Environmental Product Declaration

Environmental Product Declaration for various ready mix concrete products produced by Holcim México Operaciones S.A. de C.V. at their Toluca facility in Toluca, 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:	03 August 2023
Period of Validity:	5 years; valid until 02 August 2028
EPD Number:	d322573d-dd1d-46bc-a493-3482170a8e36

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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 47 concrete mixes manufactured at the Holcim Mexico Operaciones S.A. de C.V. Toluca 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	24005NB0514	0.49 MPa 28d strength mortars and fillers	Mortars and fillers	0.49	4.62
2	24007NB0524	0.69 MPa 28d strength mortars and fillers	Mortars and fillers	0.69	4.54
3	24015NB0524	1.47 MPa 28d strength mortars and fillers	Mortars and fillers	1.47	3.36
4	24025NB0514	2.45 MPa 28d strength mortars and fillers	Mortars and fillers	2.45	2.63
5	77035ND4010	3.43 MPa 28d strength Ready mix concrete	Ready mix concrete	3.43	0.94
6	24035NB0524	3.43 MPa 28d strength mortars and fillers	Mortars and fillers	3.43	2.21
7	77036ND4006	3.53 MPa 28d strength Ready mix concrete	Ready mix concrete	3.53	0.82
8	77038ND4010	3.73 MPa 28d strength Ready mix concrete	Ready mix concrete	3.73	0.84
9	77040ND4010	3.92 MPa 28d strength Ready mix concrete	Ready mix concrete	3.92	0.79
10	68040ND4010	3.92 MPa 28d strength Ready mix concrete	Ready mix concrete	3.92	0.76

11	39042ND2012	4.12 MPa 28d strength Ready mix concrete	Ready mix concrete	4.12	0.66
12	68042ND4010	4.12 MPa 28d strength Ready mix concrete	Ready mix concrete	4.12	0.71
13	39045NB2012	4.41 MPa 28d strength Ready mix concrete	Ready mix concrete	4.41	0.62
14	39048ND2010	4.71 MPa 28d strength Ready mix concrete	Ready mix concrete	4.71	0.54
15	77050ND4014	4.9 MPa 28d strength Ready mix concrete	Ready mix concrete	4.90	0.59
16	24050NB0514	4.9 MPa 28d strength mortars and fillers	Mortars and fillers	4.90	1.71
17	70100NB2018	9.81 MPa 28d strength Ready mix concrete	Ready mix concrete	9.81	1.67
18	40100NB1014	9.81 MPa 28d strength Ready mix concrete	Ready mix concrete	9.81	1.04
19	73100NB0518	9.81 MPa 28d strength mortars and fillers	Mortars and fillers	9.81	1.52
20	71150NB1214	14.71 MPa 28d strength Ready mix concrete	Ready mix concrete	14.71	1.35
21	40150NB1010	14.71 MPa 28d strength Ready mix concrete	Ready mix concrete	14.71	0.90
22	73150NB0518	14.71 MPa 28d strength mortars and fillers	Mortars and fillers	14.71	1.29

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
3	71175ND1210	17.16 MPa 28d strength Ready mix concrete	Ready mix concrete	17.16	1.18
24	71200ND1210	19.61 MPa 28d strength Ready mix concrete	Ready mix concrete	19.61	1.10
25	40200NB1214	19.61 MPa 28d strength special concrete	Special concrete	19.61	1.14
26	73200NB0518	19.61 MPa 28d strength mortars and fillers	Mortars and fillers	19.61	1.13

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
27	71210ND1210	20.59 MPa 28d strength Ready mix concrete	Ready mix concrete	20.59	1.08

28	38250NB4012	24.52 MPa 28d strength Ready mix concrete	Ready mix concrete	24.52	0.76
29	60250NB1224	24.52 MPa 28d strength special concrete	Special concrete	24.52	0.72
30	73250NB0518	24.52 MPa 28d strength mortars and fillers	Mortars and fillers	24.52	0.96

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
31	71280ND1210	27.46 MPa 28d strength Ready mix concrete	Ready mix concrete	27.46	0.90
32	38300ND4012	29.42 MPa 28d strength Ready mix concrete	Ready mix concrete	29.42	0.65
33	40300NB1214	29.42 MPa 28d strength Ready mix concrete	Ready mix concrete	29.42	0.63
34	73300NB0518	29.42 MPa 28d strength mortars and fillers	Mortars and fillers	29.42	0.83

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
35	70320ND2010	31.38 MPa 28d strength Ready mix concrete	Ready mix concrete	31.38	0.89
36	60320NB2014	31.38 MPa 28d strength special concrete	Special concrete	31.38	0.56
37	04350NB2018	34.32 MPa 28d strength Ready mix concrete	Ready mix concrete	34.32	0.74
38	73350NB0518	34.32 MPa 28d strength mortars and fillers	Mortars and fillers	34.32	0.72

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	71360ND1210	35.3 MPa 28d strength Ready mix concrete	Ready mix concrete	35.30	0.74
40	13400ND1212	39.23 MPa 28d strength Ready mix concrete	Ready mix concrete	39.23	0.54
41	60400NB2018	39.23 MPa 28d strength special concrete	Special concrete	39.23	0.42

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	13450ND1210	44.13 MPa 28d strength Ready mix concrete	Ready mix concrete	44.13	0.48
43	60450NB1224	44.13 MPa 28d strength special concrete	Special concrete	44.13	0.39

Mix designs: 46 to 50 MPa

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

Mix#	Unique name/ID	Short description	Product type	28 day strength, MPa	H2O to cement ratio
44	13500ND1210	49.03 MPa 28d strength Ready mix concrete	Ready mix concrete	49.03	0.44

Mix designs: 51 to 55 MPa

Table 9: **Declared products with Mix designs: 51 to 55MPa considered in this environmental product declaration**

Mix#	Unique name/ID	Short description	Product type	28 day strength, MPa	H2O to cement ratio
45	13550ND1212	53.94 MPa 28d strength Ready mix concrete	Ready mix concrete	53.94	0.41
46	60550NB2018	53.94 MPa 28d strength special concrete	Special concrete	53.94	0.36

Mix designs: 56 to 60 MPa

Table 10: **Declared products with Mix designs: 56 to 60MPa considered in this environmental product declaration**

Mix#	Unique name/ID	Short description	Product type	28 day strength, MPa	H2O to cement ratio
47	13600ND1212	58.84 MPa 28d strength Ready mix concrete	Ready mix concrete	58.84	0.38

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 11: **Design composition**

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

SYSTEM BOUNDARIES

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

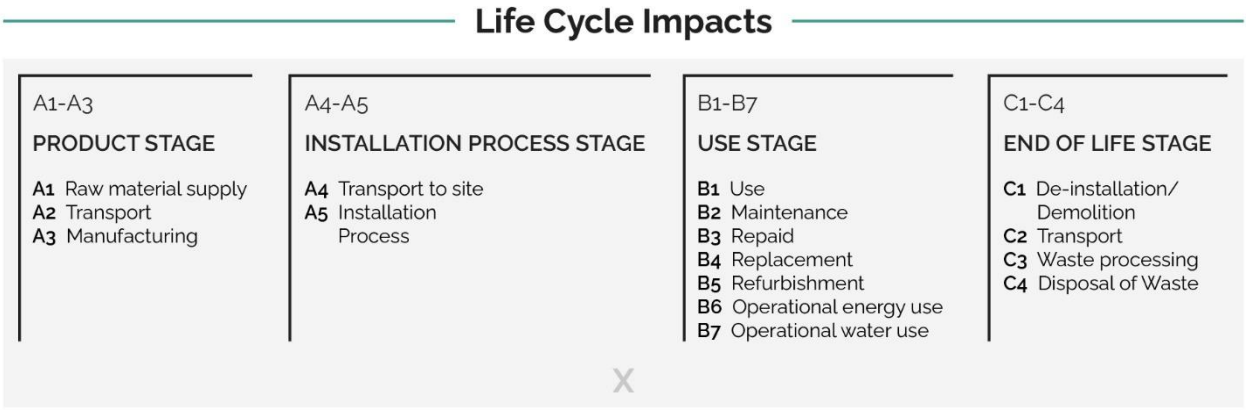

Figure 1: **General life cycle phases for consideration in a construction works system**

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

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

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

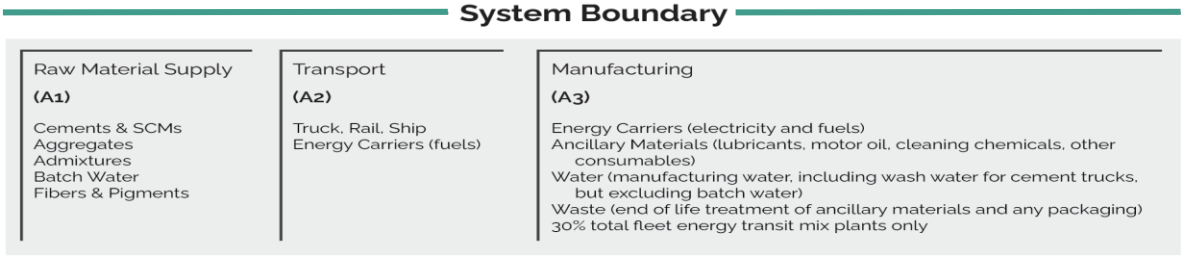

Figure 2: **General system inputs considered in the product system and categorized by modules in scope**

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

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

For this LCA the manufacturing plant, owned and operated by Holcim México Operaciones S.A. de C.V., is located at their Planta Toluca 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 12: **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	ecoinvent v3.8	Edo de Mexico	v3.8 in 2021	2	3	1	3	3

	biological treatment/tap water/RoW/kg								
Limestone Gravel	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 APAXCO (Apasco)	CPC 40	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
Cement (CPC 30) - SUPPLIER: ORIZABA (CD REYES)	CPC 30	Progam Operator: Labeling Sustainability- EPD ID: 565b7deb-ebd6-4cb3-9aa6-a585381c41f3	Edo de Mexico	25 February 2023	3	3	3	3	3

DATA QUALITY ASSESSMENT

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

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

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

electricity inputs were utilized. The most relevant EPDs requiring key A1 inputs were also utilized where readily available.

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

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

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

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

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

ENVIRONMENTAL INDICATORS AND INVENTORY METRICS

Per the PCR, this EPD supports the life cycle impact assessment indicators and inventory metrics as listed in the tables below. As specified in the PCR, the most recent US EPA Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI), impact categories were

utilized as they provide a North American context for the mandatory category indicators to be included in the EPD. Additionally, the PCR requires a set of inventory metrics to be reported with the LCIA indicators (see tables below).

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 13: **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	25.3	0.0361	92	5.03e-06	0.334	0.000349	477
Maximum	505	0.547	459	2.87e-05	11.9	0.0017	2450
Mean	216	0.238	262	1.17e-05	5	0.000882	1070
Median	215	0.234	286	9.61e-06	5.04	8e-04	917
24005NB0514	86.1	0.0951	92	5.03e-06	1.98	0.000349	477
24007NB0524	90.7	0.1	96.2	5.16e-06	2.08	0.000364	489
24015NB0524	117	0.129	119	5.55e-06	2.72	0.000449	528
24025NB0514	140	0.153	139	5.94e-06	3.26	0.000521	567
77035ND4010	313	0.341	294	9.82e-06	7.36	0.00111	917
24035NB0524	169	0.185	164	6.32e-06	3.95	0.000612	606
77036ND4006	30.7	0.0453	254	2.09e-05	0.395	0.000585	1770
77038ND4010	347	0.377	323	1.03e-05	8.17	0.00122	966
77040ND4010	365	0.396	339	1.05e-05	8.59	0.00127	991
68040ND4010	386	0.42	358	1.09e-05	9.11	0.00135	1040
39042ND2012	34.9	0.0526	305	2.49e-05	0.437	0.000717	2130
68042ND4010	415	0.45	383	1.13e-05	9.78	0.00144	1100
39045NB2012	36.3	0.0546	322	2.6e-05	0.452	0.000747	2220
39048ND2010	39.4	0.0595	360	2.87e-05	0.486	0.000824	2450
77050ND4014	505	0.547	459	1.23e-05	11.9	0.0017	1170
24050NB0514	214	0.233	201	6.54e-06	5.04	0.00073	596
70100NB2018	216	0.235	207	7.48e-06	5.05	0.000775	733
40100NB1014	313	0.339	291	8.87e-06	7.36	0.00108	867
73100NB0518	262	0.285	246	7.88e-06	6.16	0.000912	768
71150NB1214	25.3	0.0361	200	1.61e-05	0.334	0.000428	1350
40150NB1010	349	0.379	322	9.4e-06	8.23	0.00119	917
73150NB0518	303	0.329	280	8.23e-06	7.14	0.00104	807

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	526	26.8	497	14.3	0.000578	0.497	10	0.000952	0.233	2.59e-05	0.00658	0.018
Maximum	2700	95.7	2630	68	0.00664	0.893	332	0.0029	0.363	2.59e-05	0.00658	0.018
Mean	1190	57.6	1130	31.6	0.00293	0.646	74.2	0.00176	0.297	2.59e-05	0.00658	0.018
Median	1040	61.5	970	28.4	0.00288	0.633	22.1	0.00174	0.294	2.59e-05	0.00658	0.018
24005NB0514	526	26.8	497	14.3	0.0012	0.497	10	0.000952	0.335	2.59e-05	0.00658	0.018
24007NB0524	544	28	512	14.7	0.00127	0.516	10.3	0.000976	0.347	2.59e-05	0.00658	0.018
24015NB0524	591	32.7	555	16.1	0.00158	0.541	11.3	0.00105	0.343	2.59e-05	0.00658	0.018
24025NB0514	635	35.9	597	17.3	0.00188	0.548	12.3	0.00112	0.324	2.59e-05	0.00658	0.018
77035ND4010	1040	63.7	969	28.1	0.00411	0.68	23	0.00186	0.269	2.59e-05	0.00658	0.018
24035NB0524	680	40.7	637	18.6	0.00229	0.589	13.4	0.00119	0.334	2.59e-05	0.00658	0.018
77036ND4006	1940	54.2	1890	49.5	0.000747	0.51	229	0.00223	0.24	2.59e-05	0.00658	0.018
77038ND4010	1090	68.5	1020	29.8	0.0044	0.714	24.4	0.00195	0.267	2.59e-05	0.00658	0.018
77040ND4010	1120	71.4	1050	30.6	0.00469	0.732	25	0.002	0.266	2.59e-05	0.00658	0.018
68040ND4010	1190	75.7	1100	32.2	0.00508	0.758	25.9	0.00205	0.269	2.59e-05	0.00658	0.018
39042ND2012	2350	62	2290	59.3	0.000871	0.541	279	0.00262	0.234	2.59e-05	0.00658	0.018
68042ND4010	1250	80.4	1160	33.9	0.00543	0.794	27.1	0.00213	0.273	2.59e-05	0.00658	0.018
39045NB2012	2450	65	2380	61.6	0.000908	0.557	295	0.00269	0.234	2.59e-05	0.00658	0.018
39048ND2010	2700	71.6	2630	68	0.000989	0.586	332	0.0029	0.233	2.59e-05	0.00658	0.018
77050ND4014	1340	95.7	1240	36.7	0.00664	0.893	30	0.00232	0.279	2.59e-05	0.00658	0.018
24050NB0514	677	46.2	627	18.7	0.00283	0.63	14.6	0.00124	0.333	2.59e-05	0.00658	0.018
70100NB2018	826	49.5	775	22.6	0.00292	0.636	16	0.0014	0.323	2.59e-05	0.00658	0.018
40100NB1014	984	64.4	918	27.1	0.00408	0.717	19.8	0.00166	0.299	2.59e-05	0.00658	0.018

73100NB0518	872	56.3	814	23.9	0.00343	0.724	17.4	0.00148	0.363	2.59e-05	0.00658	0.018
71150NB1214	1490	45.3	1440	38.2	0.000578	0.54	178	0.00171	0.311	2.59e-05	0.00658	0.018
40150NB1010	1040	72.5	972	28.8	0.00455	0.745	21.2	0.00176	0.289	2.59e-05	0.00658	0.018
73150NB0518	919	61	856	25.3	0.00404	0.762	18.6	0.00154	0.36	2.59e-05	0.00658	0.018

Mix designs: 15 to 20 MPa

Table 14: **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	277	0.301	260	8.23e-06	6.52	0.000962	799
Maximum	343	0.372	315	8.78e-06	8.1	0.00116	864
Mean	298	0.323	277	8.46e-06	7.02	0.00102	824
Median	286	0.31	267	8.42e-06	6.72	0.000986	817
71175ND1210	277	0.301	260	8.3e-06	6.52	0.000962	805
71200ND1210	293	0.318	274	8.53e-06	6.9	0.00101	829
40200NB1214	278	0.302	260	8.23e-06	6.54	0.000963	799
73200NB0518	343	0.372	315	8.78e-06	8.1	0.00116	864

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	909	58.8	845	24.9	0.00363	0.666	18.2	0.00154	0.29	2.59e-05	0.00658	0.018
Maximum	990	69.3	917	27.2	0.00463	0.802	20.1	0.00164	0.358	2.59e-05	0.00658	0.018
Mean	938	62.6	874	25.8	0.00395	0.708	18.9	0.00158	0.31	2.59e-05	0.00658	0.018
Median	926	61	866	25.5	0.00376	0.683	18.6	0.00158	0.297	2.59e-05	0.00658	0.018
71175ND1210	913	60.1	853	25.1	0.00363	0.675	18.3	0.00156	0.298	2.59e-05	0.00658	0.018
71200ND1210	939	62	880	25.9	0.00384	0.691	19	0.0016	0.296	2.59e-05	0.00658	0.018
40200NB1214	909	58.8	845	24.9	0.00369	0.666	18.2	0.00154	0.29	2.59e-05	0.00658	0.018
73200NB0518	990	69.3	917	27.2	0.00463	0.802	20.1	0.00164	0.358	2.59e-05	0.00658	0.018

Mix designs: 21 to 25 MPa

Table 15: **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	30.4	0.046	256	8.6e-06	0.386	0.000617	836
Maximum	403	0.436	366	2.49e-05	9.51	0.00135	2180
Mean	192	0.215	306	1.62e-05	4.34	0.000925	1450
Median	167	0.189	302	1.56e-05	3.74	0.000867	1380
71210ND1210	298	0.324	278	8.6e-06	7.02	0.00103	836
38250NB4012	30.4	0.046	256	2.16e-05	0.386	0.000617	1820
60250NB1224	36.5	0.0531	326	2.49e-05	0.458	0.000704	2180
73250NB0518	403	0.436	366	9.57e-06	9.51	0.00135	947

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	948	52.6	886	26	0.000741	0.487	19.2	0.00161	0.224	2.59e-05	0.00658	0.018
Maximum	2400	77.1	2340	61.2	0.0052	0.867	298	0.00237	0.359	2.59e-05	0.00658	0.018
Mean	1610	65.2	1540	42	0.00268	0.668	143	0.00203	0.291	2.59e-05	0.00658	0.018
Median	1540	65.4	1480	40.4	0.00239	0.66	128	0.00208	0.29	2.59e-05	0.00658	0.018
71210ND1210	948	62.2	886	26	0.00389	0.696	19.2	0.00161	0.296	2.59e-05	0.00658	0.018
38250NB4012	2000	52.6	1950	50.7	0.000741	0.487	233	0.00236	0.224	2.59e-05	0.00658	0.018
60250NB1224	2400	68.7	2340	61.2	0.000893	0.624	298	0.00237	0.284	2.59e-05	0.00658	0.018
73250NB0518	1090	77.1	1000	30	0.0052	0.867	22.2	0.00179	0.359	2.59e-05	0.00658	0.018

Mix designs: 26 to 30 MPa

Table 16: **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	33.4	0.0508	293	9.33e-06	0.418	0.000692	908
Maximum	493	0.533	446	2.42e-05	11.7	0.00164	2050
Mean	337	0.368	372	1.38e-05	7.89	0.00127	1280
Median	410	0.444	374	1.08e-05	9.72	0.00138	1080
71280ND1210	354	0.384	326	9.33e-06	8.35	0.0012	908
38300ND4012	33.4	0.0508	293	2.42e-05	0.418	0.000692	2050
40300NB1214	493	0.533	446	1.13e-05	11.7	0.00164	1110
73300NB0518	467	0.505	422	1.04e-05	11.1	0.00155	1040

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	58.9	965	28.5	0.000829	0.515	21.2	0.00175	0.223	2.59e-05	0.00658	0.018
Maximum	2250	92.8	2200	56.8	0.00628	0.938	269	0.00257	0.361	2.59e-05	0.00658	0.018
Mean	1440	78.1	1360	38.4	0.00445	0.776	85.3	0.0021	0.292	2.59e-05	0.00658	0.018
Median	1230	80.4	1140	34	0.00535	0.825	25.6	0.00203	0.292	2.59e-05	0.00658	0.018
71280ND1210	1030	72	965	28.5	0.00459	0.754	21.2	0.00175	0.295	2.59e-05	0.00658	0.018
38300ND4012	2250	58.9	2200	56.8	0.000829	0.515	269	0.00257	0.223	2.59e-05	0.00658	0.018
40300NB1214	1270	92.8	1180	35.2	0.00628	0.896	26.5	0.00211	0.288	2.59e-05	0.00658	0.018
73300NB0518	1190	88.7	1100	32.9	0.0061	0.938	24.6	0.00195	0.361	2.59e-05	0.00658	0.018

Mix designs: 31 to 35 MPa

Table 17: **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	358	0.389	330	9.54e-06	8.45	0.00122	935
Maximum	538	0.582	485	1.24e-05	12.7	0.00179	1190
Mean	448	0.486	410	1.13e-05	10.6	0.00153	1100
Median	448	0.487	412	1.16e-05	10.6	0.00156	1130
70320ND2010	358	0.389	330	9.54e-06	8.45	0.00122	935
60320NB2014	474	0.515	434	1.24e-05	11.2	0.00163	1140
04350NB2018	423	0.459	390	1.17e-05	9.97	0.00148	1120
73350NB0518	538	0.582	485	1.16e-05	12.7	0.00179	1190

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	1070	72.5	991	29.3	0.0047	0.761	21.6	0.00179	0.246	2.59e-05	0.00658	0.018
Maximum	1380	101	1270	37.8	0.00697	1.02	31.3	0.00236	0.364	2.59e-05	0.00658	0.018
Mean	1250	85	1160	34.2	0.00584	0.852	27.2	0.00212	0.298	2.59e-05	0.00658	0.018
Median	1280	83.2	1190	34.8	0.00585	0.814	28	0.00217	0.292	2.59e-05	0.00658	0.018
70320ND2010	1070	72.5	991	29.3	0.0047	0.761	21.6	0.00179	0.295	2.59e-05	0.00658	0.018
60320NB2014	1290	86.5	1200	35.1	0.00618	0.816	31.3	0.00236	0.246	2.59e-05	0.00658	0.018
04350NB2018	1270	79.9	1180	34.4	0.00552	0.812	28.5	0.0022	0.288	2.59e-05	0.00658	0.018
73350NB0518	1380	101	1270	37.8	0.00697	1.02	27.4	0.00214	0.364	2.59e-05	0.00658	0.018

Mix designs: 36 to 40 MPa

Table 18: **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	436	0.472	397	1.04e-05	10.3	0.00145	1010
Maximum	618	0.67	559	1.45e-05	14.6	0.0021	1400
Mean	512	0.555	465	1.25e-05	12.1	0.00174	1200
Median	481	0.522	440	1.25e-05	11.4	0.00166	1200
71360ND1210	436	0.472	397	1.04e-05	10.3	0.00145	1010
13400ND1212	481	0.522	440	1.25e-05	11.4	0.00166	1200
60400NB2018	618	0.67	559	1.45e-05	14.6	0.0021	1400

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	1160	83.6	1070	32.1	0.00562	0.824	24.2	0.00195	0.24	2.59e-05	0.00658	0.018
Maximum	1600	113	1480	43.9	0.00817	0.973	36.6	0.00274	0.298	2.59e-05	0.00658	0.018
Mean	1370	94.8	1270	37.7	0.00667	0.88	30.6	0.00235	0.261	2.59e-05	0.00658	0.018
Median	1360	87.7	1270	37	0.00623	0.844	31	0.00237	0.244	2.59e-05	0.00658	0.018
71360ND1210	1160	83.6	1070	32.1	0.00562	0.844	24.2	0.00195	0.298	2.59e-05	0.00658	0.018
13400ND1212	1360	87.7	1270	37	0.00623	0.824	31	0.00237	0.24	2.59e-05	0.00658	0.018
60400NB2018	1600	113	1480	43.9	0.00817	0.973	36.6	0.00274	0.244	2.59e-05	0.00658	0.018

Mix designs: 41 to 45 MPa

Table 19: **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	535	0.58	487	1.33e-05	12.6	0.00183	1280
Maximum	640	0.693	576	1.46e-05	15.2	0.00214	1370
Mean	588	0.636	532	1.4e-05	13.9	0.00198	1320
Median	588	0.636	532	1.4e-05	13.9	0.00198	1320
13450ND1210	535	0.58	487	1.33e-05	12.6	0.00183	1280
60450NB1224	640	0.693	576	1.46e-05	15.2	0.00214	1370

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	1460	97.4	1360	39.7	0.00697	0.878	33.2	0.00252	0.236	2.59e-05	0.00658	0.018
Maximum	1580	113	1450	43.3	0.00842	0.986	36.9	0.00276	0.237	2.59e-05	0.00658	0.018
Mean	1520	105	1400	41.5	0.0077	0.932	35	0.00264	0.236	2.59e-05	0.00658	0.018
Median	1520	105	1400	41.5	0.0077	0.932	35	0.00264	0.236	2.59e-05	0.00658	0.018
13450ND1210	1460	97.4	1360	39.7	0.00697	0.878	33.2	0.00252	0.237	2.59e-05	0.00658	0.018
60450NB1224	1580	113	1450	43.3	0.00842	0.986	36.9	0.00276	0.236	2.59e-05	0.00658	0.018

Mix designs: 46 to 50 MPa

Table 20: **Total life cycle (across modules in scope) impact results for Mix designs: 46 to 50MPa, assuming the geometric mean point values on a per 1 m3 of concrete basis**

a) Midpoint Impact Categories:

Indicator/LCI Metric	AP	EP	GWP	ODP	PCOP	ADPe	ADPf
Unit	moles of H+-Eq	kg N	kg CO2-Eq	kg CFC-11-Eq	kg NOx-Eq	kg Sb-Eq	MJ, net calorific value
13500ND1210	581	0.63	527	1.39e-05	13.7	0.00198	1340

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
13500ND1210	1530	107	1420	41.8	0.00755	0.928	34.9	0.00263	0.238	2.59e-05	0.00658	0.018

Mix designs: 51 to 55 MPa

Table 21: **Total life cycle (across modules in scope) impact results for Mix designs: 51 to 55MPa, assuming the geometric mean point values on a per 1 m3 of concrete basis**

a) Midpoint Impact Categories:

Indicator/LCI Metric	AP	EP	GWP	ODP	PCOP	ADPe	ADPf
Unit	moles of H+-Eq	kg N	kg CO2-Eq	kg CFC-11-Eq	kg NOx-Eq	kg Sb-Eq	MJ, net calorific value
Minimum	626	0.678	566	1.45e-05	14.8	0.00212	1400
Maximum	739	0.799	662	1.59e-05	17.5	0.00245	1500
Mean	682	0.738	614	1.52e-05	16.2	0.00228	1450
Median	682	0.738	614	1.52e-05	16.2	0.00228	1450
13550ND1212	626	0.678	566	1.45e-05	14.8	0.00212	1400
60550NB2018	739	0.799	662	1.59e-05	17.5	0.00245	1500

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	1610	113	1490	43.7	0.00813	0.98	36.5	0.00273	0.242	2.59e-05	0.00658	0.018
Maximum	1730	130	1600	47.6	0.00952	1.1	41	0.00302	0.247	2.59e-05	0.00658	0.018
Mean	1670	122	1540	45.7	0.00882	1.04	38.8	0.00288	0.244	2.59e-05	0.00658	0.018
Median	1670	122	1540	45.7	0.00882	1.04	38.8	0.00288	0.244	2.59e-05	0.00658	0.018
13550ND1212	1610	113	1490	43.7	0.00813	0.98	36.5	0.00273	0.242	2.59e-05	0.00658	0.018
60550NB2018	1730	130	1600	47.6	0.00952	1.1	41	0.00302	0.247	2.59e-05	0.00658	0.018

Mix designs: 56 to 60 MPa

Table 22: **Total life cycle (across modules in scope) impact results for Mix designs: 56 to 60MPa, assuming the geometric mean point values on a per 1 m3 of concrete basis**

a) Midpoint Impact Categories:

Indicator/LCI Metric	AP	EP	GWP	ODP	PCOP	ADPe	ADPf
Unit	moles of H+-Eq	kg N	kg CO2-Eq	kg CFC-11-Eq	kg NOx-Eq	kg Sb-Eq	MJ, net calorific value
13600ND1212	677	0.733	610	1.52e-05	16	0.00228	1470

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
13600ND1212	1690	118	1570	46.3	0.00877	1.04	38.4	0.00286	0.244	2.59e-05	0.00658	0.018

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.