Environmental Product Declaration

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

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:	13 July 2023
Period of Validity:	5 years; valid until 12 July 2028
EPD Number:	26ebf7db-8db7-4d80-b460-4d035e0348a7

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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 CO_2 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 41 concrete mixes manufactured at the Holcim Mexico Operaciones S.A. de C.V. Villahermosa concrete facility in Tabasco, 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
3	24007NB0518	0.7 MPa 28d strength mortars and fillers	Mortars and fillers	0.70	1.54
4	24015NB0518	2 MPa 28d strength mortars and fillers	Mortars and fillers	2.00	1.27
5	24025NB0518	2.5 MPa 28d strength mortars and fillers	Mortars and fillers	2.50	1.04
6	77035ND2014	3.5 MPa 28d strength Ready mix concrete	Ready mix concrete	3.50	0.92
7	24035NB0518	3.5 MPa 28d strength mortars and fillers	Mortars and fillers	3.50	0.87
8	77036ND4006	3.6 MPa 28d strength Ready mix concrete	Ready mix concrete	3.60	0.69
9	77038ND2014	3.8 MPa 28d strength Ready mix concrete	Ready mix concrete	3.80	0.82
10	77040NB2014	0.4 MPa 28d strength Ready mix concrete	Ready mix concrete	0.40	0.76
11	77042ND2014	0.42 MPa 28d strength Ready mix concrete	Ready mix concrete	0.42	0.73
12	68042ND2010	0.42 MPa 28d strength special concrete	Special concrete	0.42	0.70

13	77045NB2014	0.45 MPa 28d strength Ready mix concrete	Ready mix concrete	0.45	0.69
14	77048NB2014	0.48 MPa 28d strength Ready mix concrete	Ready mix concrete	0.48	0.67
15	77050NB2014	0.5 MPa 28d strength Ready mix concrete	Ready mix concrete	0.50	0.62
16	24050NB0518	0.5 MPa 28d strength mortars and fillers	Mortars and fillers	0.50	0.76
17	60080NB0518	8 MPa 28d strength special concrete	Special concrete	8.00	0.94
18	70100NB2018	10 MPa 28d strength Ready mix concrete	Ready mix concrete	10.00	0.99
19	60100NB0524	10 MPa 28d strength special concrete	Special concrete	10.00	0.76
20	73100NB0518	10 MPa 28d strength mortars and fillers	Mortars and fillers	10.00	0.91
21	70150ND2010	10.5 MPa 28d strength Ready mix concrete	Ready mix concrete	10.50	0.92

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
22	60150NB1024	15 MPa 28d strength special concrete	Special concrete	15.0	0.63
23	73150NB0518	15 MPa 28d strength mortars and fillers	Mortars and fillers	15.0	0.79
24	70175NB2014	17.5 MPa 28d strength Ready mix concrete	Ready mix concrete	17.5	0.94
25	70200ND2010	20 MPa 28d strength Ready mix concrete	Ready mix concrete	20.0	0.82
26	60200NB2014	20 MPa 28d strength special concrete	Special concrete	20.0	0.78
27	73200NB0518	20 MPa 28d strength mortars and fillers	Mortars and fillers	20.0	0.71

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
28	70210NB2014	21 MPa 28d strength Ready mix concrete	Ready mix concrete	21	0.87
29	60210NB1024	21 MPa 28d strength special concrete	Special concrete	21	0.66

30	70250NB2018	25 MPa 28d strength Ready mix concrete	Ready mix concrete	25	0.73
31	60250NB1065	25 MPa 28d strength special concrete	Special concrete	25	0.55
32	73250NB0518	25 MPa 28d strength mortars and fillers	Mortars and fillers	25	0.62

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
33	70280NB2018	28 MPa 28d strength Ready mix concrete	Ready mix concrete	28	0.78
34	70300ND2010	30 MPa 28d strength Ready mix concrete	Ready mix concrete	30	0.64
35	73300NB0518	30 MPa 28d strength mortars and fillers	Mortars and fillers	30	0.55

Mix designs: 31 to 35 MPa

Table 5: **Declared products with Mix designs: 36 to 40MPa considered in this environmental product declaration**

Mix#	Unique name/ID	Short description	Product type	28 day strength, MPa	H2O to cement ratio
36	70320ND2010	32 MPa 28d strength Ready mix concrete	Ready mix concrete	32	0.74
37	04350ND2010	35 MPa 28d strength Ready mix concrete	Ready mix concrete	35	0.56
38	60350NB2022	35 MPa 28d strength special concrete	Special concrete	35	0.63
39	73350NB0518	35 MPa 28d strength mortars and fillers	Mortars and fillers	35	0.49

Mix designs: 36 to 40 MPa

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

Mix#	Unique name/ID	Short description	Product type	28 day strength, MPa	H2O to cement ratio
40	70360NB2018	36 MPa 28d strength Ready mix concrete	Ready mix concrete	36	0.71
41	70400ND2014	40 MPa 28d strength Ready mix concrete	Ready mix concrete	40	0.67

Mix designs: 41 to 45 MPa

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

Mix#	Unique name/ID	Short description	Product type	28 day strength, MPa	H2O to cement ratio
2	19.50NB2022	45 MPa 28d strength Ready mix concrete	Ready mix concrete	45	0.48

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
1	19.45NB2018	48 MPa 28d strength Ready mix concrete	Ready mix concrete	48	0.45

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 9: **Design composition**

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

SYSTEM BOUNDARIES

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

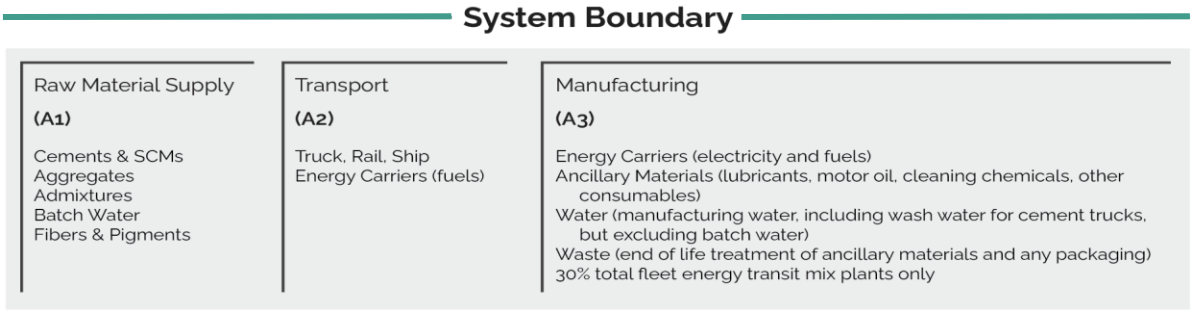

Figure 1: **General life cycle phases for consideration in a construction works system**

This is a Cradle-to-gate life cycle assessment and the following life cycle stages are included in the study:

- A1: Raw material supply (upstream processes) - Extraction, handling, and processing of the materials used in manufacturing the declared products in this LCA.
- A2: Transportation - Transportation of A1 materials from the supplier to the "gate" of the manufacturing facility (i.e. A3).
- A3: Manufacturing (core processes)- The energy and other utility inputs used to store, move, and manufacturer the declared products and to operate the facility.

As according to the PCR, the following figure illustrates the general activities and input requirements for producing ready mix concrete products and is not necessarily exhaustive.

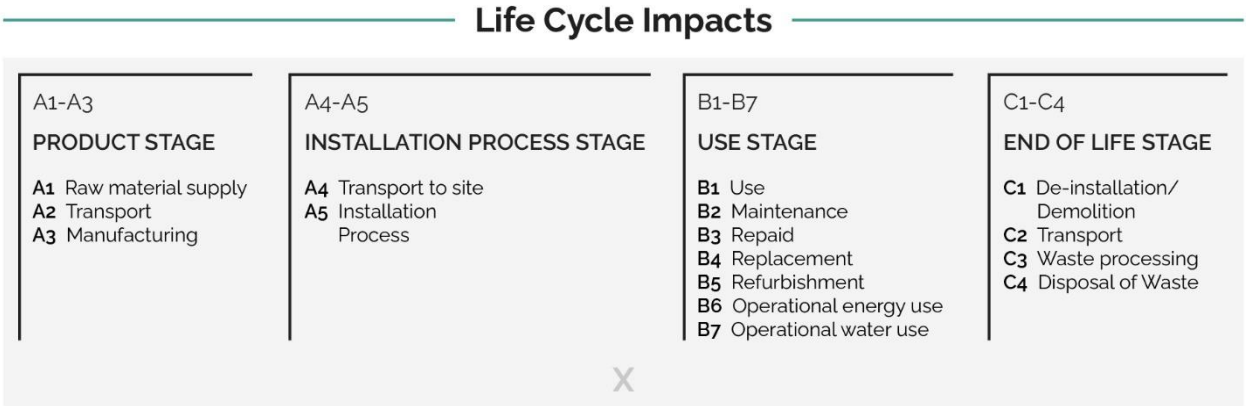

Figure 2: **General system inputs considered in the product system and categorized by modules in scope**

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

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

For this LCA the manufacturing plant, owned and operated by Holcim México Operaciones S.A. de C.V., is located at their Planta Villahermosa 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 10: **LCI inputs assumed for module A1 (i.e. raw material supply)** ***Data Quality Assessment Key Fair=1, Good=2, Very Good =3.***

Input	LCI.activity	Data.source	Geo	Year	Technology	Time	Geography	Reliability	Completeness
Water	tap water production, conventional with biological treatment/tap water/RoW/kg	ecoinvent v3.8	Tabasco	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	Tabasco, Veracruz	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) - PROVEEDOR : Mascupana	CPC 40	Progam Operator: Labeling Sustainability- EPD ID: 09cddb67-dd75-4879-9c7d-74d4664d8e10	Tabasco	30 November 2021	3	NA	3	3	3

DATA QUALITY ASSESSMENT

Data quality/variability requirements, as specified in the PCR, are applied. This section describes the achieved data quality relative to the ISO 14044:2006 requirements. Data quality is judged based on its precision (measured, calculated, or estimated), completeness (e.g., unreported emissions),

consistency (degree of uniformity of the methodology applied within a study serving as a data source) and representativeness (geographical, temporal, and technological).

Precision: Through measurement and calculation, the manufacturers collected and provided primary data on their annual production. For accuracy, the LCA practitioner and 3rd Party Verifier validated the plant gate-to-gate data.

Completeness: All relevant specific processes, including inputs (raw materials, energy, and ancillary materials) and outputs (emissions and production volume) were considered and modeled to represent the specified and declared products. The majority of relevant background materials and processes were taken from ecoinvent v3.8 LCI datasets where relatively recent region-specific electricity inputs were utilized. The most relevant EPDs requiring key A1 inputs were also utilized where readily available.

Consistency: To ensure consistency, the same modeling structure across the respective product systems was utilized for all inputs, which consisted of raw material inputs and ancillary material, energy flows, water resource inputs, product, and co-products outputs, returned and recovered Ready Mix Concrete materials, emissions to air, water and soil, and waste recycling and treatment. The same background LCI datasets from the ecoinvent v3.8 database were used across all product systems. Crosschecks concerning the plausibility of mass and energy flows were continuously conducted. The LCA team conducted mass and energy balances at the plant and selected process level to maintain a high level of consistency.

Reproducibility: Internal reproducibility is possible since the data and the models are stored and available in a machine readable project file for all foreground and background processes, and in Labeling Sustainability's proprietary Ready Mix Concrete LCA calculator* for all production facility and product-specific calculations. A considerable level of transparency is provided throughout the detailed LCA report as the specifications and material quantity make-up for the declared products are presented and key primary and secondary LCI data sources are summarized. The provision of more detailed publicly accessible data to allow full external reproducibility was not possible due to reasons of confidentiality.

*Labeling Sustainability has developed a proprietary tool that allows the calculation of PCR-compliant LCA results for Ready Mix Concrete product designs. The tool auto-calculates results by scaling base-unit technosphere inputs (i.e. 1 kg sand, 1 kWh electricity, etc.) to replicate the reference flow conversions that take place in any typical LCA software like openLCA or SimaPro. The tool was tested against several LCAs performed in openLCA and the tool generated identical results to those realized in openLCA across every impact category and inventory metric (where comparisons could be readily made).

Representativeness: The representativeness of the data is summarized as follows.

- Time related coverage of the manufacturing processes' primary collected data from 2022-01-01 to 2022-12-31.
- Upstream (background) LCI data was either the PCR specified default (if applicable) or more appropriate LCI datasets as found in the country-adjusted ecoinvent v3.8 database.
- Geographical coverage for inputs required by the A3 facility(ies) is representative of its region of focus; other upstream and background processes are based on US, North

American, or global average data and adjusted to regional electricity mixes when relevant.

- Technological coverage is typical or average and specific to the participating facilities for all primary data.

ENVIRONMENTAL INDICATORS AND INVENTORY METRICS

Per the PCR, this EPD supports the life cycle impact assessment indicators and inventory metrics as listed in the tables below. As specified in the PCR, the most recent US EPA Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI), impact categories were utilized as they provide a North American context for the mandatory category indicators to be included in the EPD. Additionally, the PCR requires a set of inventory metrics to be reported with the LCIA indicators (see tables below).

It should be noted that emerging LCA impact categories and inventory items are still under development and can have high levels of uncertainty that preclude international acceptance pending further development. Use caution when interpreting data in any of the following categories.

TOTAL IMPACT SUMMARY

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

Mix designs: 0 to 15 MPa

Table 11: **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	24.5	0.084	191	1.62e-05	0.351	0.000491	1240
Maximum	50.3	0.127	396	3.65e-05	0.703	0.00111	2780
Mean	39.8	0.109	312	2.82e-05	0.561	0.000857	2160
Median	39.3	0.11	315	2.89e-05	0.55	0.000873	2220
24007NB0518	24.5	0.084	191	1.62e-05	0.351	0.000491	1240
24015NB0518	27.9	0.0891	222	1.85e-05	0.398	0.000563	1420
24025NB0518	31.8	0.095	258	2.11e-05	0.454	0.000646	1620
77035ND2014	39.3	0.11	294	2.91e-05	0.55	0.000874	2220
24035NB0518	36	0.101	296	2.39e-05	0.513	0.000734	1840
77036ND4006	46.1	0.121	353	3.41e-05	0.646	0.00102	2560
77038ND2014	42	0.114	318	3.1e-05	0.587	0.000932	2360
77040NB2014	43.8	0.117	336	3.2e-05	0.613	0.000967	2440
77042ND2014	44.9	0.119	345	3.3e-05	0.629	0.000996	2510
68042ND2010	47	0.122	363	3.44e-05	0.657	0.00104	2630
77045NB2014	46.7	0.121	362	3.41e-05	0.654	0.00103	2600

77048NB2014	48.1	0.123	374	3.5e-05	0.673	0.00106	2670
77050NB2014	50.3	0.127	396	3.65e-05	0.703	0.00111	2780
24050NB0518	40.3	0.108	336	2.68e-05	0.573	0.000824	2060
60080NB0518	35.4	0.101	287	2.35e-05	0.505	0.000718	1800
70100NB2018	39.1	0.11	293	2.88e-05	0.546	0.000871	2210
60100NB0524	38.6	0.105	315	2.56e-05	0.549	0.000795	1990
73100NB0518	36.3	0.102	296	2.41e-05	0.518	0.000736	1840
70150ND2010	39	0.11	290	2.89e-05	0.544	0.000873	2220

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	1380	41.4	1340	33.8	0.00247	0.464	52.6	0.00181	0.214	1.17e-05	0.0402	28.9
Maximum	3100	96.4	3000	75.4	0.00528	0.633	87.2	0.00422	0.271	1.17e-05	0.0402	28.9
Mean	2400	73.1	2320	58.6	0.00407	0.56	72.6	0.00325	0.242	1.17e-05	0.0402	28.9
Median	2450	72.1	2380	60.5	0.00407	0.558	81.3	0.00374	0.229	1.17e-05	0.0402	28.9
24007NB0518	1380	41.4	1340	33.8	0.00247	0.464	52.6	0.00181	0.269	1.17e-05	0.0402	28.9
24015NB0518	1570	50.6	1530	38.3	0.0029	0.492	54.3	0.00196	0.268	1.17e-05	0.0402	28.9
24025NB0518	1810	60.3	1750	43.8	0.0035	0.523	56.1	0.00214	0.265	1.17e-05	0.0402	28.9
77035ND2014	2450	64.3	2380	60.5	0.00364	0.532	81.3	0.00374	0.226	1.17e-05	0.0402	28.9
24035NB0518	2050	72.1	1990	49.5	0.00398	0.558	58.1	0.00233	0.262	1.17e-05	0.0402	28.9
77036ND4006	2840	81.2	2750	70	0.00447	0.576	87.2	0.00422	0.214	1.17e-05	0.0402	28.9
77038ND2014	2610	71.7	2540	64.2	0.00407	0.553	82.8	0.00388	0.224	1.17e-05	0.0402	28.9
77040NB2014	2700	78.4	2620	66.3	0.0042	0.572	82.7	0.00391	0.226	1.17e-05	0.0402	28.9
77042ND2014	2790	80	2710	68.5	0.00441	0.579	84.4	0.00403	0.224	1.17e-05	0.0402	28.9
68042ND2010	2920	86.9	2820	71.6	0.00466	0.602	85.7	0.00414	0.229	1.17e-05	0.0402	28.9
77045NB2014	2900	86.8	2790	70.5	0.00464	0.598	84.5	0.00407	0.227	1.17e-05	0.0402	28.9
77048NB2014	2970	89.5	2870	72.5	0.00495	0.611	85.3	0.00414	0.228	1.17e-05	0.0402	28.9
77050NB2014	3100	96.4	3000	75.4	0.00528	0.633	86	0.00421	0.229	1.17e-05	0.0402	28.9

24050NB0518	2300	83.2	2220	55.3	0.00465	0.595	60	0.00252	0.262	1.17e-05	0.0402	28.9
60080NB0518	2010	68.3	1950	48.6	0.00385	0.557	58.7	0.00236	0.27	1.17e-05	0.0402	28.9
70100NB2018	2450	65.7	2360	60.1	0.0037	0.55	80.1	0.00367	0.244	1.17e-05	0.0402	28.9
60100NB0524	2240	77.5	2140	53.5	0.00432	0.557	60.1	0.0025	0.242	1.17e-05	0.0402	28.9
73100NB0518	2060	70.5	1990	49.8	0.00403	0.566	59.1	0.0024	0.271	1.17e-05	0.0402	28.9
70150ND2010	2450	65	2380	60.8	0.00366	0.524	81.3	0.00374	0.22	1.17e-05	0.0402	28.9

Mix designs: 15 to 20 MPa

Table 12: **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	39.9	0.107	307	2.66e-05	0.565	0.000813	2030
Maximum	57	0.136	462	4.05e-05	0.799	0.00124	3100
Mean	44.2	0.116	350	3.14e-05	0.623	0.000953	2400
Median	42.2	0.113	332	3.03e-05	0.593	0.000909	2300
60150NB1024	57	0.136	462	4.05e-05	0.799	0.00124	3100
73150NB0518	39.9	0.107	329	2.66e-05	0.569	0.000813	2030
70175NB2014	40.5	0.112	307	3.02e-05	0.565	9e-04	2280
70200ND2010	41	0.113	308	3.04e-05	0.573	0.000918	2330
60200NB2014	43.7	0.117	336	3.2e-05	0.613	0.000964	2430
73200NB0518	43.4	0.113	361	2.89e-05	0.618	0.000885	2210

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	2280	69.5	2190	54.6	0.0038	0.535	60.8	0.00256	0.214	1.17e-05	0.0402	28.9
Maximum	3470	117	3360	84.1	0.00605	0.754	85.7	0.00432	0.288	1.17e-05	0.0402	28.9
Mean	2670	84.8	2580	65	0.00461	0.608	76.2	0.00354	0.252	1.17e-05	0.0402	28.9
Median	2540	80	2470	62.8	0.00441	0.586	82.5	0.00386	0.256	1.17e-05	0.0402	28.9

60150NB1024	3470	117	3360	84.1	0.00605	0.754	85.7	0.00432	0.288	1.17e-05	0.0402	28.9
73150NB0518	2280	81.8	2190	54.6	0.00454	0.595	60.8	0.00256	0.268	1.17e-05	0.0402	28.9
70175NB2014	2520	69.5	2450	62.2	0.004	0.564	82.6	0.00384	0.245	1.17e-05	0.0402	28.9
70200ND2010	2570	70.1	2490	63.4	0.0038	0.535	83.1	0.00388	0.214	1.17e-05	0.0402	28.9
60200NB2014	2700	78.2	2620	66.5	0.00428	0.578	82.4	0.00389	0.232	1.17e-05	0.0402	28.9
73200NB0518	2490	92.4	2400	59.4	0.0049	0.623	62.4	0.00272	0.266	1.17e-05	0.0402	28.9

Mix designs: 21 to 25 MPa

Table 13: **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	42.1	0.115	321	3.13e-05	0.588	0.000935	2360
Maximum	52.3	0.129	418	3.71e-05	0.736	0.00113	2830
Mean	47.3	0.121	375	3.36e-05	0.665	0.00102	2560
Median	48.5	0.12	386	3.28e-05	0.685	0.000996	2510
70210NB2014	42.1	0.115	321	3.13e-05	0.588	0.000935	2360
60210NB1024	48.7	0.123	386	3.46e-05	0.685	0.00106	2650
70250NB2018	44.8	0.119	344	3.28e-05	0.627	0.000996	2510
60250NB1065	52.3	0.129	418	3.71e-05	0.736	0.00113	2830
73250NB0518	48.5	0.12	408	3.23e-05	0.69	0.000992	2470

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	2600	73.7	2540	64.3	0.00409	0.575	64.7	0.00295	0.222	1.17e-05	0.0402	28.9
Maximum	3160	104	3050	77.1	0.00564	0.668	83.9	0.00407	0.267	1.17e-05	0.0402	28.9
Mean	2860	90.6	2770	69.6	0.00501	0.62	79.1	0.00376	0.239	1.17e-05	0.0402	28.9
Median	2790	93.5	2710	68.6	0.0052	0.634	82.8	0.00393	0.243	1.17e-05	0.0402	28.9

70210NB2014	2600	73.7	2540	64.3	0.00409	0.575	83.7	0.00393	0.243	1.17e-05	0.0402	28.9
60210NB1024	2960	93.5	2860	71.6	0.0052	0.634	80.3	0.00385	0.243	1.17e-05	0.0402	28.9
70250NB2018	2790	79	2710	68.6	0.00449	0.577	83.9	0.004	0.222	1.17e-05	0.0402	28.9
60250NB1065	3160	103	3050	77.1	0.00562	0.644	82.8	0.00407	0.222	1.17e-05	0.0402	28.9
73250NB0518	2780	104	2680	66.2	0.00564	0.668	64.7	0.00295	0.267	1.17e-05	0.0402	28.9

Mix designs: 26 to 30 MPa

Table 14: **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	46	0.121	358	3.4e-05	0.643	0.00102	2560
Maximum	53.7	0.128	458	3.58e-05	0.764	0.00109	2710
Mean	48.8	0.124	392	3.47e-05	0.686	0.00105	2630
Median	46.6	0.122	359	3.43e-05	0.651	0.00104	2630
70280NB2018	46	0.121	358	3.4e-05	0.643	0.00102	2560
70300ND2010	46.6	0.122	359	3.43e-05	0.651	0.00104	2630
73300NB0518	53.7	0.128	458	3.58e-05	0.764	0.00109	2710

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	2850	84	2750	69.7	0.0046	0.574	67	0.00318	0.205	1.17e-05	0.0402	28.9
Maximum	3040	117	2930	72.8	0.00648	0.716	86.5	0.00419	0.269	1.17e-05	0.0402	28.9
Mean	2940	95.2	2840	71.4	0.00523	0.636	79.7	0.00383	0.242	1.17e-05	0.0402	28.9
Median	2920	84.5	2840	71.6	0.00461	0.619	85.7	0.00412	0.252	1.17e-05	0.0402	28.9
70280NB2018	2850	84.5	2750	69.7	0.0046	0.619	85.7	0.00412	0.252	1.17e-05	0.0402	28.9
70300ND2010	2920	84	2840	71.6	0.00461	0.574	86.5	0.00419	0.205	1.17e-05	0.0402	28.9

73300NB0518	3040	117	2930	72.8	0.00648	0.716	67	0.00318	0.269	1.17e-05	0.0402	28.9

Mix designs: 31 to 35 MPa

Table 15: **Total life cycle (across modules in scope) impact results for Mix designs: 31 to 35MPa, assuming the geometric mean point values on a per 1 m3 of concrete basis**

a) Midpoint Impact Categories:

Indicator/LCI Metric	**AP**	**EP**	**GWP**	**ODP**	**PCOP**	**ADPe**	**ADPf**
Unit	**moles of H+-Eq**	**kg N**	**kg CO2-Eq**	**kg CFC-11-Eq**	**kg NOx-Eq**	**kg Sb-Eq**	**MJ, net calorific value**
Minimum	46.2	0.121	357	3.45e-05	0.645	0.00103	2600
Maximum	60.1	0.138	515	4e-05	0.853	0.00124	3060
Mean	53.1	0.13	428	3.79e-05	0.746	0.00115	2880
Median	53.1	0.131	421	3.86e-05	0.744	0.00117	2920
70320ND2010	46.2	0.121	357	3.45e-05	0.645	0.00103	2600
04350ND2010	52.7	0.131	415	3.85e-05	0.737	0.00117	2930
60350NB2022	53.5	0.131	427	3.87e-05	0.75	0.00117	2920
73350NB0518	60.1	0.138	515	4e-05	0.853	0.00124	3060

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	2870	83.7	2790	70.8	0.00467	0.599	69.9	0.00347	0.215	1.17e-05	0.0402	28.9
Maximum	3440	137	3310	81.9	0.00696	0.775	89.7	0.00448	0.272	1.17e-05	0.0402	28.9
Mean	3210	107	3100	77.9	0.00572	0.675	83.8	0.00414	0.244	1.17e-05	0.0402	28.9
Median	3260	104	3140	79.5	0.00562	0.664	87.8	0.00431	0.244	1.17e-05	0.0402	28.9
70320ND2010	2870	83.7	2790	70.8	0.00467	0.599	88.2	0.00427	0.232	1.17e-05	0.0402	28.9
04350ND2010	3260	101	3150	79.7	0.00543	0.638	89.7	0.00448	0.215	1.17e-05	0.0402	28.9
60350NB2022	3270	106	3140	79.3	0.00581	0.689	87.3	0.00435	0.257	1.17e-05	0.0402	28.9
73350NB0518	3440	137	3310	81.9	0.00696	0.775	69.9	0.00347	0.272	1.17e-05	0.0402	28.9

Mix designs: 36 to 40 MPa

Table 16: **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	49.9	0.127	393	3.68e-05	0.697	0.0011	2770
Maximum	50.9	0.128	402	3.78e-05	0.711	0.00112	2820
Mean	50.4	0.128	398	3.73e-05	0.704	0.00111	2800
Median	50.4	0.128	398	3.73e-05	0.704	0.00111	2800
70360NB2018	49.9	0.127	393	3.68e-05	0.697	0.0011	2770
70400ND2014	50.9	0.128	402	3.78e-05	0.711	0.00112	2820

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	3080	94	2960	75.2	0.00517	0.656	88.2	0.00433	0.247	1.17e-05	0.0402	28.9
Maximum	3120	96.2	3030	76.7	0.00524	0.658	90.3	0.00448	0.257	1.17e-05	0.0402	28.9
Mean	3100	95.1	3000	76	0.0052	0.657	89.2	0.0044	0.252	1.17e-05	0.0402	28.9
Median	3100	95.1	3000	76	0.0052	0.657	89.2	0.0044	0.252	1.17e-05	0.0402	28.9
70360NB2018	3080	94	2960	75.2	0.00517	0.658	88.2	0.00433	0.257	1.17e-05	0.0402	28.9
70400ND2014	3120	96.2	3030	76.7	0.00524	0.656	90.3	0.00448	0.247	1.17e-05	0.0402	28.9

Mix designs: 41 to 45 MPa

Table 17: **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
19.50NB2022	52.8	0.131	417	3.82e-05	0.74	0.00117	2930

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
19.50NB2022	3260	102	3170	79.3	0.00555	0.612	87.5	0.00435	0.189	1.17e-05	0.0402	28.9

Mix designs: 46 to 50 MPa

Table 18: **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
19.45NB2018	54.3	0.133	429	3.93e-05	0.76	0.0012	3010

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
19.45NB2018	3360	105	3240	81.6	0.00571	0.619	89.1	0.00448	0.184	1.17e-05	0.0402	28.9

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.