Environmental Product Declaration

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

ADMINISTRATIVE INFORMATION

International Certified Environmental Product Declaration

Declared Product:	This Environmental Product Declaration (EPD) covers concrete products produced by Holcim México Operaciones S.A. de C.V.. Declared unit: 1 m3 of concrete
Declaration Owner:	Holcim México Operaciones S.A. de C.V. Av. Prolongación Vasco de Quiroga #4800 Torre II Ofic. 101 Piso 1, Santa Fe Cuajimalpa de Morelos Ciudad de México, México www.holcim.com.mx
Program Operator:	Labeling Sustainability 11670 W Sunset Blvd. Los Angeles, CA www.labelingsustainability.com/
Product Category Rule:	Core PCR: ISO 21930:2017 Sustainability in buildings and civil engineering works – Core rules for environmental product declarations of construction products and services SubPCR: NSF International (March 2020). Product Category Rul (PCR) for Environmental Product Declarations (EPD) PCR for Concrete, v2.1 Sub PCR Program Operator: NSF International Sub-category PCR review was conducted by: Thomas P. Gloria, Ph. D. of Industrial Ecology Consultants: 35 Bracebridge, Rd., Newton, MA 02459-1728, t.gloria@industrial-ecology.com. Dr. Michael Overcash of Environmental Clarity: 2908 Chipmunk Lane, Raleigh, NC 27607-3117, mrovercash@earthlink.net. Mr. Bill Stough of Sustainable Research Group: PO Box 1684, Grand Rapids, MI 49501-1684, bstough@sustainableresearchgroup.com. Mr. Jack Geilbig, EcoForm: 2624 Abelia Way, Suite 611, Knoxville, TN 37931, jgeilbig@ecoform.com.
Independent LCA Reviewer and EPD Verifier:	This EPD was independently verified in accordance with ISO 14025 and ISO 21930. The life cycle assessment was independently reviewed in accordance ISO 14044 and the referenced PCR. Independent verification of the declaration, according to ISO 14025:2006 Internal ☐ ; External X Third Party Verifier Geoffrey Guest, Certified 3rd Party Verifier under the International EPD Program (www.environdec.com), CSA Group (www.csaregistries.ca)
Date of Issue:	24 July 2023
Period of Validity:	5 years; valid until 23 July 2028
EPD Number:	5afe1a51-c63d-495d-b410-c4fe20f2463e

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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 42 concrete mixes manufactured at the Holcim Mexico Operaciones S.A. de C.V. Tecamac concrete facility in Estado de México, México.

This LCA assumes the impacts from products manufactured in accordance with the standards outlined in this report. This LCA is a cradle-to-gate study, and therefore, stages extending beyond the plant gate are not included in this LCA. Excluded stages include transportation of the manufactured material to the construction site; on-site construction processes and components; building (infrastructure) use and maintenance; and "end-of-life" effects.

READY MIX CONCRETE DESIGN SUMMARY

The following tables provide a list of the ready mix concrete products considered in this EPD along with key performance parameters.

Mix designs: 0 to 15 MPa

Table 1: **Declared products with Mix designs: 0 to 15MPa considered in this environmental product declaration**

Mix#	Unique name/ID	Short description	Product type	28 day strength, MPa	H2O to cement ratio
1	24005NB0518	0.49 MPa 28d strength mortars and fillers	Mortars and fillers	0.49	4.29
2	24007NB0518	0.69 MPa 28d strength mortars and fillers	Mortars and fillers	0.69	4.29
3	24010NB0520	0.98 MPa 28d strength mortars and fillers	Mortars and fillers	0.98	3.73
4	24015NB0518	1.47 MPa 28d strength mortars and fillers	Mortars and fillers	1.47	3.10
5	24020NB0518	1.96 MPa 28d strength mortars and fillers	Mortars and fillers	1.96	2.78
6	24025NB0520	2.45 MPa 28d strength mortars and fillers	Mortars and fillers	2.45	2.52
7	24030NB0520	2.94 MPa 28d strength mortars and fillers	Mortars and fillers	2.94	2.31
8	77035ND4010	3.43 MPa 28d strength Ready mix concrete	Ready mix concrete	3.43	0.82
9	24035NB0520	3.43 MPa 28d strength mortars and fillers	Mortars and fillers	3.43	2.13
10	77036ND2010	3.53 MPa 28d strength Ready mix concrete	Ready mix concrete	3.53	0.77

11	77038ND2010	3.73 MPa 28d strength Ready mix concrete	Ready mix concrete	3.73	0.72
12	77040ND2010	3.93 MPa 28d strength Ready mix concrete	Ready mix concrete	3.93	0.68
13	24040NB0520	3.93 MPa 28d strength mortars and fillers	Mortars and fillers	3.93	2.04
14	77042ND2010	4.12 MPa 28d strength Ready mix concrete	Ready mix concrete	4.12	0.65
15	77045ND2010	4.42 MPa 28d strength Ready mix concrete	Ready mix concrete	4.42	0.62
16	77048ND2010	4.71 MPa 28d strength Ready mix concrete	Ready mix concrete	4.71	0.60
17	77050ND4010	4.91 MPa 28d strength Ready mix concrete	Ready mix concrete	4.91	0.58
18	24050NB0524	4.91 MPa 28d strength mortars and fillers	Mortars and fillers	4.91	1.89
19	24060NB0514	5.89 MPa 28d strength mortars and fillers	Mortars and fillers	5.89	1.74
20	24075NB0518	7.36 MPa 28d strength mortars and fillers	Mortars and fillers	7.36	1.95
21	60080NB1918	7.85 MPa 28d strength special concrete	Special concrete	7.85	0.88
22	70100NB1914	9.81 MPa 28d strength Ready mix concrete	Ready mix concrete	9.81	1.08
23	73100NB0518	9.81 MPa 28d strength mortars and fillers	Mortars and fillers	9.81	1.48
24	70150NB2014	14.72 MPa 28d strength Ready mix concrete	Ready mix concrete	14.72	0.94
25	11150NB0514	14.72 MPa 28d strength mortars and fillers	Mortars and fillers	14.72	1.00

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
26	71175ND1210	17.17 MPa 28d strength Ready mix concrete	Ready mix concrete	17.17	0.88
27	70200NB2014	19.63 MPa 28d strength Ready mix concrete	Ready mix concrete	19.63	0.84
28	73200NB0518	19.63 MPa 28d strength mortars and fillers	Mortars and fillers	19.63	0.98

Mix designs: 21 to 25 MPa

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

Mix#	Unique name/ID	Short description	Product type	28 day strength, MPa	H2O to cement ratio
29	71210ND1210	20.61 MPa 28d strength Ready mix concrete	Ready mix concrete	20.61	0.81
30	04250NB2018	24.53 MPa 28d strength Ready mix concrete	Ready mix concrete	24.53	0.75
31	60250NB1218	24.53 MPa 28d strength special concrete	Special concrete	24.53	0.76
32	73250NB0518	24.53 MPa 28d strength mortars and fillers	Mortars and fillers	24.53	0.85

Mix designs: 26 to 30 MPa

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

Mix#	Unique name/ID	Short description	Product type	28 day strength, MPa	H2O to cement ratio
33	07280ND1210	27.48 MPa 28d strength Ready mix concrete	Ready mix concrete	27.48	0.71
34	04300NB2018	29.44 MPa 28d strength Ready mix concrete	Ready mix concrete	29.44	0.64
35	73300NB0518	29.44 MPa 28d strength mortars and fillers	Mortars and fillers	29.44	0.76

Mix designs: 31 to 35 MPa

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

Mix#	Unique name/ID	Short description	Product type	28 day strength, MPa	H2O to cement ratio
36	70320ND2010	31.4 MPa 28d strength Ready mix concrete	Ready mix concrete	31.40	0.61
37	70350ND2014	34.35 MPa 28d strength Ready mix concrete	Ready mix concrete	34.35	0.57
38	73350NB0514	34.35 MPa 28d strength mortars and fillers	Mortars and fillers	34.35	0.68

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
39	04360NB2012	35.33 MPa 28d strength Ready mix concrete	Ready mix concrete	35.33	0.55
40	70400ND2010	39.25 MPa 28d strength Ready mix concrete	Ready mix concrete	39.25	0.50
41	60400NB1265	39.25 MPa 28d strength special concrete	Special concrete	39.25	0.32

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
42	60450NB1265	44.16 MPa 28d strength special concrete	Special concrete	44.16	0.3

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 8: **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

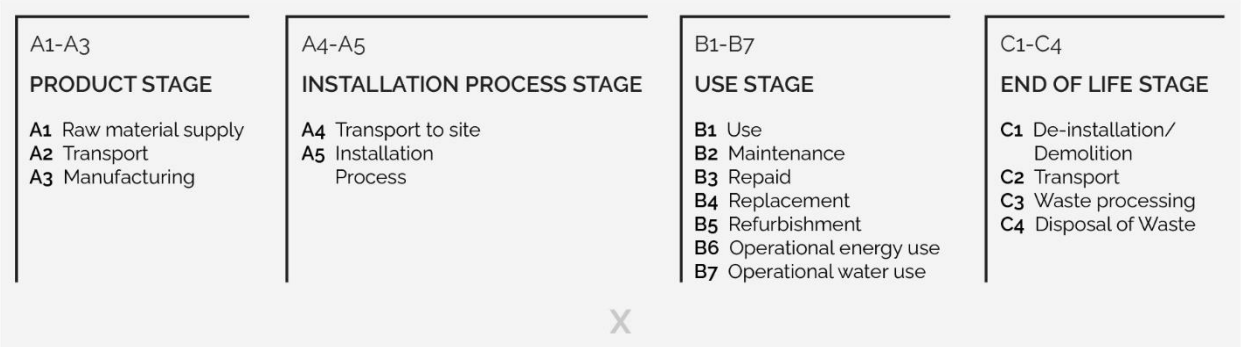

Figure 1: **General life cycle phases for consideration in a construction works system**

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

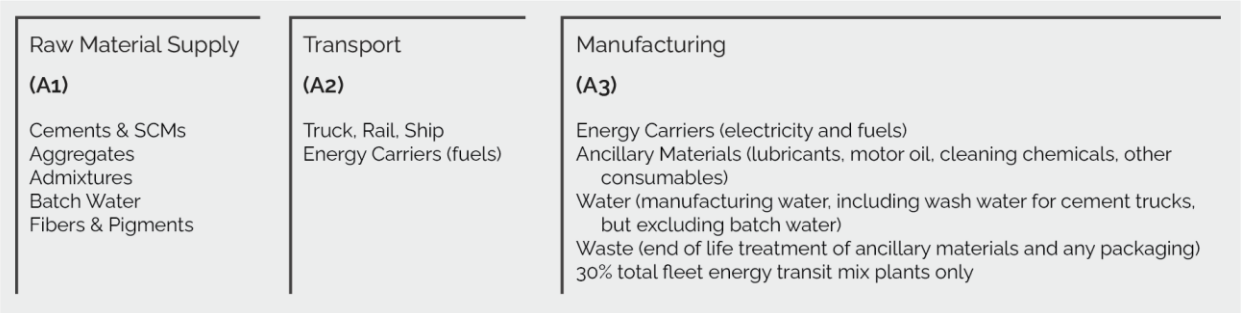

Figure 2: **General system inputs considered in the product system and categorized by modules in scope**

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 Tecamac 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 9: **LCI inputs assumed for module A1 (i.e. raw material supply)** ***Data Quality Assessment Key Fair=1, Good=2, Very Good =3.***

Input	LCI.activity	Data.source	Geo	Year	Technology	Time	Geography	Reliability	Completeness
Andesite sand	basalt quarry operation/basalt/RoW/kg ; Note: modifications made (see ecoinvent activity changes table)	ecoinvent v3.8	Edo de Mexico	v3.8 in 2021	2	3	1	3	3
Water	tap water production, conventional with biological treatment/tap water/RoW/kg	ecoinvent v3.8	Edo de Mexico	v3.8 in 2021	2	3	1	3	3
Limestone Sand	limestone quarry operation/limestone, unprocessed/RoW/kg; Note: modifications made (see ecoinvent activity changes table)	ecoinvent v3.8	Estado de México	v3.8 in 2021	2	3	1	3	3
Additives	market for chemical, organic/chemical, organic/GLO/kg	ecoinvent v3.8	Edo de Mexico	v3.8 in 2021	2	3	1	3	3
Cement (CPC 40) - PROVEEDOR : HOLCIM	CPC 40	Progam Operator: Labeling Sustainability-	Estado de México	very good, 3rd party	3	3	3	3	3

APAXCO (Apasco)		EPD ID: e38f688d-1fa5-41b0-a9b1-e5b1422ea654		verfied facility-specific EPD dataset					
Cement CPC 40R PROVEEDOR: HOLCIM APAXCO (Apasco)	CPC 40R	Progam Operator: Labeling Sustainability-EPD ID: e38f688d-1fa5-41b0-a9b1-e5b1422ea654	Estado de México	very good, 3rd party verfied facility-specific EPD dataset	3	NA	3	3	3
Natural River sand	sand quarry operation, extraction from river bed/sand/BR/kg; Note: modifications made (see ecoinvent activity changes table)	ecoinvent v3.8	Morelos	v3.8 in 2021	2	3	1	3	3

DATA QUALITY ASSESSMENT

Data quality/variability requirements, as specified in the PCR, are applied. This section describes the achieved data quality relative to the ISO 14044:2006 requirements. Data quality is judged based on its precision (measured, calculated, or estimated), completeness (e.g., unreported emissions), consistency (degree of uniformity of the methodology applied within a study serving as a data source) and representativeness (geographical, temporal, and technological).

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

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

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

conducted. The LCA team conducted mass and energy balances at the plant and selected process level to maintain a high level of consistency.

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

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

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

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

ENVIRONMENTAL INDICATORS AND INVENTORY METRICS

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

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

TOTAL IMPACT SUMMARY

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

Mix designs: 0 to 15 MPa

Table 10: **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	83.6	0.0937	87.3	5.15e-06	1.93	0.000364	413
Maximum	406	0.44	381	9.39e-06	9.61	0.00142	852
Mean	235	0.256	221	7.21e-06	5.52	0.000842	636
Median	236	0.257	226	7.29e-06	5.53	0.000845	661
24005NB0518	83.6	0.0937	87.3	5.15e-06	1.93	0.000364	413
24007NB0518	83.6	0.0937	87.3	5.15e-06	1.93	0.000364	413
24010NB0520	95.7	0.107	97.5	5.24e-06	2.22	4e-04	426
24015NB0518	111	0.123	111	5.46e-06	2.59	0.000449	448
24020NB0518	122	0.135	120	5.58e-06	2.85	0.000482	463
24025NB0520	135	0.149	131	5.68e-06	3.16	0.000521	476
24030NB0520	146	0.161	140	5.8e-06	3.42	0.000554	490
77035ND4010	290	0.316	278	8.26e-06	6.84	0.00105	716
24035NB0520	157	0.172	150	5.92e-06	3.69	0.000588	504
77036ND2010	306	0.334	280	8.43e-06	7.24	0.00106	741
77038ND2010	323	0.351	294	8.6e-06	7.63	0.00111	760
77040ND2010	339	0.369	308	8.76e-06	8.03	0.00116	779
24040NB0520	164	0.179	155	5.99e-06	3.84	0.000608	512
77042ND2010	356	0.387	322	8.92e-06	8.42	0.00121	798
77045ND2010	372	0.404	336	9.08e-06	8.81	0.00126	817
77048ND2010	390	0.422	366	9.22e-06	9.22	0.00137	833
77050ND4010	406	0.44	381	9.39e-06	9.61	0.00142	852
24050NB0524	181	0.198	170	6.07e-06	4.27	0.00066	526
24060NB0514	182	0.199	171	6.35e-06	4.27	0.000668	545
24075NB0518	181	0.197	178	7.29e-06	4.21	0.000675	687
60080NB1918	370	0.399	341	6.78e-06	8.77	0.00124	660
70100NB1914	237	0.259	227	8.51e-06	5.57	0.000866	775
73100NB0518	236	0.257	226	8.21e-06	5.53	0.000845	766
70150NB2014	255	0.278	246	7.79e-06	6.02	0.000936	661
11150NB0514	341	0.369	326	8.64e-06	8.05	0.0012	844

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	455	18.2	437	11.7	0.00111	0.47	12.6	0.000998	0.252	2.88e-05	0.00275	0.0335
Maximum	985	67.6	915	26.7	0.00521	0.687	23	0.00173	0.353	2.88e-05	0.00275	0.0335
Mean	727	43.6	680	19.3	0.00302	0.572	17.5	0.00136	0.309	2.88e-05	0.00275	0.0335
Median	777	45.8	709	21.2	0.00308	0.573	16.3	0.00137	0.34	2.88e-05	0.00275	0.0335
24005NB0518	455	18.2	437	11.7	0.00111	0.47	12.6	0.000998	0.349	2.88e-05	0.00275	0.0335
24007NB0518	458	18.4	439	11.7	0.00111	0.47	12.6	0.000998	0.349	2.88e-05	0.00275	0.0335
24010NB0520	475	20	452	12.2	0.00126	0.485	12.8	0.00101	0.351	2.88e-05	0.00275	0.0335
24015NB0518	504	22.7	477	13	0.00146	0.495	13.4	0.00105	0.343	2.88e-05	0.00275	0.0335
24020NB0518	520	24.5	490	13.4	0.0016	0.504	13.7	0.00107	0.341	2.88e-05	0.00275	0.0335
24025NB0520	533	26.6	507	13.9	0.00178	0.52	14	0.00109	0.343	2.88e-05	0.00275	0.0335
24030NB0520	551	28.1	521	14.4	0.0019	0.531	14.3	0.00111	0.342	2.88e-05	0.00275	0.0335
77035ND4010	824	50.1	766	21.8	0.00372	0.504	20.2	0.00155	0.257	2.88e-05	0.00275	0.0335
24035NB0520	571	30	538	14.9	0.00204	0.541	14.6	0.00113	0.34	2.88e-05	0.00275	0.0335
77036ND2010	852	52.8	797	22.6	0.00385	0.617	21	0.0016	0.254	2.88e-05	0.00275	0.0335
77038ND2010	877	55.9	815	23.3	0.0042	0.633	21.4	0.00163	0.253	2.88e-05	0.00275	0.0335
77040ND2010	902	60.3	838	24	0.00428	0.65	21.8	0.00166	0.252	2.88e-05	0.00275	0.0335
24040NB0520	578	31.2	546	15.1	0.00214	0.548	14.8	0.00114	0.34	2.88e-05	0.00275	0.0335
77042ND2010	918	61.4	855	24.6	0.00457	0.667	22.2	0.00168	0.252	2.88e-05	0.00275	0.0335
77045ND2010	946	64.3	877	25.3	0.00479	0.686	22.6	0.00171	0.253	2.88e-05	0.00275	0.0335
77048ND2010	961	66.1	890	25.9	0.00489	0.573	22.5	0.00171	0.254	2.88e-05	0.00275	0.0335
77050ND4010	985	67.6	915	26.6	0.00521	0.588	23	0.00173	0.257	2.88e-05	0.00275	0.0335
24050NB0524	600	32.9	561	15.6	0.00234	0.578	15	0.00115	0.351	2.88e-05	0.00275	0.0335
24060NB0514	620	34	582	16.2	0.00238	0.554	15.7	0.00121	0.326	2.88e-05	0.00275	0.0335
24075NB0518	778	43.5	733	21.2	0.00245	0.622	16.3	0.00137	0.351	2.88e-05	0.00275	0.0335

60080NB1918	777	64	709	21.5	0.00465	0.646	16.1	0.00123	0.34	2.88e-05	0.00275	0.0335
70100NB1914	882	50.9	830	23.7	0.00308	0.59	19.8	0.00161	0.269	2.88e-05	0.00275	0.0335
73100NB0518	875	52.9	820	23.8	0.00315	0.687	18.6	0.00155	0.353	2.88e-05	0.00275	0.0335
70150NB2014	755	45.8	707	20	0.00317	0.479	19.1	0.00147	0.258	2.88e-05	0.00275	0.0335
11150NB0514	970	67.6	908	26.7	0.00442	0.674	19.6	0.00158	0.352	2.88e-05	0.00275	0.0335

Mix designs: 15 to 20 MPa

Table 11: **Total life cycle (across modules in scope) impact results for Mix designs: 15 to 20MPa, assuming the geometric mean point values on a per 1 m3 of concrete basis**

Indicator/LCI Metric	**AP**	**EP**	**GWP**	**ODP**	**PCOP**	**ADPe**	**ADPf**
Unit	**moles of H+-Eq**	**kg N**	**kg CO2-Eq**	**kg CFC-11-Eq**	**kg NOx-Eq**	**kg Sb-Eq**	**MJ, net calorific value**
Minimum	283	0.308	271	7.84e-06	6.68	0.00103	693
Maximum	346	0.375	319	9.32e-06	8.16	0.00118	904
Mean	306	0.332	288	8.44e-06	7.22	0.00108	770
Median	288	0.313	275	8.15e-06	6.81	0.00104	713
71175ND1210	288	0.313	275	7.84e-06	6.81	0.00104	693
70200NB2014	283	0.308	271	8.15e-06	6.68	0.00103	713
73200NB0518	346	0.375	319	9.32e-06	8.16	0.00118	904

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	795	49.6	740	21.2	0.00366	0.498	19.1	0.00146	0.256	2.88e-05	0.00275	0.0335
Maximum	1040	70.6	971	28.5	0.00457	0.798	21.4	0.00174	0.348	2.88e-05	0.00275	0.0335
Mean	884	56.8	825	23.8	0.00396	0.604	20.1	0.00157	0.292	2.88e-05	0.00275	0.0335
Median	816	50.2	765	21.7	0.00366	0.516	19.9	0.00152	0.271	2.88e-05	0.00275	0.0335
71175ND1210	795	49.6	740	21.2	0.00366	0.516	19.1	0.00146	0.271	2.88e-05	0.00275	0.0335
70200NB2014	816	50.2	765	21.7	0.00366	0.498	19.9	0.00152	0.256	2.88e-05	0.00275	0.0335
73200NB0518	1040	70.6	971	28.5	0.00457	0.798	21.4	0.00174	0.348	2.88e-05	0.00275	0.0335

Mix designs: 21 to 25 MPa

Table 12: **Total life cycle (across modules in scope) impact results for Mix designs: 21 to 25MPa, assuming the geometric mean point values on a per 1 m3 of concrete basis**

Indicator/LCI Metric	AP	EP	GWP	ODP	PCOP	ADPe	ADPf
Unit	moles of H+-Eq	kg N	kg CO2-Eq	kg CFC-11-Eq	kg NOx-Eq	kg Sb-Eq	MJ, net calorific value
Minimum	311	0.338	295	8.08e-06	7.36	0.00111	721
Maximum	395	0.428	361	9.74e-06	9.34	0.00133	950
Mean	353	0.383	332	8.94e-06	8.35	0.00124	828
Median	354	0.383	335	8.96e-06	8.34	0.00125	820
71210ND1210	311	0.338	295	8.08e-06	7.36	0.00111	721
04250NB2018	348	0.377	328	8.58e-06	8.22	0.00123	769
60250NB1218	359	0.389	342	9.34e-06	8.46	0.00127	871
73250NB0518	395	0.428	361	9.74e-06	9.34	0.00133	950

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	830	53.7	770	22.1	0.00393	0.531	19.7	0.0015	0.269	2.88e-05	0.00275	0.0335
Maximum	1100	77.4	1020	30.2	0.00517	0.85	22.6	0.0018	0.349	2.88e-05	0.00275	0.0335
Mean	955	64.5	885	25.8	0.0045	0.639	21.3	0.00166	0.296	2.88e-05	0.00275	0.0335
Median	944	63.4	876	25.5	0.00444	0.588	21.4	0.00166	0.282	2.88e-05	0.00275	0.0335
71210ND1210	830	53.7	770	22.1	0.00393	0.531	19.7	0.0015	0.269	2.88e-05	0.00275	0.0335
04250NB2018	889	60.1	819	23.7	0.00427	0.565	21	0.00159	0.277	2.88e-05	0.00275	0.0335
60250NB1218	1000	66.7	932	27.4	0.00461	0.611	21.8	0.00172	0.288	2.88e-05	0.00275	0.0335
73250NB0518	1100	77.4	1020	30.2	0.00517	0.85	22.6	0.0018	0.349	2.88e-05	0.00275	0.0335

Mix designs: 26 to 30 MPa

Table 13: **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	366	0.397	345	8.86e-06	8.66	0.00129	797
Maximum	445	0.481	402	1.02e-05	10.5	0.00148	1000
Mean	405	0.438	375	9.39e-06	9.56	0.00139	876
Median	403	0.436	377	9.11e-06	9.53	0.0014	832
07280ND1210	366	0.397	345	8.86e-06	8.66	0.00129	797
04300NB2018	403	0.436	377	9.11e-06	9.53	0.0014	832
73300NB0518	445	0.481	402	1.02e-05	10.5	0.00148	1000

b) Inventory Metrics:

Indicator/LCI Metric	TPE	RE	NRE	NRR	RR	WDP	LFW	LFHW	CBWC	CWWC	CHW	CNHW
Unit	MJ-Eq	MJ-Eq	MJ-Eq	kg	m3	m3	kg waste	kg waste	m3	m3	kg	kg
Minimum	922	62.8	851	24.8	0.00462	0.581	21.7	0.00164	0.278	2.88e-05	0.00275	0.0335
Maximum	1170	84.8	1080	32.2	0.0057	0.904	23.7	0.00189	0.351	2.88e-05	0.00275	0.0335
Mean	1020	72.1	940	27.7	0.00516	0.697	22.6	0.00174	0.303	2.88e-05	0.00275	0.0335
Median	965	68.7	890	26	0.00515	0.606	22.3	0.00168	0.279	2.88e-05	0.00275	0.0335
07280ND1210	922	62.8	851	24.8	0.00462	0.581	21.7	0.00164	0.279	2.88e-05	0.00275	0.0335
04300NB2018	965	68.7	890	26	0.00515	0.606	22.3	0.00168	0.278	2.88e-05	0.00275	0.0335
73300NB0518	1170	84.8	1080	32.2	0.0057	0.904	23.7	0.00189	0.351	2.88e-05	0.00275	0.0335

Mix designs: 31 to 35 MPa

Table 14: **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	373	0.405	352	9.09e-06	8.82	0.00132	816
Maximum	485	0.524	436	1.06e-05			1030
Mean	423	0.459	391	11.5	0.00159		901
Median	412	0.447	386	10	0.00145	0.00144	858
70320ND2010	373	0.405	352	9.09e-06	8.82	0.00132	816
70350ND2014	412	0.447	386	9.44e-06	9.76	0.00144	858
73350NB0514	485	0.524	436	1.06e-05	11.5	0.00159	1030

b) Inventory Metrics:

Indicator/LCI Metric	TPE	RE	NRE	NRR	RR	WDP	LFW	LFHW	CBWC	CWWC	CHW	CNHW
Unit	MJ-Eq	MJ-Eq	MJ-Eq	kg	m3	m3	kg waste	kg waste	m3	m3	kg	kg
Minimum	943	63.5	873	25.3	0.00472	0.557	22.2	0.00169	0.25	2.88e-05	0.00275	0.0335
Maximum	1200	90.9	1110	33.5	0.00639	0.938	24.8	0.00196	0.343	2.88e-05	0.00275	0.0335
Mean	1050	74.9	967	28.5	0.00546	0.695	23.4	0.0018	0.283	2.88e-05	0.00275	0.0335
Median	994	70.3	918	26.8	0.00528	0.591	23.1	0.00174	0.256	2.88e-05	0.00275	0.0335
70320ND2010	943	63.5	873	25.3	0.00472	0.557	22.2	0.00169	0.25	2.88e-05	0.00275	0.0335
70350ND2014	994	70.3	918	26.8	0.00528	0.591	23.1	0.00174	0.256	2.88e-05	0.00275	0.0335
73350NB0514	1200	90.9	1110	33.5	0.00639	0.938	24.8	0.00196	0.343	2.88e-05	0.00275	0.0335

Mix designs: 36 to 40 MPa

Table 15: **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	455	0.492	423	9.63e-06	10.8	0.00156	879
Maximum	662	0.718	632	1.64e-05	15.7	0.00241	1690
Mean	526	0.57	495	1.2e-05	12.5	0.00186	1170
Median	462	0.5	431	1.01e-05	10.9	0.00161	950
04360NB2012	455	0.492	423	9.63e-06	10.8	0.00156	879
70400ND2010	462	0.5	431	1.01e-05	10.9	0.00161	950
60400NB1265	662	0.718	632	1.64e-05	15.7	0.00241	1690

b) Inventory Metrics:

Indicator/LCI Metric	TPE	RE	NRE	NRR	RR	WDP	LFW	LFHW	CBWC	CWWC	CHW	CNHW
Unit	MJ-Eq	MJ-Eq	MJ-Eq	kg	m3	m3	kg waste	kg waste	m3	m3	kg	kg
Minimum	1030	75.4	942	27.8	0.00571	0.627	23.6	0.00177	0.236	2.88e-05	0.00275	0.0335
Maximum	1950	117	1810	51.9	0.00857	4.87	39.6	0.00295	0.269	2.88e-05	0.00275	0.0335
Mean	1360	89.8	1260	36.5	0.00672	2.04	29.2	0.00219	0.253	2.88e-05	0.00275	0.0335
Median	1100	76.9	1020	29.7	0.00589	0.634	24.4	0.00184	0.254	2.88e-05	0.00275	0.0335
04360NB2012	1030	75.4	942	27.8	0.00571	0.634	23.6	0.00177	0.269	2.88e-05	0.00275	0.0335
70400ND2010	1100	76.9	1020	29.7	0.00589	0.627	24.4	0.00184	0.254	2.88e-05	0.00275	0.0335
60400NB1265	1950	117	1810	51.9	0.00857	4.87	39.6	0.00295	0.236	2.88e-05	0.00275	0.0335

Mix designs: 41 to 45 MPa

Table 16: **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
60450NB1265	707	0.767	672	1.67e-05	16.7	0.00256	1740

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
60450NB1265	2010	126	1870	53.9	0.00961	4.67	40.2	0.003	0.238	2.88e-05	0.00275	0.0335

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.