Environmental Product Declaration

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

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:	22 July 2023
Period of Validity:	5 years; valid until 21 July 2028
EPD Number:	5057b7d6-e99d-4dba-b2d0-4e4269cb1a8d

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COMPANY DESCRIPTION

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

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

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

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

STUDY GOAL

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

This project report was commissioned to differentiate Holcim México Operaciones S.A. de C.V. from their competition for the following reasons: generate an advantage for the organization; offer customers information to help them make informed product decisions; improve the environmental performance of Holcim México Operaciones S.A. de C.V. by continuously measuring, controlling and reducing the environmental impacts of their products; help project facilitators working on Leadership

in Energy and Environmental Design (LEED) projects achieve their credit goal; and to strengthen Holcim México Operaciones S.A. de C.V.'s license to operate in the community. The intended audience for this LCA report is Holcim México Operaciones S.A. de C.V.'s employees, their suppliers, project specifiers of their products, architects, and engineers. The EPD report is also available for policy makers, government officials interested in sustainability, academic professors, and LCA professionals. This LCA report does not include product comparisons from other facilities.

DESCRIPTION OF PRODUCT AND SCOPE

This EPD reports on 26 concrete mixes manufactured at the Holcim Mexico Operaciones S.A. de C.V. Tijuana III concrete facility in Baja California, 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	24007NB0518	1 MPa 28d strength mortars and fillers	mortars and fillers	1	2.3214093
2	24015NB0518	1 MPa 28d strength mortars and fillers	mortars and fillers	1	1.7974423
3	24025NB0514	2 MPa 28d strength mortars and fillers	mortars and fillers	2	1.4063241
4	77035NB2014	4 MPa 28d strength Ready mix concrete	Ready mix concrete	4	0.7850118
5	24035NB0514	3 MPa 28d strength mortars and fillers	mortars and fillers	3	1.1105941
6	77036ND2014	4 MPa 28d strength Ready mix concrete	Ready mix concrete	4	0.7485138
7	77038ND4010	4 MPa 28d strength Ready mix concrete	Ready mix concrete	4	0.6952384
8	68038ND2010	4 MPa 28d strength Special concrete	Special concrete	4	0.8071308
9	77040ND2010	4 MPa 28d strength Ready mix concrete	Ready mix concrete	4	0.6716940

10	77042ND4010	4 MPa 28d strength Ready mix concrete	Ready mix concrete	4	0.6472399
11	68042ND2010	4 MPa 28d strength special concrete	special concrete	4	0.6446972
12	77045ND4010	5 MPa 28d strength Ready mix concrete	Ready mix concrete	5	0.6208462
13	77048ND2010	5 MPa 28d strength Ready mix concrete	Ready mix concrete	5	0.6252865
14	77050ND2006	5 MPa 28d strength Ready mix concrete	Ready mix concrete	5	0.6086372
15	24050NB0514	5 MPa 28d strength mortars and fillers	mortars and fillers	5	1.0364158
16	70100NB2014	10 MPa 28d strength Ready mix concrete	Ready mix concrete	10	1.0103551

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
17	70150NB2018	15 MPa 28d strength Ready mix concrete	Ready mix concrete	15	0.9179085

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
18	70200NB2018	25 MPa 28d strength Ready mix concrete	Ready mix concrete	25	0.8191514
19	70210ND2010	21 MPa 28d strength Ready mix concrete	Ready mix concrete	21	0.8058475
21	40250NB1210	25 MPa 28d strength special concrete	special concrete	25	0.6172992
22	73250NB0514	25 MPa 28d strength mortars and fillers	mortars and fillers	25	0.7042204

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
20	70250NB2018	29 MPa 28d strength Ready mix concrete	Ready mix concrete	29	0.7166239

23	38280ND2014	29 MPa 28d strength Ready mix concrete	Ready mix concrete	29	0.6248047
24	70300NB2014	30 MPa 28d strength Ready mix concrete	Ready mix concrete	30	0.6231962

Mix designs: 36 to 40 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
25	70350NB2014	39 MPa 28d strength Ready mix concrete	Ready mix concrete	39	0.5395099

Mix designs: 41 to 45 MPa

Table 6: **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
26	13450NB2014	44 MPa 28d strength Ready mix concrete	Ready mix concrete	44	0.434867

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 7: **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:

Life Cycle Impacts

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

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:

System Boundary

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

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

- 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.

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 Tijuana III 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 8: **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
Granite sand	silica sand production/silica sand/RoW/kg; Note: modifications made (see ecoinvent activity changes table)	ecoinvent v3.8	Baja California	v3.8 in 2021	2	3	1	3	3
Water	tap water production, conventional with biological treatment/tap water/RoW/kg	ecoinvent v3.8	Baja California	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	Baja California	v3.8 in 2021	2	3	1	3	3

Additives	market for chemical, organic/chemical, organic/GLO/kg	ecoinvent v3.8	Estado de Mexico, Baja California, Queretaro	v3.8 in 2021	2	3	1	3	3
Cement (CPC 40) - PROVEEDOR: Holcim México Operaciones Hermosillo	CPC 40	Progam Operator: Labeling Sustainability - EPD ID: 25f793ca-e744-463a-b573-9c6a661311a3	Sonora	30 Novembe r 2021	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	TLAXCALA	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 9: **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	23.8	0.0372	156	1.66e-05	0.354	0.000585	1220
Maximum	48.4	0.07	353	2.91e-05	0.703	0.00123	2150
Mean	40.9	0.0597	290	2.51e-05	0.595	0.00102	1860
Median	42.7	0.062	305	2.59e-05	0.62	0.00108	1900
24007NB0518	23.8	0.0372	156	1.66e-05	0.354	0.000585	1220
24015NB0518	27.6	0.0425	188	1.89e-05	0.408	0.00069	1380
24015NB0518	27.6	0.0425	188	1.89e-05	0.408	0.00069	1380
77035NB2014	42.1	0.0614	301	2.57e-05	0.614	0.00106	1890
24035NB0514	36.9	0.0556	263	2.44e-05	0.538	0.000947	1800
77036ND2014	43	0.0626	309	2.61e-05	0.627	0.00109	1920
77038ND4010	44	0.064	317	2.66e-05	0.642	0.00111	1960
68038ND2010	39.7	0.0578	282	2.41e-05	0.58	0.000991	1760
77040ND2010	45.2	0.0656	326	2.73e-05	0.658	0.00114	2010
77042ND4010	46.5	0.0674	338	2.8e-05	0.677	0.00118	2070
68042ND2010	48.1	0.0697	351	2.91e-05	0.699	0.00123	2150
77045ND4010	48.4	0.07	353	2.91e-05	0.703	0.00123	2150
77048ND2010	48	0.0694	350	2.88e-05	0.698	0.00122	2130

77050ND2006	47.6	0.0688	346	2.85e-05	0.691	0.00121	2110
24050NB0514	39	0.0585	280	2.56e-05	0.567	0.001	1890
70100NB2014	42.4	0.0561	259	2.09e-05	0.602	0.000859	1710

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	1340	40.7	1310	32.8	0.00214	6.01	30.1	0.00239	0.228	2.25e-05	0.0265	0.0459
Maximum	2400	93.2	2310	56.8	0.00549	13.9	43.2	0.0033	0.317	2.25e-05	0.0265	0.0459
Mean	2070	76.6	1990	49.5	0.00431	8.84	39.4	0.00301	0.26	2.25e-05	0.0265	0.0459
Median	2120	80.7	2040	50.8	0.00457	6.84	40.2	0.00309	0.246	2.25e-05	0.0265	0.0459
24007NB0518	1340	40.7	1310	32.8	0.00214	13.9	30.1	0.00239	0.317	2.25e-05	0.0265	0.0459
24015NB0518	1540	48.7	1480	37.2	0.00262	13.8	33.1	0.00259	0.311	2.25e-05	0.0265	0.0459
24015NB0518	1740	56.4	1670	41.8	0.00294	13.9	36.3	0.00282	0.293	2.25e-05	0.0265	0.0459
77035NB2014	2110	77.3	2020	50.1	0.0044	7.37	39.1	0.003	0.251	2.25e-05	0.0265	0.0459
24035NB0514	2010	68.5	1930	48.3	0.00371	13.6	40.5	0.00312	0.291	2.25e-05	0.0265	0.0459
77036ND2014	2140	80.7	2060	51.1	0.0045	6.88	39.3	0.00302	0.247	2.25e-05	0.0265	0.0459
77038ND4010	2190	80.7	2110	51.9	0.00464	6.66	39.9	0.00306	0.236	2.25e-05	0.0265	0.0459
68038ND2010	1970	72.9	1890	46.6	0.00415	6.81	36.6	0.00282	0.242	2.25e-05	0.0265	0.0459
77040ND2010	2250	85.2	2160	53.4	0.00479	6.63	40.8	0.00313	0.236	2.25e-05	0.0265	0.0459
77042ND4010	2310	89.1	2220	54.7	0.00488	6.34	41.6	0.00319	0.236	2.25e-05	0.0265	0.0459
68042ND2010	2400	91.4	2310	56.7	0.00517	6.68	43.2	0.0033	0.245	2.25e-05	0.0265	0.0459
77045ND4010	2400	93.2	2310	56.8	0.00549	6.12	42.9	0.00328	0.238	2.25e-05	0.0265	0.0459
77048ND2010	2380	90.7	2290	56.3	0.00513	6.07	42.6	0.00325	0.238	2.25e-05	0.0265	0.0459
77050ND2006	2340	89.2	2260	55.9	0.0051	6.01	42.2	0.00322	0.228	2.25e-05	0.0265	0.0459
24050NB0514	2110	73	2030	50.6	0.004	13.5	42.1	0.00323	0.292	2.25e-05	0.0265	0.0459

70100NB2014	1900	88	1810	47.8	0.00536	7.1	39.7	0.00276	0.253	2.25e-05	0.0265	0.0459

Mix designs: 15 to 20 MPa

Table 10: **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	45.1	0.0601	284	2.27e-05	0.641	0.000945	1830
Maximum	45.1	0.0601	284	2.27e-05	0.641	0.000945	1830
Mean	45.1	0.0601	284	2.27e-05	0.641	0.000945	1830
Median	45.1	0.0601	284	2.27e-05	0.641	0.000945	1830
70150NB2018	45.1	0.0601	284	2.27e-05	0.641	0.000945	1830

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	2050	93.3	1940	50.4	0.00556	6.72	41.5	0.0029	0.259	2.25e-05	0.0265	0.0459
Maximum	2050	93.3	1940	50.4	0.00556	6.72	41.5	0.0029	0.259	2.25e-05	0.0265	0.0459
Mean	2050	93.3	1940	50.4	0.00556	6.72	41.5	0.0029	0.259	2.25e-05	0.0265	0.0459
Median	2050	93.3	1940	50.4	0.00556	6.72	41.5	0.0029	0.259	2.25e-05	0.0265	0.0459
70150NB2018	2050	93.3	1940	50.4	0.00556	6.72	41.5	0.0029	0.259	2.25e-05	0.0265	0.0459

Mix designs: 21 to 25 MPa

Table 11: **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	45.3	0.0606	287	2.3e-05	0.645	0.00096	1840
Maximum	53.7	0.0787	399	3.37e-05	0.775	0.0014	2500

Mean	49.5	0.0698	343	2.86e-05	0.71	0.00118	2180
Median	49.4	0.07	342	2.88e-05	0.71	0.00118	2180
70200NB2018	47.9	0.0642	309	2.45e-05	0.681	0.00103	1960
70210ND2010	45.3	0.0606	287	2.3e-05	0.645	0.00096	1840
40250NB1210	53.7	0.0787	399	3.37e-05	0.775	0.0014	2500
73250NB0514	51	0.0757	376	3.31e-05	0.74	0.00132	2410

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	2050	93.1	1950	50.5	0.00548	6.25	41.2	0.00289	0.233	2.25e-05	0.0265	0.0459
Maximum	2800	104	2690	66.6	0.00599	14.8	52.7	0.00402	0.275	2.25e-05	0.0265	0.0459
Mean	2430	98.1	2330	58.8	0.0057	9.62	47.3	0.00347	0.257	2.25e-05	0.0265	0.0459
Median	2440	97.6	2340	59.1	0.00567	8.72	47.6	0.00348	0.26	2.25e-05	0.0265	0.0459
70200NB2018	2180	97.8	2080	54	0.00599	6.43	43.5	0.00305	0.257	2.25e-05	0.0265	0.0459
70210ND2010	2050	93.1	1950	50.5	0.00554	6.25	41.2	0.00289	0.233	2.25e-05	0.0265	0.0459
40250NB1210	2800	104	2690	66.6	0.0058	11	51.7	0.00392	0.262	2.25e-05	0.0265	0.0459
73250NB0514	2690	97.5	2590	64.2	0.00548	14.8	52.7	0.00402	0.275	2.25e-05	0.0265	0.0459

Mix designs: 26 to 30 MPa

Table 12 **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	44.2	0.0644	316	2.69e-05	0.644	0.00112	1990
Maximum	56.9	0.0774	389	3.03e-05	0.809	0.0013	2370
Mean	50.9	0.0705	350	2.81e-05	0.73	0.00119	2160
Median	51.7	0.0698	344	2.7e-05	0.736	0.00115	2130
70250NB2018	51.7	0.0698	344	2.7e-05	0.736	0.00115	2130
38280ND2014	44.2	0.0644	316	2.69e-05	0.644	0.00112	1990
70300NB2014	56.9	0.0774	389	3.03e-05	0.809	0.0013	2370

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	2220	83.3	2130	52.7	0.00471	5.86	40.8	0.00313	0.21	2.25e-05	0.0265	0.0459
Maximum	2650	118	2520	64.4	0.00704	7.43	50.2	0.00355	0.256	2.25e-05	0.0265	0.0459
Mean	2420	103	2310	58.5	0.00605	6.48	45.8	0.00331	0.24	2.25e-05	0.0265	0.0459
Median	2380	107	2270	58.5	0.0064	6.14	46.3	0.00326	0.255	2.25e-05	0.0265	0.0459
70250NB2018	2380	107	2270	58.5	0.0064	6.14	46.3	0.00326	0.255	2.25e-05	0.0265	0.0459
38280ND2014	2220	83.3	2130	52.7	0.00471	7.43	40.8	0.00313	0.21	2.25e-05	0.0265	0.0459
70300NB2014	2650	118	2520	64.4	0.00704	5.86	50.2	0.00355	0.256	2.25e-05	0.0265	0.0459

Mix designs: 36 to 40 MPa

Table 13: **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	63.8	0.0873	450	3.46e-05	0.907	0.0015	2680
Maximum	63.8	0.0873	450	3.46e-05	0.907	0.0015	2680
Mean	63.8	0.0873	450	3.46e-05	0.907	0.0015	2680
Median	63.8	0.0873	450	3.46e-05	0.907	0.0015	2680
70350NB2014	63.8	0.0873	450	3.46e-05	0.907	0.0015	2680

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	3000	135	2860	72.6	0.00793	5.51	55.3	0.00394	0.261	2.25e-05	0.0265	0.0459
Maximum	3000	135	2860	72.6	0.00793	5.51	55.3	0.00394	0.261	2.25e-05	0.0265	0.0459

Mean	3000	135	2860	72.6	0.00793	5.51	55.3	0.00394	0.261	2.25e-05	0.0265	0.0459
Median	3000	135	2860	72.6	0.00793	5.51	55.3	0.00394	0.261	2.25e-05	0.0265	0.0459
70350NB2014	3000	135	2860	72.6	0.00793	5.51	55.3	0.00394	0.261	2.25e-05	0.0265	0.0459

Mix designs: 41 to 45 MPa

Table 14: **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	36	0.0587	449	3.15e-05	0.394	0.000499	2570
Maximum	38.3	0.062	465	3.33e-05	0.436	8e-04	2620
Mean	37.2	0.0604	457	3.24e-05	0.415	0.00065	2600
Median	37.2	0.0604	457	3.24e-05	0.415	0.00065	2600
70400ND2014	38.3	0.062	449	3.33e-05	0.436	8e-04	2620

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	64.8	0.0933	489	3.9e-05	0.933	0.00169	2900	64.8	0.0933	489	3.9e-05	0.933
Maximum	64.8	0.0933	489	3.9e-05	0.933	0.00169	2900	64.8	0.0933	489	3.9e-05	0.933
Mean	64.8	0.0933	489	3.9e-05	0.933	0.00169	2900	64.8	0.0933	489	3.9e-05	0.933
Median	64.8	0.0933	489	3.9e-05	0.933	0.00169	2900	64.8	0.0933	489	3.9e-05	0.933
70400ND2014	64.8	0.0933	489	3.9e-05	0.933	0.00169	2900	64.8	0.0933	489	3.9e-05	0.933

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.