
Maximum	398	0.432	385	1.1e-05	9.38	0.00141	1030
Mean	348	0.379	341	1.05e-05	8.2	0.00126	980
Median	354	0.385	346	1.04e-05	8.33	0.00128	979
70210NB2014	287	0.315	288	1.03e-05	6.74	0.00109	931
71250ND1210	311	0.339	309	1.01e-05	7.31	0.00115	961
27250NB1200	398	0.432	385	1.1e-05	9.38	0.0014	997
73250NB0518	397	0.431	383	1.05e-05	9.35	0.00141	1030



b) Inventory Metrics:

Indicator/LCI Metric	TPE	RE	NR E	NR R	RR	WD P	LFW	LFHW	CBW C	CWW C	CHW	CNH W
Unit	MJ-Eq	MJ-Eq	MJ-Eq	kg	m ³	m ³	kg waste	kg waste	m ³	m ³	kg	kg
Minimum	1050	58	992	28.3	0.00374	0.367	25.3	0.0019	0	2.56e-05	0.0954	0.349
Maximum	1170	79.5	1090	32.3	0.0052	0.727	28.3	0.0021	0.349	2.56e-05	0.0954	0.349
Mean	1120	70.6	1040	30.6	0.00451	0.576	26.8	0.00198	0.238	2.56e-05	0.0954	0.349
Median	1120	72.4	1040	31	0.00454	0.605	26.9	0.00196	0.3	2.56e-05	0.0954	0.349
70210NB2014	1050	58	992	28.3	0.00374	0.589	27.3	0.00196	0.302	2.56e-05	0.0954	0.349
71250ND1210	1090	66.7	1020	30.1	0.00408	0.621	25.3	0.0019	0.299	2.56e-05	0.0954	0.349
27250NB1200	1150	79.5	1060	31.8	0.005	0.367	28.3	0.0021	0	2.56e-05	0.0954	0.349
73250NB0518	1170	78.1	1090	32.3	0.0052	0.727	26.5	0.00196	0.349	2.56e-05	0.0954	0.349

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 CO ₂ -Eq	kg CFC-11-Eq	kg NO _x -Eq	kg Sb-Eq	MJ, net calorific value
Minimum	335	0.366	330	1.08e-05	7.88	0.00124	980
Maximum	471	0.516	467	1.59e-05	11.1	0.00178	1440
Mean	403	0.44	394	1.22e-05	9.49	0.00148	1130
Median	403	0.438	390	1.1e-05	9.49	0.00144	1040
70280ND2014	335	0.366	330	1.08e-05	7.88	0.00124	980
70300NB2014	360	0.392	352	1.1e-05	8.48	0.00132	1010
56300NB1224	471	0.516	467	1.59e-05	11.1	0.00178	1440
73300NB0518	446	0.484	427	1.1e-05	10.5	0.00157	1080



b) Inventory Metrics:

Indicator/LCI Metric	TPE	RE	NR E	NR R	RR	WD P	LFW	LFHW	CBW C	CWW C	CHW	CNH W
Unit	MJ-Eq	MJ-Eq	MJ-Eq	kg	m ³	m ³	kg waste	kg waste	m ³	m ³	kg	kg
Minimum	1110	66.4	1050	30.1	0.00436	0.616	27.8	0.00204	0.246	2.56e-05	0.0954	0.349
Maximum	1620	87.9	1540	43.3	0.0062	8.75	44	0.00305	0.351	2.56e-05	0.0954	0.349
Mean	1280	77.7	1200	34.6	0.00526	2.69	32.4	0.00231	0.299	2.56e-05	0.0954	0.349
Median	1200	78.2	1120	32.6	0.00524	0.701	29	0.00206	0.3	2.56e-05	0.0954	0.349
70280ND2014	1110	66.4	1050	30.1	0.00436	0.616	28.8	0.00205	0.298	2.56e-05	0.0954	0.349
70300NB2014	1150	71	1070	31	0.00467	0.638	29.2	0.00208	0.301	2.56e-05	0.0954	0.349
56300NB1224	1620	87.9	1540	43.3	0.0062	8.75	44	0.00305	0.246	2.56e-05	0.0954	0.349
73300NB0518	1250	85.4	1160	34.1	0.00582	0.764	27.8	0.00204	0.351	2.56e-05	0.0954	0.349

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 CO ₂ -Eq	kg CFC-11-Eq	kg NO _x -Eq	kg Sb-Eq	MJ, net calorific value
Minimum	371	0.404	362	1.12e-05	8.73	0.00136	1020
Maximum	496	0.537	471	1.15e-05	11.7	0.00172	1130
Mean	438	0.475	420	1.14e-05	10.3	0.00155	1080
Median	442	0.479	423	1.14e-05	10.4	0.00156	1080
70320ND2010	371	0.404	362	1.12e-05	8.73	0.00136	1020
70350NB2014	415	0.451	400	1.15e-05	9.79	0.00149	1060
40350NB1214	468	0.507	446	1.14e-05	11	0.00163	1110
73350NB0518	496	0.537	471	1.15e-05	11.7	0.00172	1130



b) Inventory Metrics:

Indicator/LCI Metric	TPE	RE	NRE	NR	RR	WDP	LFW	LFHW	CBWC	CWWC	CHW	CNH
Unit	MJ-Eq	MJ-Eq	MJ-Eq	kg	m3	m3	kg waste	kg waste	m3	m3	kg	kg
Minimum	1160	71.2	1090	31.5	0.00485	0.634	28.7	0.00211	0.291	2.56e-05	0.0954	0.349
Maximum	1310	94.5	1210	36	0.00627	0.801	30.7	0.00217	0.353	2.56e-05	0.0954	0.349
Mean	1240	83	1150	33.9	0.00566	0.715	29.6	0.00213	0.316	2.56e-05	0.0954	0.349
Median	1240	83.1	1160	34.1	0.00575	0.712	29.4	0.00213	0.31	2.56e-05	0.0954	0.349
70320ND2010	1160	71.2	1090	31.5	0.00485	0.634	29.9	0.00213	0.291	2.56e-05	0.0954	0.349
70350NB2014	1210	77.1	1130	32.9	0.00539	0.678	30.7	0.00217	0.303	2.56e-05	0.0954	0.349
40350NB1214	1280	89.1	1180	35.3	0.00611	0.746	28.7	0.00211	0.317	2.56e-05	0.0954	0.349
73350NB0518	1310	94.5	1210	36	0.00627	0.801	29	0.00212	0.353	2.56e-05	0.0954	0.349

Mix designs: 36 to 40 MPa

Table 19: Total life cycle (across modules in scope) impact results for Mix designs: 36 to 40MPa, 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	414	0.45	399	1.16e-05	9.76	0.00149	1060
Maximum	569	0.616	537	1.51e-05	13.5	0.00196	1380
Mean	479	0.521	462	1.31e-05	11.3	0.00172	1220
Median	455	0.498	450	1.27e-05	10.7	0.00172	1220
70360ND2010	414	0.45	399	1.16e-05	9.76	0.00149	1060
13400ND1210	455	0.498	450	1.51e-05	10.7	0.00172	1380
40400NB1218	569	0.616	537	1.27e-05	13.5	0.00196	1220



b) Inventory Metrics:

Indicator/LCI Metric	TPE	RE	NRE	NR	RR	WDP	LFW	LFHW	CBWC	CWWC	CHW	CNH
Unit	MJ-Eq	MJ-Eq	MJ-Eq	kg	m3	m3	kg waste	kg waste	m3	m3	kg	kg
Minimum	1210	77.7	1130	33.1	0.00523	0.665	31	0.00219	0.233	2.56e-05	0.0954	0.349
Maximum	1560	105	1470	41.6	0.00728	6.75	41.6	0.00289	0.293	2.56e-05	0.0954	0.349
Mean	1390	89.3	1300	37.9	0.00613	2.73	35.2	0.00248	0.268	2.56e-05	0.0954	0.349
Median	1410	85.2	1300	39	0.00587	0.77	33.1	0.00237	0.279	2.56e-05	0.0954	0.349
70360ND2010	1210	77.7	1130	33.1	0.00523	0.665	31	0.00219	0.293	2.56e-05	0.0954	0.349
13400ND1210	1560	85.2	1470	41.6	0.00587	6.75	41.6	0.00289	0.233	2.56e-05	0.0954	0.349
40400NB1218	1410	105	1300	39	0.00728	0.77	33.1	0.00237	0.279	2.56e-05	0.0954	0.349

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	528	0.576	514	1.56e-05	12.5	0.00195	1450
Maximum	687	0.747	659	1.76e-05	16.3	0.0025	1770
Mean	608	0.662	586	1.66e-05	14.4	0.00222	1610
Median	608	0.662	586	1.66e-05	14.4	0.00222	1610
13450ND1212	528	0.576	514	1.56e-05	12.5	0.00195	1450
56450NB1265	687	0.747	659	1.76e-05	16.3	0.0025	1770

b) Inventory Metrics:

Indicator/LCI Metric	TPE	RE	NRE	NR	RR	WDP	LFW	LFHW	CBWC	CWWC	CHW	CNH
Unit	MJ-Eq	MJ-Eq	MJ-Eq	kg	m3	m3	kg waste	kg waste	m3	m3	kg	kg
Minimum	1650	94.5	1550	44.4	0.00696	6.35	42.8	0.00296	0.24	2.56e-05	0.0954	0.349



Maximum	2030	124	1900	54.6	0.00873	6.78	46.8	0.00325	0.272	2.56e-05	0.0954	0.349
Mean	1840	109	1720	49.5	0.00784	6.56	44.8	0.0031	0.256	2.56e-05	0.0954	0.349
Median	1840	109	1720	49.5	0.00784	6.56	44.8	0.0031	0.256	2.56e-05	0.0954	0.349
13450ND1212	1650	94.5	1550	44.4	0.00696	6.35	42.8	0.00296	0.24	2.56e-05	0.0954	0.349
56450NB1265	2030	124	1900	54.6	0.00873	6.78	46.8	0.00325	0.272	2.56e-05	0.0954	0.349

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	588	0.64	567	1.61e-05	13.9	0.00214	1520
Maximum	737	0.8	703	1.8e-05	17.4	0.00266	1830
Mean	662	0.72	635	1.7e-05	15.6	0.0024	1680
Median	662	0.72	635	1.7e-05	15.6	0.0024	1680
13500ND1212	588	0.64	567	1.61e-05	13.9	0.00214	1520
56500NB1265	737	0.8	703	1.8e-05	17.4	0.00266	1830

b) Inventory Metrics:

Indicator/LCI Metric	TPE	RE	NR E	NR R	RR	WD P	LFW	LFHW	CBW C	CW/W C	CHW	CNH W
Unit	MJ-Eq	MJ-Eq	MJ-Eq	kg	m3	m3	kg waste	kg waste	m3	m3	kg	kg
Minimum	1730	107	1620	46.8	0.00763	6.03	43.9	0.00303	0.242	2.56e-05	0.0954	0.349
Maximum	2110	132	1970	56.6	0.00965	6.4	47.6	0.00331	0.275	2.56e-05	0.0954	0.349
Mean	1920	120	1800	51.7	0.00864	6.22	45.8	0.00317	0.258	2.56e-05	0.0954	0.349
Median	1920	120	1800	51.7	0.00864	6.22	45.8	0.00317	0.258	2.56e-05	0.0954	0.349
13500ND1212	1730	107	1620	46.8	0.00763	6.03	43.9	0.00303	0.242	2.56e-05	0.0954	0.349
56500NB1265	2110	132	1970	56.6	0.00965	6.4	47.6	0.00331	0.275	2.56e-05	0.0954	0.349



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 CO ₂ -Eq	kg CFC-11-Eq	kg NO _x -Eq	kg Sb-Eq	MJ, net calorific value
13550ND1212	649	0.705	621	1.66e-05	15.4	0.00233	1580

b) Inventory Metrics:

Indicator/LCI Metric	TPE	RE	NRE	NR	RR	WDP	LFW	LFHW	CBWC	CWWC	CHW	CNH
Unit	MJ-Eq	MJ-Eq	MJ-Eq	kg	m ³	m ³	kg waste	kg waste	m ³	m ³	kg	kg
13550ND1212	1810	115	1700	49	0.00858	5.72	44.9	0.0031	0.243	2.56e-05	0.0954	0.349

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 CO ₂ -Eq	kg CFC-11-Eq	kg NO _x -Eq	kg Sb-Eq	MJ, net calorific value
13600NB2012	671	0.729	642	1.7e-05	15.9	0.00241	1640

b) Inventory Metrics:

Indicator/LCI Metric	TPE	RE	NRE	NR	RR	WDP	LFW	LFHW	CBWC	CWWC	CHW	CNH
Unit	MJ-Eq	MJ-Eq	MJ-Eq	kg	m ³	m ³	kg waste	kg waste	m ³	m ³	kg	kg
13600NB2012	1880	118	1760	50.7	0.0085	6.09	46.1	0.00319	0.25	2.56e-05	0.0954	0.349



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:

Indicator/LCI Metric	AP	EP	GWP	ODP	PCOP	ADPe	ADPf
Unit	moles of H ⁺ -Eq	kg N	kg CO ₂ -Eq	kg CFC-11-Eq	kg NO _x -Eq	kg Sb-Eq	MJ, net calorific value
Minimum	724	0.785	686	1.67e-05	17.2	0.00258	1700
Maximum	733	0.795	695	1.69e-05	17.4	0.00263	1770
Mean	729	0.791	691	1.68e-05	17.3	0.00261	1740
Median	731	0.792	692	1.68e-05	17.3	0.00261	1740
14650NB2024	724	0.785	686	1.67e-05	17.2	0.00258	1700
14700NB2024	731	0.792	692	1.68e-05	17.3	0.00261	1740
14750NB2024	733	0.795	695	1.69e-05	17.4	0.00263	1770

b) Inventory Metrics:

Indicator/LCI Metric	TPE	RE	NRE	NR R	RR	WDP	LFW	LFHW	CBWC	CWWC	CHW	CNH W
Unit	MJ-Eq	MJ-Eq	MJ-Eq	kg	m ³	m ³	kg waste	kg waste	m ³	m ³	kg	kg
Minimum	1950	126	1820	52.7	0.0094	3.25	44.1	0.00306	0.24	2.56e-05	0.0954	0.349
Maximum	2030	129	1900	55	0.00951	3.54	44.3	0.00306	0.246	2.56e-05	0.0954	0.349
Mean	1990	128	1860	53.8	0.00945	3.4	44.2	0.00306	0.243	2.56e-05	0.0954	0.349
Median	2000	128	1860	53.8	0.00945	3.4	44.2	0.00306	0.244	2.56e-05	0.0954	0.349
14650NB2024	1950	126	1820	52.7	0.00951	3.54	44.1	0.00306	0.24	2.56e-05	0.0954	0.349
14700NB2024	2000	129	1860	53.8	0.00945	3.4	44.2	0.00306	0.246	2.56e-05	0.0954	0.349
14750NB2024	2030	128	1900	55	0.0094	3.25	44.3	0.00306	0.244	2.56e-05	0.0954	0.349

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>.

