Environmental Product Declaration

Environmental Product Declaration for various ready mix concrete products produced by Holcim Colombia at their Tunja facility in Boyacá, Colombia

ADMINISTRATIVE INFORMATION

International Certified Environmental Product Declaration

Declared Product:	This Environmental Product Declaration (EPD) covers concrete products produced by Holcim Colombia. Declared unit: 1 m3 of concrete
Declaration Owner:	Holcim Colombia 7-45 Calle 13, Piso 12, Torre B, Ed. Teleport Business Park Bogotá, Colombia www.holcim.com.co
Program Operator:	Labeling Sustainability Address, 11670 W Sunset Blvd. City, State, Los Angeles, CA www.labelinsustainability.com/
Product Category Rule:	Core PCR: ISO 21930:2017 Sustainability in buildings and civil engineering works – Core rules for environmental product declarations of construction products and services SubPCR: NSF International (March 2020). Product Category Rul (PCR) for Environmental Product Declarations (EPD) PCR for Concrete, v2.1 Sub PCR Program Operator: NSF International Sub-category PCR review was conducted by: Thomas P. Gloria, Ph. D. of Industrial Ecology Consultants: 35 Bracebridge, Rd., Newton, MA 02459-1728, t.gloria@industrial-ecology.com. Dr. Michael Overcash of Environmental Clarity: 2908 Chipmunk Lane, Raleigh, NC 27607-3117, mrovercash@earthlink.net. Mr. Bill Stough of Sustainable Research Group: PO Box 1684, Grand Rapids, MI 49501-1684, bstough@sustainableresearchgroup.com. Mr. Jack Geilbig, EcoForm: 2624 Abelia Way, Suite 611, Knoxville, TN 37931, jgeilbig@ecoform.com.
Independent LCA Reviewer and EPD Verifier:	This EPD was independently verified in accordance with ISO 14025 and ISO 21930. The life cycle assessment was independently reviewed in accordance ISO 14044 and the referenced PCR. Independent verification of the declaration, according to ISO 14025:2006 Internal ☐ ; External X Third Party Verifier Geoffrey Guest, Certified 3rd Party Verifier under the International EPD Program (www.environdec.com), CSA Group (www.csaregistries.ca)
Date of Issue:	29 April 2023
Period of Validity:	5 years; valid until 29 April 2028
EPD Number:	66925275-8dc8-472f-886d-d58c2c22ca78

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COMPANY DESCRIPTION

Holcim Colombia, as part of Grupo Holcim, a world leader in innovative and sustainable solutions for construction, is making it possible to have greener cities, smarter infrastructures and improve the standard of living of people around the world. With sustainability at the heart of its strategy, Holcim is becoming a Net Zero company, where its people and communities are the foundation of its success. The company is driving circular construction as a world leader in recycling to build more with less.

Holcim Colombia produces and markets cement, ready-mix concrete, aggregates (gravel and sand) and other products and solutions for construction. Additionally, it offers the GacoFlex TechoProtec waterproofing line and the Tector family of adhesives and mortars. The company has a team passionate about building progress for people and the planet. It has a national presence through 1 cement plant, 10 ready-mix concrete plants, 1 Geocycle platform, 1 aggregates plant, its own network of hardware stores, Disensa, with more than 400 stores nationwide; and offers specialized services for transporting materials or products through Transcem.

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 Colombia 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 Colombia 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 Colombia's license to operate in the community. The intended audience for this LCA report is Holcim Colombia'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 74 concrete mixes manufactured at the Holcim Colombia, Tunja concrete facility in Boyacá, Colombia.

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 cement products considered in this EPD along with key performance parameters.

Mix Designs: 0 to 15MPa

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	10062750	1 MPa 28d strength ready mix concrete.	Ready Mix Concrete	1.0	1.379310
2	10065079	3 MPa 28d strength ready mix concrete.	Ready Mix Concrete	3.0	1.212121
3	10010951	3.2 MPa 28d strength ready mix concrete.	Ready Mix Concrete	3.2	0.578358
4	10057014	3.5 MPa 28d strength ready mix concrete.	Ready Mix Concrete	3.5	0.519481
5	10010936	3.6 MPa 28d strength ready mix concrete.	Ready Mix Concrete	3.6	0.528053
6	10057085	3.8 MPa 28d strength ready mix concrete.	Ready Mix Concrete	3.8	0.487805
7	10062861	3.9 MPa 28d strength ready mix concrete.	Ready Mix Concrete	3.9	0.523810
8	10058155	3.9 MPa 28d strength ready mix concrete.	Ready Mix Concrete	3.9	0.432432
9	10058262	3.9 MPa 28d strength ready mix concrete.	Ready Mix Concrete	3.9	0.349345
10	10070686	4 MPa 28d strength ready mix concrete.	Ready Mix Concrete	4.0	0.472561
11	10044717	4 MPa 28d strength ready mix concrete.	Ready Mix Concrete	4.0	0.373494
12	10069891	4 MPa 28d strength ready mix concrete.	Ready Mix Concrete	4.0	0.345572
13	10062862	4.1 MPa 28d strength ready mix concrete.	Ready Mix Concrete	4.1	0.470588
14	10064492	4.1 MPa 28d strength ready mix concrete.	Ready Mix Concrete	4.1	0.417755
15	10056668	4.1 MPa 28d strength ready mix concrete.	Ready Mix Concrete	4.1	0.341880
16	10044388	4.2 MPa 28d strength ready mix concrete.	Ready Mix Concrete	4.2	0.428954

17	10058218	4.2 MPa 28d strength ready mix concrete.	Ready Mix Concrete	4.2	0.385542
18	10057273	4.3 MPa 28d strength ready mix concrete.	Ready Mix Concrete	4.3	0.404700
19	10056232	4.5 MPa 28d strength ready mix concrete.	Ready Mix Concrete	4.5	0.428922
20	10065429	4.5 MPa 28d strength ready mix concrete.	Ready Mix Concrete	4.5	0.353201
21	10065428	4.5 MPa 28d strength ready mix concrete.	Ready Mix Concrete	4.5	0.336538
22	10062775	5 MPa 28d strength ready mix concrete.	Ready Mix Concrete	5.0	0.329670
23	10067487	7 MPa 28d strength ready mix concrete.	Ready Mix Concrete	7.0	0.800000
24	10065078	7 MPa 28d strength ready mix concrete.	Ready Mix Concrete	7.0	0.952381
25	10063545	10 MPa 28d strength ready mix concrete.	Ready Mix Concrete	10.0	0.724138
26	10010704	10.5 MPa 28d strength ready mix concrete.	Ready Mix Concrete	10.5	1.145251
27	10010802	10.5 MPa 28d strength ready mix concrete.	Ready Mix Concrete	10.5	0.732601
28	10062864	12.5 MPa 28d strength ready mix concrete.	Ready Mix Concrete	12.5	0.656250
29	10012710	12.5 MPa 28d strength ready mix concrete.	Ready Mix Concrete	12.5	0.671233
30	10019490	14 MPa 28d strength ready mix concrete.	Ready Mix Concrete	14.0	1.100000
31	10020592	14 MPa 28d strength ready mix concrete.	Ready Mix Concrete	14.0	1.004902
32	10058762	14 MPa 28d strength ready mix concrete.	Ready Mix Concrete	14.0	0.907080
33	10066905	14 MPa 28d strength ready mix concrete.	Ready Mix Concrete	14.0	0.716724
34	10010804	14 MPa 28d strength ready mix concrete.	Ready Mix Concrete	14.0	0.666667

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
35	10071155	15 MPa 28d strength ready mix concrete.	Ready Mix Concrete	15.0	0.756677
36	10010710	17.5 MPa 28d strength ready mix concrete.	Ready Mix Concrete	17.5	0.919283
37	10064747	17.5 MPa 28d strength ready mix concrete.	Ready Mix Concrete	17.5	0.781893

38	10010758	17.5 MPa 28d strength ready mix concrete.	Ready Mix Concrete	17.5	0.586081
39	10010757	17.5 MPa 28d strength ready mix concrete.	Ready Mix Concrete	17.5	0.511182
40	10066906	17.5 MPa 28d strength ready mix concrete.	Ready Mix Concrete	17.5	0.608696
41	10071904	17.5 MPa 28d strength ready mix concrete.	Ready Mix Concrete	17.5	0.496183

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
42	10059167	21 MPa 28d strength ready mix concrete.	Ready Mix Concrete	21.0	0.791667
43	10010719	21 MPa 28d strength ready mix concrete.	Ready Mix Concrete	21.0	0.773585
44	10010790	21 MPa 28d strength ready mix concrete.	Ready Mix Concrete	21.0	0.682594
45	10018393	21 MPa 28d strength ready mix concrete.	Ready Mix Concrete	21.0	0.507692
46	10062691	21 MPa 28d strength ready mix concrete.	Ready Mix Concrete	21.0	0.611111
47	10059283	21 MPa 28d strength ready mix concrete.	Ready Mix Concrete	21.0	0.476190
48	10059161	24.5 MPa 28d strength ready mix concrete.	Ready Mix Concrete	24.5	0.760000
49	10010730	24.5 MPa 28d strength ready mix concrete.	Ready Mix Concrete	24.5	0.737410
50	10067703	24.5 MPa 28d strength ready mix concrete.	Ready Mix Concrete	24.5	0.653595
51	10057086	24.5 MPa 28d strength ready mix concrete.	Ready Mix Concrete	24.5	0.517751
52	10011045	24.5 MPa 28d strength ready mix concrete.	Ready Mix Concrete	24.5	0.536193
53	10010774	24.5 MPa 28d strength ready mix concrete.	Ready Mix Concrete	24.5	0.365297

Mix Designs: 26 to 30 MPa

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

Mix#	Unique name/ID	Short description	Product type	28 day strength, MPa	H2O to cement ratio
54	10059162	28 MPa 28d strength ready mix concrete.	Ready Mix Concrete	28	0.716981

55	10062525	28 MPa 28d strength ready mix concrete.	Ready Mix Concrete	28	0.683333
56	10050430	28 MPa 28d strength ready mix concrete.	Ready Mix Concrete	28	0.615616
57	10010784	28 MPa 28d strength ready mix concrete.	Ready Mix Concrete	28	0.434783
58	10067564	28 MPa 28d strength ready mix concrete.	Ready Mix Concrete	28	0.445545
59	10059877	28 MPa 28d strength ready mix concrete.	Ready Mix Concrete	28	0.426966
60	10059611	28 MPa 28d strength ready mix concrete.	Ready Mix Concrete	28	0.361446
61	10071311	28 MPa 28d strength ready mix concrete.	Ready Mix Concrete	28	0.307692

Mix Designs: 31 to 35 MPa

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

Mix#	Unique name/ID	Short description	Product type	28 day strength, MPa	H2O to cement ratio
62	10059170	31.5 MPa 28d strength ready mix concrete.	Ready Mix Concrete	31.5	0.622951
63	10059142	31.5 MPa 28d strength ready mix concrete.	Ready Mix Concrete	31.5	0.615616
64	10010788	31.5 MPa 28d strength ready mix concrete.	Ready Mix Concrete	31.5	0.387409
65	10059164	35 MPa 28d strength ready mix concrete.	Ready Mix Concrete	35.0	0.567164
66	10064230	35 MPa 28d strength ready mix concrete.	Ready Mix Concrete	35.0	0.554054
67	10017291	35 MPa 28d strength ready mix concrete.	Ready Mix Concrete	35.0	0.484262
68	10056853	35 MPa 28d strength ready mix concrete.	Ready Mix Concrete	35.0	0.382096
69	10052014	35 MPa 28d strength ready mix concrete.	Ready Mix Concrete	35.0	0.321970

Mix Designs: 36 to 40 MPa

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

Mix#	Unique name/ID	Short description	Product type	28 day strength, MPa	H2O to cement ratio
70	10058040	40 MPa 28d strength ready mix concrete.	Ready Mix Concrete	40	0.515075

Mix Designs: 41 to 45 MPa

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

Mix#	Unique name/ID	Short description	Product type	28 day strength, MPa	H2O to cement ratio
71	10010756	42 MPa 28d strength ready mix concrete.	Ready Mix Concrete	42	0.506667
72	10034945	42 MPa 28d strength ready mix concrete.	Ready Mix Concrete	42	0.490431

Mix Designs: 46 to 50 MPa

Table 8: **Declared products with Mix designs: 46 to 50 MPa considered in this environmental product declaration**

Mix#	Unique name/ID	Short description	Product type	28 day strength, MPa	H2O to cement ratio
73	10048089	49 MPa 28d strength ready mix concrete.	Ready Mix Concrete	49	0.319716
74	10053583	49 MPa 28d strength ready mix concrete.	Ready Mix Concrete	49	0.414847

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: **Ready mix concrete 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:

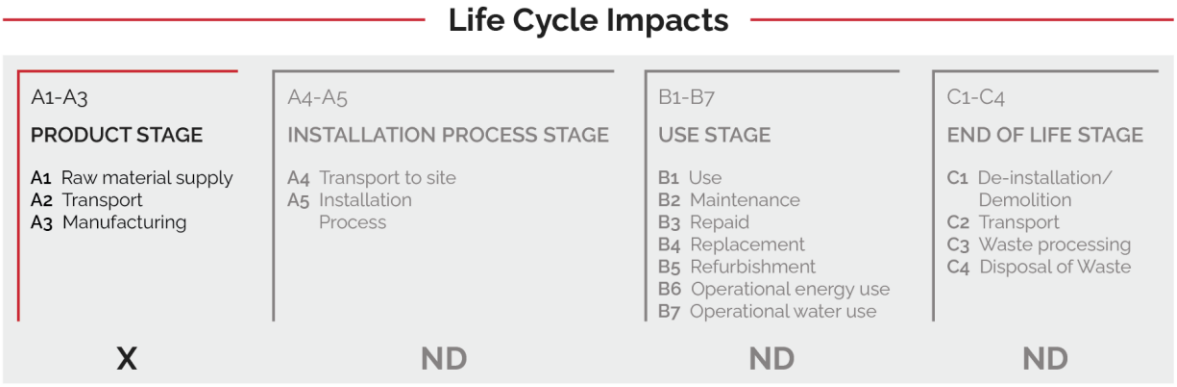

Figure 1: **General life cycle phases for consideration in a construction works system**

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 cement products and is not necessarily exhaustive.

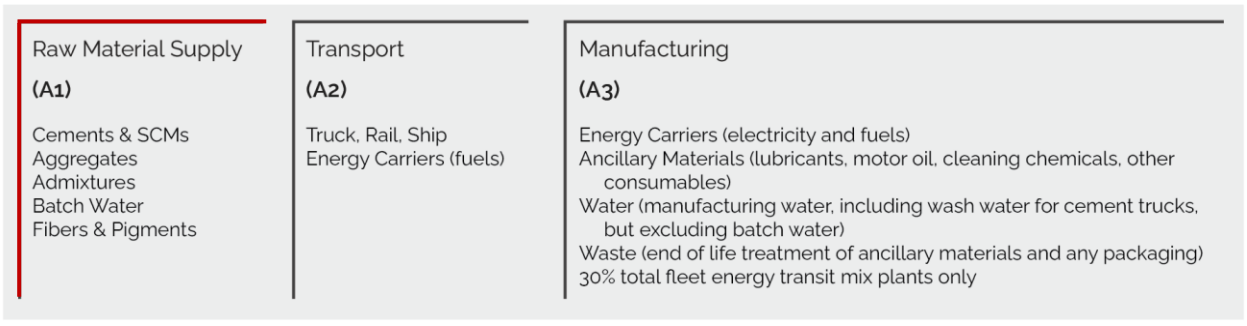

Figure 2: **General system inputs considered in the product system and categorized by modules in scope**

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 Colombia, is located at their Tunja facility in Colombia. All operating data is formulated using the actual data from Holcim Colombia'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 Colombia 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: Not applicable.

Electricity: Electricity consumption values are for Colombia in calendar year 2021. These values were direct reported from Colombia records. The unit process "market for electricity, medium voltage/electricity, medium voltage/CO/kWh" was used to represent the Colombia 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. This plant does not have electricity therefore it uses diesel to power generators.

Waste generation: Waste generation values are directly reported from Holcim operations for bulk waste. No hazardous or high-level radioactive waste is generated on-site at this facility. Wash water for trucks was also primary reported data for 2021.

Recovered energy: Not applicable.

Recycled/reused material/components: Not applicable.

Module A1 material losses: Not applicable.

Direct A3 emissions accounting: Not applicable.

Waste transport requirements: Not applicable.

Product transport requirements: The diesel fuel used by the mixing trucks is direct primary information reported from Holcim Colombia records for the year 2021. Holcim records their fuel for their trucks in l/km and therefore the information was converted with the following formula: (Ave. km to site)* 2 for return L diesel/km /(ave. m3 of concrete in a load) total concrete volume in m3 * fraction allocated to A3. A4 is outside the scope of this study.

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 treatment/tap water/RoW/kg	ecoinvent v3.8	Boyacá	v3.8 in 2021	2	3	2	3	3
Additives	market for chemical, organic/chemical, organic/GLO/kg	ecoinvent v3.8	Cundinamarca	v3.8 in 2021	2	3	2	3	3
RIVER SAND	sand quarry operation, extraction from river bed/sand/RoW/kg	ecoinvent v3.8	Boyacá	v3.8 in 2021	2	3	2	3	3
Cement	HE Cement	Progam Operator: Labeling Sustainability- EPD ID: 6328e320-6cab-4d85-83f4-dca33374d11b	Boaycá	06 January 2023	3	3	3	3	3
Gravel	gravel production, crushed/gravel, crushed/BR/kg; Note:	ecoinvent v3.8	Boayacá	v3.8 in 2021	2	3	2	3	3

	modifications made (see ecoinvent activity changes table)								

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 Cement 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 2021-01-01 to 2021-12-31.
- 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 cement 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 All declared products, 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	26.8	0.0403	154	1.57e-05	0.418	0.000677	1100
Maximum	70.1	0.101	464	3.78e-05	1.05	0.002	2660
Mean	49.2	0.0715	307	2.65e-05	0.749	0.00133	1860
Median	50.2	0.0719	305	2.63e-05	0.768	0.00134	1850
10062750	26.8	0.0403	154	1.57e-05	0.418	0.000677	1100
10065079	28.8	0.0432	171	1.69e-05	0.446	0.000747	1180
10010951	45.8	0.0657	256	2.28e-05	0.707	0.00113	1600
10057014	49.9	0.0715	289	2.51e-05	0.765	0.00127	1770
10010936	49.3	0.0707	285	2.48e-05	0.756	0.00125	1750
10057085	51.8	0.0744	305	2.63e-05	0.793	0.00134	1850
10062861	50.4	0.0723	294	2.55e-05	0.772	0.00129	1790
10058155	56.1	0.0805	340	2.88e-05	0.854	0.00148	2030
10058262	64.9	0.0933	413	3.41e-05	0.981	0.00179	2400
10070686	52.2	0.0748	305	2.63e-05	0.799	0.00134	1850
10044717	60.9	0.0874	378	3.15e-05	0.924	0.00164	2220
10069891	65.5	0.0941	417	3.43e-05	0.989	0.00181	2420
10062862	52.9	0.076	315	2.71e-05	0.808	0.00138	1900
10064492	55.8	0.0805	350	2.95e-05	0.846	0.00152	2070
10056668	66	0.0948	421	3.47e-05	0.997	0.00182	2440
10044388	56.4	0.081	343	2.9e-05	0.858	0.00149	2040
10058218	60.5	0.087	377	3.15e-05	0.918	0.00164	2220
10057273	56.6	0.0817	352	2.98e-05	0.86	0.00153	2090
10056232	59.8	0.0858	371	3.09e-05	0.907	0.00161	2180
10065429	64.5	0.0926	409	3.38e-05	0.974	0.00177	2380
10065428	70.1	0.101	464	3.78e-05	1.05	0.002	2660
10062775	65.2	0.0936	411	3.39e-05	0.987	0.00178	2380
10067487	36.2	0.0547	243	2.26e-05	0.551	0.00105	1570
10065078	33.3	0.0497	208	1.97e-05	0.511	0.000904	1370
10063545	38.7	0.0586	275	2.48e-05	0.583	0.00118	1730
10010704	34.6	0.0501	181	1.73e-05	0.541	0.000808	1210
10010802	37.6	0.0571	263	2.42e-05	0.568	0.00113	1680
10062864	43.8	0.0651	299	2.62e-05	0.661	0.00128	1830
10012710	44.7	0.0668	332	2.8e-05	0.664	0.00141	1960
10019490	35.5	0.051	182	1.73e-05	0.554	0.000815	1220
10020592	37.2	0.0538	202	1.88e-05	0.578	0.000895	1320
10058762	38.5	0.0557	219	1.99e-05	0.594	0.000965	1400
10066905	39.1	0.0592	278	2.5e-05	0.589	0.00119	1740
10010804	44.4	0.0668	321	2.81e-05	0.664	0.00137	1960

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	1240	76.1	1160	29.9	0.00054	4.66	37.8	0.00175	0.158	2.5e-05	0.0246	0.0316
Maximum	3070	220	2840	72.4	0.0013	16.2	90	0.00275	0.257	2.5e-05	0.0246	0.0316
Mean	2140	148	1990	50.8	0.000912	8.26	63.7	0.00224	0.189	2.5e-05	0.0246	0.0316
Median	2130	148	1980	50.6	0.000907	6.25	64	0.00224	0.17	2.5e-05	0.0246	0.0316
10062750	1240	76.1	1160	29.9	0.00054	13	37.8	0.00175	0.21	2.5e-05	0.0246	0.0316
10065079	1330	83.4	1250	32.1	0.000576	12.9	40.6	0.00181	0.21	2.5e-05	0.0246	0.0316
10010951	1840	129	1710	43.8	0.000796	6.47	55.8	0.00206	0.163	2.5e-05	0.0246	0.0316
10057014	2040	144	1890	48.5	0.000907	6	61.2	0.00216	0.168	2.5e-05	0.0246	0.0316
10010936	2010	143	1860	47.5	0.000907	6.12	60.5	0.00215	0.168	2.5e-05	0.0246	0.0316
10057085	2130	151	1980	50.7	0.000923	5.91	63.9	0.00222	0.168	2.5e-05	0.0246	0.0316
10062861	2070	146	1920	49.2	0.000895	5.98	62	0.00218	0.173	2.5e-05	0.0246	0.0316
10058155	2330	167	2170	55	0.001	5.57	69.7	0.00234	0.168	2.5e-05	0.0246	0.0316
10058262	2760	200	2560	65.3	0.00115	5.06	81.7	0.00258	0.168	2.5e-05	0.0246	0.0316
10070686	2130	152	1980	50.5	0.000952	5.66	64	0.00222	0.163	2.5e-05	0.0246	0.0316
10044717	2550	184	2380	60.5	0.0011	5.09	75.9	0.00246	0.163	2.5e-05	0.0246	0.0316
10069891	2790	202	2590	65.8	0.00118	4.9	82.3	0.00259	0.168	2.5e-05	0.0246	0.0316
10062862	2200	155	2030	52.1	0.000968	5.98	65.6	0.00226	0.168	2.5e-05	0.0246	0.0316
10064492	2390	170	2230	56.7	0.00101	6.38	70.9	0.00235	0.168	2.5e-05	0.0246	0.0316
10056668	2830	203	2610	66.7	0.00119	4.9	83.1	0.00261	0.168	2.5e-05	0.0246	0.0316
10044388	2350	169	2190	55.7	0.00106	5.58	70.1	0.00235	0.168	2.5e-05	0.0246	0.0316
10058218	2560	183	2380	60.7	0.00108	5.38	75.8	0.00246	0.168	2.5e-05	0.0246	0.0316
10057273	2410	170	2240	57.2	0.00104	6.66	71.7	0.00241	0.163	2.5e-05	0.0246	0.0316
10056232	2520	180	2340	59.4	0.00108	4.97	74.5	0.00241	0.184	2.5e-05	0.0246	0.0316

10065429	2720	196	2540	64.9	0.00113	5.04	81	0.00257	0.168	2.5e-05	0.0246	0.0316
10065428	3070	220	2840	72.4	0.0013	5.4	90	0.00275	0.184	2.5e-05	0.0246	0.0316
10062775	2750	199	2570	64.9	0.00113	4.66	81.4	0.00258	0.158	2.5e-05	0.0246	0.0316
10067487	1800	112	1680	42.9	0.000732	14.9	53.2	0.00215	0.21	2.5e-05	0.0246	0.0316
10065078	1560	99.6	1460	37.3	0.000667	12.6	46.9	0.00194	0.21	2.5e-05	0.0246	0.0316
10063545	1980	124	1840	47	0.000787	15	57.9	0.00222	0.22	2.5e-05	0.0246	0.0316
10010704	1380	94.8	1300	33.2	0.000622	8.03	42.7	0.00177	0.215	2.5e-05	0.0246	0.0316
10010802	1920	119	1790	45.8	0.000782	16.2	56.5	0.00225	0.21	2.5e-05	0.0246	0.0316
10062864	2100	138	1960	50	0.00088	12.2	61.9	0.00224	0.22	2.5e-05	0.0246	0.0316
10012710	2250	150	2100	53.2	0.000904	11.6	65.4	0.00219	0.257	2.5e-05	0.0246	0.0316
10019490	1390	95.6	1300	33.3	0.000622	7.37	42.9	0.00177	0.208	2.5e-05	0.0246	0.0316
10020592	1500	104	1400	35.8	0.000693	7.76	46.1	0.00184	0.215	2.5e-05	0.0246	0.0316
10058762	1600	111	1490	38.1	0.000732	7.67	48.6	0.00186	0.215	2.5e-05	0.0246	0.0316
10066905	1990	125	1860	47.3	0.000777	15.1	58.4	0.00223	0.22	2.5e-05	0.0246	0.0316
10010804	2250	145	2100	53.5	0.000889	14.8	65.6	0.00238	0.242	2.5e-05	0.0246	0.0316

Mix Designs: 15 to 20 MPa

Table 12: **Total life cycle (across modules in scope) impact results for All declared products, 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	39.1	0.0565	217	1.99e-05	0.605	0.000962	1400
Maximum	51.7	0.0767	361	3.1e-05	0.777	0.00155	2170
Mean	45.4	0.0665	286	2.52e-05	0.691	0.00124	1770
Median	45.6	0.0668	294	2.56e-05	0.698	0.00128	1800
10071155	46.2	0.0687	315	2.76e-05	0.698	0.00135	1930
10010710	39.1	0.0565	217	1.99e-05	0.605	0.000962	1400
10064747	41.3	0.0595	233	2.09e-05	0.638	0.00103	1470
10010758	45.6	0.0657	260	2.32e-05	0.702	0.00115	1630
10010757	49.4	0.0713	294	2.56e-05	0.756	0.00128	1800

10066906	44.3	0.0668	321	2.81e-05	0.664	0.00137	1960
10071904	51.7	0.0767	361	3.1e-05	0.777	0.00155	2170

b) Inventory Metrics:

Indicator/LCI Metric	TPE	RE	NRE	NRR	RR	WDP	LFW	LFHW	CBWC	CWWC	CHW	CNHW
Unit	**MJ-Eq**	**MJ-Eq**	**MJ-Eq**	**kg**	**m3**	**m3**	**kg waste**	**kg waste**	**m3**	**m3**	**kg**	**kg**
Minimum	1600	110	1490	38.2	0.000711	6.66	48.8	0.00189	0.168	2.5e-05	0.0246	0.0316
Maximum	2480	165	2310	58.6	0.001	14.7	72.9	0.00252	0.268	2.5e-05	0.0246	0.0316
Mean	2020	137	1890	48	0.000852	9.84	60.3	0.00219	0.206	2.5e-05	0.0246	0.0316
Median	2070	144	1930	49.2	0.000888	7.74	62.1	0.00221	0.205	2.5e-05	0.0246	0.0316
10071155	2200	145	2050	52.3	0.000902	12.7	65.1	0.00235	0.268	2.5e-05	0.0246	0.0316
10010710	1600	110	1490	38.2	0.000711	7.74	48.8	0.00189	0.215	2.5e-05	0.0246	0.0316
10064747	1690	118	1570	40.2	0.000743	6.66	51.1	0.00191	0.2	2.5e-05	0.0246	0.0316
10010758	1870	130	1740	44.4	0.000837	7.25	56.5	0.00209	0.168	2.5e-05	0.0246	0.0316
10010757	2070	144	1930	49.2	0.000888	7.22	62.1	0.00221	0.168	2.5e-05	0.0246	0.0316
10066906	2240	144	2110	53.3	0.000894	14.7	65.6	0.00238	0.22	2.5e-05	0.0246	0.0316
10071904	2480	165	2310	58.6	0.001	12.6	72.9	0.00252	0.205	2.5e-05	0.0246	0.0316

Mix Designs: 21 to 25 MPa

Table 13: **Total life cycle (across modules in scope) impact results for All declared products, 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	41.4	0.0597	232	2.1e-05	0.64	0.00102	1470
Maximum	62	0.0895	397	3.31e-05	0.937	0.00172	2320
Mean	49	0.071	301	2.61e-05	0.746	0.00131	1830
Median	48.7	0.0706	295	2.56e-05	0.738	0.00128	1800
10059167	41.4	0.0597	232	2.1e-05	0.64	0.00102	1470
10010719	43.5	0.0628	252	2.24e-05	0.668	0.00111	1570

10010790	46.3	0.0669	275	2.41e-05	0.709	0.00121	1690
10018393	50	0.0724	304	2.64e-05	0.764	0.00132	1850
10062691	49.6	0.0729	332	2.85e-05	0.748	0.00143	2000
10059283	54.3	0.0804	383	3.25e-05	0.812	0.00164	2270
10059161	42.4	0.0612	240	2.16e-05	0.654	0.00106	1520
10010730	44.5	0.0641	261	2.29e-05	0.682	0.00115	1610
10067703	47.7	0.0688	286	2.49e-05	0.728	0.00125	1750
10057086	51.7	0.0742	312	2.66e-05	0.787	0.00136	1870
10011045	54.3	0.0785	342	2.89e-05	0.823	0.00148	2030
10010774	62	0.0895	397	3.31e-05	0.937	0.00172	2320

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	1690	118	1570	40.3	0.000764	5.63	51.4	0.00196	0.168	2.5e-05	0.0246	0.0316
Maximum	2680	189	2480	63.4	0.00117	12.3	79.2	0.00258	0.231	2.5e-05	0.0246	0.0316
Mean	2100	147	1960	50	0.000901	7.65	62.8	0.0022	0.202	2.5e-05	0.0246	0.0316
Median	2060	144	1920	49.2	0.000881	7.22	62	0.00215	0.21	2.5e-05	0.0246	0.0316
10059167	1690	118	1570	40.3	0.000775	7.38	51.4	0.00196	0.2	2.5e-05	0.0246	0.0316
10010719	1810	126	1690	43	0.00078	7.25	54.5	0.00201	0.215	2.5e-05	0.0246	0.0316
10010790	1940	136	1820	46.2	0.000819	7.18	58.5	0.0021	0.21	2.5e-05	0.0246	0.0316
10018393	2120	147	1980	50.6	0.00092	7.67	63.7	0.00225	0.173	2.5e-05	0.0246	0.0316
10062691	2290	156	2150	54.6	0.00095	10.4	67.7	0.00234	0.231	2.5e-05	0.0246	0.0316
10059283	2600	176	2430	62.1	0.00104	12.3	76.4	0.00258	0.21	2.5e-05	0.0246	0.0316
10059161	1740	121	1620	41.4	0.000764	7.36	52.8	0.00199	0.2	2.5e-05	0.0246	0.0316
10010730	1850	131	1730	43.7	0.000787	6.34	55.6	0.00199	0.215	2.5e-05	0.0246	0.0316
10067703	2010	141	1870	47.7	0.000842	7.11	60.3	0.00213	0.21	2.5e-05	0.0246	0.0316
10057086	2150	155	2000	51.1	0.000966	5.63	64.4	0.00218	0.184	2.5e-05	0.0246	0.0316

10011045	2350	164	2170	55.5	0.00099 4	6.79	69.5	0.00232	0.21	2.5e-05	0.0246	0.0316
10010774	2680	189	2480	63.4	0.00117	6.41	79.2	0.00256	0.168	2.5e-05	0.0246	0.0316

Mix Designs: 26 to 30 MPa

Table 14: **Total life cycle (across modules in scope) impact results for All declared products, 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	43.9	0.0633	253	2.25e-05	0.675	0.00111	1580
Maximum	76	0.11	518	4.17e-05	1.14	0.00222	2930
Mean	56.8	0.0823	365	3.07e-05	0.86	0.00158	2150
Median	56.6	0.0818	354	2.99e-05	0.86	0.00154	2100
10059162	43.9	0.0633	253	2.25e-05	0.675	0.00111	1580
10062525	47.2	0.068	281	2.45e-05	0.722	0.00123	1720
10050430	48.2	0.0706	310	2.69e-05	0.732	0.00134	1880
10010784	55.1	0.0795	339	2.89e-05	0.839	0.00148	2030
10067564	58.2	0.084	368	3.09e-05	0.881	0.0016	2170
10059877	59.5	0.0869	403	3.37e-05	0.894	0.00173	2360
10059611	66.7	0.0963	445	3.63e-05	1	0.00191	2550
10071311	76	0.11	518	4.17e-05	1.14	0.00222	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**
Minimum	1810	126	1690	43.1	0.000806	5.73	54.8	0.00203	0.168	2.5e-05	0.0246	0.0316
Maximum	3380	243	3140	79.9	0.00139	9.59	98.8	0.00295	0.215	2.5e-05	0.0246	0.0316
Mean	2480	174	2300	58.6	0.00105	7.17	73.4	0.00242	0.196	2.5e-05	0.0246	0.0316
Median	2420	170	2250	57.1	0.00102	6.71	71.8	0.0024	0.194	2.5e-05	0.0246	0.0316
10059162	1810	126	1690	43.1	0.000806	7.32	54.8	0.00203	0.2	2.5e-05	0.0246	0.0316
10062525	1980	139	1840	46.8	0.000818	6.77	59.3	0.0021	0.215	2.5e-05	0.0246	0.0316

10050430	2160	147	2010	51.4	0.000949	9.59	64.3	0.00227	0.215	2.5e-05	0.0246	0.0316
10010784	2350	165	2170	55.4	0.000101	6.65	69.6	0.00236	0.168	2.5e-05	0.0246	0.0316
10067564	2500	175	2330	58.8	0.000104	6.28	74	0.00243	0.189	2.5e-05	0.0246	0.0316
10059877	2710	187	2520	64.3	0.000111	9.27	79.9	0.00261	0.2	2.5e-05	0.0246	0.0316
10059611	2950	210	2720	69.5	0.000124	5.76	86.3	0.00265	0.189	2.5e-05	0.0246	0.0316
10071311	3380	243	3140	79.9	0.000139	5.73	98.8	0.00295	0.189	2.5e-05	0.0246	0.0316

Mix Designs: 31 to 35 MPa

Table 15: **Total life cycle (across modules in scope) impact results for All declared products, 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	48.2	0.0695	286	2.48e-05	0.738	0.00125	1740
Maximum	71.5	0.103	471	3.82e-05	1.07	0.00203	2690
Mean	57.1	0.0824	360	3.02e-05	0.865	0.00156	2120
Median	56	0.0809	357	3e-05	0.847	0.00154	2110
10059170	48.2	0.0695	286	2.48e-05	0.738	0.00125	1740
10059142	50.6	0.073	308	2.64e-05	0.772	0.00134	1850
10010788	60	0.0863	376	3.15e-05	0.909	0.00163	2210
10059164	51.3	0.0739	310	2.66e-05	0.783	0.00135	1870
10064230	54.4	0.0784	339	2.86e-05	0.826	0.00147	2010
10017291	57.6	0.0835	375	3.14e-05	0.869	0.00162	2210
10056853	63.5	0.0917	413	3.42e-05	0.956	0.00178	2400
10052014	71.5	0.103	471	3.82e-05	1.07	0.00203	2690

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	2000	141	1860	47.8	0.000886	4.91	60.3	0.00213	0.168	2.5e-05	0.0246	0.0316
Maximum	3110	224	2880	73.3	0.00129	7.42	91.1	0.00278	0.215	2.5e-05	0.0246	0.0316
Mean	2450	174	2270	57.9	0.00104	6.25	72.6	0.00239	0.196	2.5e-05	0.0246	0.0316

Median	2430	172	2260	57.4	0.00 0994	6.34	72	0.002 37	0.2	2.5e-05	0.024 6	0.031 6
10059170	2000	141	1860	47.8	0.00 0887	6.62	60.3	0.002 13	0.2	2.5e-05	0.024 6	0.031 6
10059142	2140	151	1980	50.4	0.00 0886	6.36	63.8	0.002 19	0.215	2.5e-05	0.024 6	0.031 6
10010788	2550	184	2370	60.5	0.001 12	5.94	75.7	0.002 47	0.168	2.5e-05	0.024 6	0.031 6
10059164	2150	152	2000	51	0.00 092	6.33	64.4	0.002 21	0.2	2.5e-05	0.024 6	0.031 6
10064230	2330	164	2160	54.6	0.00 0977	6.08	68.9	0.002 29	0.215	2.5e-05	0.024 6	0.031 6
10017291	2530	179	2360	60.3	0.001 01	7.42	75	0.002 45	0.21	2.5e-05	0.024 6	0.031 6
10056853	2780	197	2570	65.3	0.001 2	6.34	81.6	0.002 59	0.184	2.5e-05	0.024 6	0.031 6
10052014	3110	224	2880	73.3	0.001 29	4.91	91.1	0.002 78	0.178	2.5e-05	0.024 6	0.031 6

Mix Designs: 36 to 40 MPa

Table 16: **Total life cycle (across modules in scope) impact results for All declared products, 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**
10058040	57	0.0823	362	3.03e-05	0.863	0.00157	2130

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**
10058040	2460	176	2290	58	0.001 02	6.14	72.7	0.002 37	0.215	2.5e-05	0.024 6	0.031 6

Mix Designs: 41 to 45 MPa

Table 17: **Total life cycle (across modules in scope) impact results for All declared products, 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	56.3	0.0807	343	2.88e-05	0.856	0.0015	2030
Maximum	58.7	0.0849	379	3.16e-05	0.887	0.00164	2220
Mean	57.5	0.0828	361	3.02e-05	0.871	0.00157	2120
Median	57.5	0.0828	361	3.02e-05	0.871	0.00157	2120
10010756	56.3	0.0807	343	2.88e-05	0.856	0.0015	2030
10034945	58.7	0.0849	379	3.16e-05	0.887	0.00164	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	2330	169	2170	55.2	0.00101	4.88	69.7	0.0023	0.2	2.5e-05	0.0246	0.0316
Maximum	2560	181	2380	60.2	0.00105	6.37	75.5	0.00244	0.215	2.5e-05	0.0246	0.0316
Mean	2440	175	2280	57.7	0.00103	5.62	72.6	0.00237	0.208	2.5e-05	0.0246	0.0316
Median	2440	175	2280	57.7	0.00103	5.62	72.6	0.00237	0.208	2.5e-05	0.0246	0.0316
10010756	2330	169	2170	55.2	0.00101	4.88	69.7	0.0023	0.2	2.5e-05	0.0246	0.0316
10034945	2560	181	2380	60.2	0.00105	6.37	75.5	0.00244	0.215	2.5e-05	0.0246	0.0316

Mix Designs: 46 to 50 MPa

Table 18: **Total life cycle (across modules in scope) impact results for All declared products, 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	64.6	0.0927	412	3.38e-05	0.975	0.00178	2380
Maximum	73	0.106	500	4.05e-05	1.09	0.00214	2850

Mean	68.8	0.0993	456	3.72e-05	1.03	0.00196	2620
Median	68.8	0.0993	456	3.72e-05	1.03	0.00196	2620
10048089	73	0.106	500	4.05e-05	1.09	0.00214	2850
10053583	64.6	0.0927	412	3.38e-05	0.975	0.00178	2380

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	2740	198	2550	64.8	0.00114	4.4	81	0.00253	0.189	2.5e-05	0.0246	0.0316
Maximum	3280	233	3060	77.3	0.00134	6.71	95.9	0.0029	0.2	2.5e-05	0.0246	0.0316
Mean	3010	216	2800	71	0.00124	5.56	88.4	0.00272	0.194	2.5e-05	0.0246	0.0316
Median	3010	216	2800	71	0.00124	5.56	88.4	0.00272	0.194	2.5e-05	0.0246	0.0316
10048089	3280	233	3060	77.3	0.00134	6.71	95.9	0.0029	0.189	2.5e-05	0.0246	0.0316
10053583	2740	198	2550	64.8	0.00114	4.4	81	0.00253	0.2	2.5e-05	0.0246	0.0316

ADDITIONAL ENVIRONMENTAL INFO

No regulated substances of very high concern are utilized on site.

The PCR allows for the grouping of similar products. Examples of grouping for concrete products include performance categories of compressive strength and high early strength, material characteristics of lightweight concrete, and production categories of ready-mix and central mix. Alternately, if a single value is chosen for each impact category for all products, the value reported should be the highest impact within the range of variation; therefore, the EPD would report the highest single value for each impact category amongst all of the products or plants included in the average EPD analysis." (PCR for Concrete v2.1)

All the ready-mix concrete products manufactured at the plant are listed below. A complete LCA with resulting impacts for the study was performed on all highlighted mixes. The non-highlighted mixes listed below are grouped by characteristics and then the amount of cement. The highest value for the GWP for each mix that was not part of the LCA but is within the 10% range is taken from the LCA mix as part of the study. The table outlines the GWP for all mixes produced at this plant as allowed by the PCR.

Table 19: **Mix Designs 0 to 15 MPa**

Mix	GWP	MPa
10062750	254	1
10065079	171	3

10010951	256	3.2
10057014	289	3.5
10010936	285	3.6
10057085	305	3.8
10057532	305	3.8
10065200	305	3.8
10065427	305	3.8
10058262	413	3.9
10052596	413	3.9
10058263	413	3.9
10058155	413	3.9
10058264	413	3.9
10010939	413	3.9
10028157	413	3.9
10062861	413	3.9
10069891	417	4
10044717	417	4
10010940	417	4
10048564	417	4
10070686	417	4
10057311	421	4.1
10064492	421	4.1
10056668	421	4.1
10059514	421	4.1
10011110	421	4.1
10062989	421	4.1
10011117	421	4.1
10059963	421	4.1
10010938	421	4.1
10035615	421	4.1
10042832	421	4.1
10047471	421	4.1
10049061	421	4.1
10049922	421	4.1
10052156	421	4.1
10052190	421	4.1
10056651	421	4.1
10056790	421	4.1
10062862	421	4.1
10064961	421	4.1
10066879	421	4.1
10067624	421	4.1
10058218	377	4.2
10011176	377	4.2
10045017	377	4.2
10032559	377	4.2
10010941	377	4.2

10044388	377	4.2
10056691	377	4.2
10057503	377	4.2
10057504	377	4.2
10062759	377	4.2
10010942	352	4.3
10057273	352	4.3
10068818	352	4.3
10060233	464	4.5
10065428	464	4.5
10027517	464	4.5
10046925	464	4.5
10052039	464	4.5
10065429	464	4.5
10021060	464	4.5
10065440	464	4.5
10010944	464	4.5
10047087	464	4.5
10052100	464	4.5
10053024	464	4.5
10056232	464	4.5
10056702	464	4.5
10065441	464	4.5
10062775	411	5
10067487	243	7
10065078	243	7
10063545	275	10
10010704	263	10.5
10010706	263	10.5
10010802	263	10.5
10030458	299	12.5
10062864	299	12.5
10071124	299	12.5
10012710	299	12.5
10020592	321	14
10058762	321	14
10062137	321	14
10063921	321	14
10010707	321	14
10010709	321	14
10019490	321	14
10063844	321	14
10066905	321	14
10067171	321	14
10010804	321	14
10010798	321	14
10063544	321	14

10071155	315	15

Table 20: **Mix Designs 16 to 20 MPa**

Mix	GWP	MPa
10010757	361	17.5
10010758	361	17.5
10066935	361	17.5
10064748	361	17.5
10064749	361	17.5
10046883	361	17.5
10064747	361	17.5
10010710	361	17.5
10010715	361	17.5
10010716	361	17.5
10010717	361	17.5
10063584	361	17.5
10010690	361	17.5
10071904	361	17.5
10066906	361	17.5
10067111	361	17.5
10010805	361	17.5
10010806	361	17.5
10010799	361	17.5
10068117	361	17.5

Table 21 **Mix Designs 21 to 25 MPa**

Mix	GWP	MPa
10067570	383	21
10034863	383	21
10059256	383	21
10010761	383	21
10011083	383	21
10013117	383	21
10019065	383	21
10026560	383	21
10064232	383	21
10010763	383	21
10010764	383	21
10057293	383	21
10065265	383	21
10065285	383	21
10010766	383	21

10010767	383	21
10020788	383	21
10010769	383	21
10010770	383	21
10057294	383	21
10030890	383	21
10010726	383	21
10031531	383	21
10032439	383	21
10050625	383	21
10058029	383	21
10058392	383	21
10059139	383	21
10062523	383	21
10063217	383	21
10067563	383	21
10010728	383	21
10011170	383	21
10047324	383	21
10054079	383	21
10056186	383	21
10059167	383	21
10062522	383	21
10063922	383	21
10063923	383	21
10064081	383	21
10064236	383	21
10010718	383	21
10010719	383	21
10011930	383	21
10059130	383	21
10062486	383	21
10063213	383	21
10064088	383	21
10010723	383	21
10010724	383	21
10010725	383	21
10059160	383	21
10062483	383	21
10063211	383	21
10064089	383	21
10065442	383	21
10071983	383	21

10059024	383	21
10011072	383	21
10062565	383	21
10018393	383	21
10013009	383	21
10069162	383	21
10047347	383	21
10073884	383	21
10010691	383	21
10065507	383	21
10010693	383	21
10010694	383	21
10053179	383	21
10056031	383	21
10010895	383	21
10052583	383	21
10062691	383	21
10062692	383	21
10010790	383	21
10010857	383	21
10065094	383	21
10062092	383	21
10010807	383	21
10010808	383	21
10059283	383	21
10010800	383	21
10043218	383	21
10035318	383	21
10067566	397	24.5
10056101	397	24.5
10047667	397	24.5
10010774	397	24.5
10010776	397	24.5
10057086	397	24.5
10059001	397	24.5
10045400	397	24.5
10010775	397	24.5
10043912	397	24.5
10047273	397	24.5
10062770	397	24.5
10045355	397	24.5
10054210	397	24.5
10017961	397	24.5

10023233	397	24.5
10050353	397	24.5
10059140	397	24.5
10072326	397	24.5
10073882	397	24.5
10010922	397	24.5
10046880	397	24.5
10051081	397	24.5
10056404	397	24.5
10059168	397	24.5
10010730	397	24.5
10010731	397	24.5
10059133	397	24.5
10059888	397	24.5
10062487	397	24.5
10010729	397	24.5
10010734	397	24.5
10010736	397	24.5
10056185	397	24.5
10059161	397	24.5
10062484	397	24.5
10063210	397	24.5
10055851	397	24.5
10058898	397	24.5
10058984	397	24.5
10059481	397	24.5
10060948	397	24.5
10017848	397	24.5
10049893	397	24.5
10051211	397	24.5
10010696	397	24.5
10061151	397	24.5
10010896	397	24.5
10031582	397	24.5
10011045	397	24.5
10010791	397	24.5
10012429	397	24.5
10065096	397	24.5
10067703	397	24.5
10048357	397	24.5
10048434	397	24.5
10032560	397	24.5

Table 22: **Mix Designs 26 to 30 MPa**

Mix	GWP	MPa
10065283	518	28
10067561	518	28
10067564	518	28
10062418	518	28
10033911	518	28
10050059	518	28
10062345	518	28
10019290	518	28
10072879	518	28
10071311	518	28
10010778	518	28
10050218	518	28
10056435	518	28
10059611	518	28
10064233	518	28
10069521	518	28
10010780	518	28
10010781	518	28
10058070	518	28
10064499	518	28
10010782	518	28
10010976	518	28
10048999	518	28
10056420	518	28
10062956	518	28
10063684	518	28
10064234	518	28
10067818	518	28
10010784	518	28
10017018	518	28
10035588	518	28
10047294	518	28
10049278	518	28
10064630	518	28
10064833	518	28
10071973	518	28
10031751	518	28
10012149	518	28
10028245	518	28
10035381	518	28

10042836	518	28
10050430	518	28
10056300	518	28
10057298	518	28
10059141	518	28
10059586	518	28
10062525	518	28
10062988	518	28
10063216	518	28
10063582	518	28
10063685	518	28
10063688	518	28
10064805	518	28
10072108	518	28
10072322	518	28
10010747	518	28
10042835	518	28
10047385	518	28
10050210	518	28
10053487	518	28
10054078	518	28
10059169	518	28
10062524	518	28
10063581	518	28
10063925	518	28
10063926	518	28
10064082	518	28
10010741	518	28
10010742	518	28
10010870	518	28
10011148	518	28
10021446	518	28
10056786	518	28
10059134	518	28
10063214	518	28
10010740	518	28
10010745	518	28
10010746	518	28
10048534	518	28
10059162	518	28
10062485	518	28
10063215	518	28
10063845	518	28

10055852	518	28
10058927	518	28
10019800	518	28
10062566	518	28
10067806	518	28
10017476	518	28
10064235	518	28
10051940	518	28
10071272	518	28
10073836	518	28
10059877	518	28
10046313	518	28
10046034	518	28
10046036	518	28
10011897	518	28
10064415	518	28
10070899	518	28
10010698	518	28
10042688	518	28
10064417	518	28
10027961	518	28
10033740	518	28
10071213	518	28
10011040	518	28
10062173	518	28
10073662	518	28
10011483	518	28
10065095	518	28
10010801	518	28
10048355	518	28
10064631	518	28

Table 23: **Mix Designs 31 to 35 MPa**

Mix	GWP	MPa
10064239	376	31.5
10010788	376	31.5
10046927	376	31.5
10059142	376	31.5
10063126	376	31.5
10059170	376	31.5
10010748	376	31.5
10016951	376	31.5
10059135	376	31.5

10010749	376	31.5
10010750	376	31.5
10059163	376	31.5
10064801	376	31.5
10064291	471	35
10066824	471	35
10053780	471	35
10017291	471	35
10046914	471	35
10058031	471	35
10064802	471	35
10070890	471	35
10058176	471	35
10067326	471	35
10068837	471	35
10052014	471	35
10052067	471	35
10056621	471	35
10011026	471	35
10056853	471	35
10058906	471	35
10063682	471	35
10010910	471	35
10026991	471	35
10052068	471	35
10052847	471	35
10052896	471	35
10052846	471	35
10010989	471	35
10035359	471	35
10035718	471	35
10056657	471	35
10058032	471	35
10059143	471	35
10059585	471	35
10063683	471	35
10046888	471	35
10050916	471	35
10054698	471	35
10055658	471	35
10059171	471	35
10010751	471	35
10059136	471	35

10064230	471	35
10070087	471	35
10010754	471	35
10052070	471	35
10059164	471	35
10028436	471	35
10023335	471	35
10021915	471	35
10018801	471	35
10055572	471	35
10065097	471	35

Table 24: **Mix Designs 36 to 40 MPa**

Mix	GWP	MPa
10058040	362	40

Table 25: **Mix Designs 41 to 45 MPa**

Mix	GWP	MPa
10031839	379	42
10034945	379	42
10059271	379	42
10059172	379	42
10010878	379	42
10059137	379	42
10010756	379	42
10059165	379	42
10050163	379	42
10046068	379	42

Table 26: **Mix Designs 46 to 50 MPa**

Mix	GWP	MPa
10048089	500	49
10053583	500	49

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.