Environmental Product Declaration

Environmental Product Declaration for various ready mix concrete products produced by Holcim México Operaciones S.A. de C.V. at their Lerma facility in Lerma, 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:	2e0ecba3-4136-4d5d-a58d-73dc51bf93d3

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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 49 concrete mixes manufactured at the Holcim Mexico Operaciones S.A. de C.V. Lerma 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
23	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	0.87
36	60320NB2018	31.38 MPa 28d strength special concrete	Special concrete	31.38	0.53
37	01350ND2010	34.32 MPa 28d strength Ready mix concrete	Ready mix concrete	34.32	0.73
38	60350NB2018	34.32 MPa 28d strength special concrete	Special concrete	34.32	0.43
39	73350NB0518	34.32 MPa 28d strength mortars and fillers	Mortars and fillers	34.32	0.70

Mix designs: 36 to 40 MPa

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

Mix#	Unique name/ID	Short description	Product type	28 day strength, MPa	H2O to cement ratio
40	71360ND1210	35.3 MPa 28d strength Ready mix concrete	Ready mix concrete	35.30	0.75
41	13400NB1212	39.23 MPa 28d strength Ready mix concrete	Ready mix concrete	39.23	0.53

42	60400NB1224	39.23 MPa 28d strength special concrete	Special concrete	39.23	0.43

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
43	13450NB1212	44.13 MPa 28d strength Ready mix concrete	Ready mix concrete	44.13	0.49
44	60450NB1224	44.13 MPa 28d strength special concrete	Special concrete	44.13	0.38

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
45	13500ND1210	49.03 MPa 28d strength Ready mix concrete	Ready mix concrete	49.03	0.44
46	60500NB2018	49.03 MPa 28d strength special concrete	Special concrete	49.03	0.37

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
47	13550ND1212	53.94 MPa 28d strength Ready mix concrete	Ready mix concrete	53.94	0.41
48	60550NB2018	53.94 MPa 28d strength special concrete	Special concrete	53.94	0.34

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
49	13600ND1212	58.84 MPa 28d strength High Resistance oncrete	High Resistance 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:

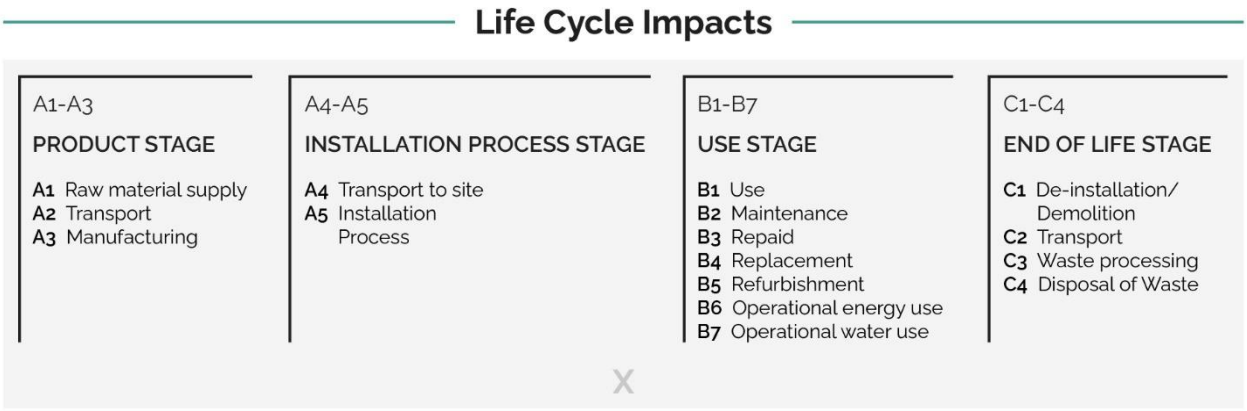

Figure 1: **General life cycle phases for consideration in a construction works system**

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.

System Boundary

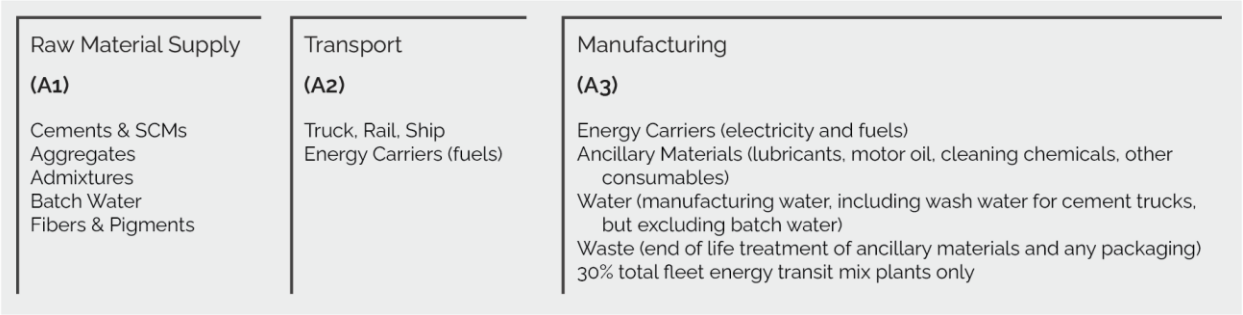

Figure 2: **General system inputs considered in the product system and categorized by modules in scope**

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

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

For this LCA the manufacturing plant, owned and operated by Holcim México Operaciones S.A. de C.V., is located at their Planta Lerma 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 14: **LCI inputs assumed for module A1 (i.e. raw material supply)** ***Data Quality Assessment Key Fair=1, Good=2, Very Good =3.***

Input	LCI.activity	Data.source	Geo	Year	Technology	Time	Geography	Reliability	Completeness
Andesite sand	basalt quarry operation/basalt/RoW/kg; Note: modifications made (see ecoinvent activity changes table)	ecoinvent v3.8	Edo de Mexico	v3.8 in 2021	2	3	1	3	3
Water	tap water production, conventional with biological treatment/tap water/RoW/kg	ecoinvent v3.8	Edo de Mexico	v3.8 in 2021	2	3	1	3	3
Limestone 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).

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

TOTAL IMPACT SUMMARY

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

Mix designs: 0 to 15 MPa

Table 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	32.2	0.0493	92.5	5.85e-06	0.411	0.000357	532
Maximum	507	0.55	464	2.97e-05	12	0.00174	2520
Mean	215	0.238	266	1.29e-05	4.96	0.000905	1150
Median	214	0.234	283	9.94e-06	5.01	0.000812	946
24005NB0514	82.7	0.0922	92.5	5.85e-06	1.88	0.000357	532
24007NB0524	90.4	0.101	99.5	6.02e-06	2.07	0.000382	548
24015NB0524	117	0.129	122	6.39e-06	2.7	0.000465	585
24025NB0514	139	0.153	142	6.77e-06	3.23	0.000536	623

39035ND2010	320	0.351	308	1.18e-05	7.52	0.00119	1070
24035NB0524	170	0.186	168	7.09e-06	3.96	0.00063	657
39036ND2010	32.2	0.0493	270	2.33e-05	0.411	0.000654	1950
39038ND4012	32.9	0.0505	282	2.41e-05	0.415	0.000681	2030
39040ND2010	34.2	0.0524	294	2.49e-05	0.432	0.000705	2100
68040ND4010	384	0.418	359	1.17e-05	9.05	0.00135	1090
39042ND4012	35.3	0.0542	313	2.62e-05	0.441	0.000737	2200
68042ND4014	415	0.451	385	1.2e-05	9.79	0.00145	1130
77045ND4010	417	0.454	388	1.21e-05	9.83	0.00146	1150
39048ND2012	40	0.0612	366	2.97e-05	0.494	0.000843	2520
77050ND4010	507	0.55	464	1.32e-05	12	0.00174	1270
24050NB0518	215	0.235	207	7.77e-06	5.04	0.000775	730
70100NB2018	213	0.233	208	8.27e-06	4.98	0.000781	779
40100NB1014	313	0.341	294	9.67e-06	7.37	0.00109	919
73100NB0518	263	0.286	248	8.41e-06	6.17	0.000924	798
70150NB2018	251	0.274	241	8.8e-06	5.9	0.000902	834
40150NB1010	350	0.38	326	1.02e-05	8.24	0.00121	974
73150NB0518	305	0.331	284	8.97e-06	7.17	0.00105	856

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	595	27.4	564	16.1	0.000817	0.489	12.7	0.00111	0.231	2.68e-05	0.00194	0.0238
Maximum	2790	95	2710	70.2	0.00664	0.889	338	0.00304	0.353	2.68e-05	0.00194	0.0238
Mean	1290	58.6	1230	34.1	0.00294	0.643	80.1	0.00195	0.289	2.68e-05	0.00194	0.0238
Median	1080	59	1010	29.7	0.00287	0.633	23.3	0.00186	0.294	2.68e-05	0.00194	0.0238
24005NB0514	595	27.4	564	16.1	0.00118	0.489	12.7	0.00111	0.326	2.68e-05	0.00194	0.0238
24007NB0524	608	28.9	585	16.5	0.00129	0.517	13.1	0.00114	0.343	2.68e-05	0.00194	0.0238
24015NB0524	653	32.8	622	17.8	0.00159	0.541	14.1	0.00121	0.339	2.68e-05	0.00194	0.0238
24025NB0514	703	36.5	662	19	0.00194	0.537	15.1	0.00128	0.311	2.68e-05	0.00194	0.0238
39035ND2010	1220	65.7	1150	32.5	0.00414	0.654	29.5	0.00223	0.234	2.68e-05	0.00194	0.0238
24035NB0524	744	41.7	700	20.3	0.00227	0.593	16	0.00134	0.334	2.68e-05	0.00194	0.0238
39036ND2010	2150	56.5	2100	54.2	0.000817	0.513	245	0.00259	0.233	2.68e-05	0.00194	0.0238
39038ND4012	2230	57.8	2170	56.2	0.000833	0.522	257	0.00264	0.235	2.68e-05	0.00194	0.0238

39040ND2010	2310	60.2	2250	58.4	0.000868	0.531	268	0.00272	0.231	2.68e-05	0.0194	0.0238
68040ND4010	1250	76.2	1160	33.6	0.00503	0.757	28.9	0.00219	0.267	2.68e-05	0.0194	0.0238
39042ND4012	2420	62.8	2360	61.1	9e-04	0.546	288	0.00279	0.234	2.68e-05	0.0194	0.0238
68042ND4014	1290	80.4	1200	35	0.00534	0.795	29.7	0.00225	0.271	2.68e-05	0.0194	0.0238
77045ND4010	1320	81.7	1230	35.7	0.00559	0.782	29.8	0.00226	0.255	2.68e-05	0.0194	0.0238
39048ND2012	2790	73	2710	70.2	0.00102	0.596	338	0.00304	0.236	2.68e-05	0.0194	0.0238
77050ND4010	1470	95	1370	39.7	0.00664	0.889	32.7	0.00245	0.267	2.68e-05	0.0194	0.0238
24050NB0518	831	49.3	777	22.7	0.00292	0.635	17.8	0.00146	0.325	2.68e-05	0.0194	0.0238
70100NB2018	882	49.8	834	24	0.00282	0.631	18.8	0.00155	0.317	2.68e-05	0.0194	0.0238
40100NB1014	1050	66.6	983	28.8	0.0041	0.721	22.6	0.00181	0.299	2.68e-05	0.0194	0.0238
73100NB0518	913	56.5	851	24.8	0.00342	0.715	19.6	0.00158	0.353	2.68e-05	0.0194	0.0238
70150NB2018	946	56.8	890	25.9	0.00328	0.668	20.2	0.00165	0.313	2.68e-05	0.0194	0.0238
40150NB1010	1120	71.7	1040	30.6	0.00461	0.75	24	0.00191	0.289	2.68e-05	0.0194	0.0238
73150NB0518	981	62.4	915	26.8	0.00398	0.757	21.1	0.00168	0.35	2.68e-05	0.0194	0.0238

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	285	0.31	270	9.32e-06	6.69	0.00101	888
Maximum	383	0.415	354	1.05e-05	9.02	0.00131	1010
Mean	326	0.354	304	9.67e-06	7.66	0.00113	924
Median	317	0.344	296	9.43e-06	7.46	0.0011	900
71175ND1210	285	0.31	270	9.32e-06	6.69	0.00101	889
01200NB2014	290	0.315	274	9.37e-06	6.81	0.00102	888
40200NB1210	383	0.415	354	1.05e-05	9.02	0.00131	1010
73200NB0518	344	0.374	318	9.49e-06	8.12	0.00118	911

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	306	0.333	288	9.6e-06	7.19	0.00107	919
Maximum	432	0.469	397	1.14e-05	10.2	0.00146	1070
Mean	367	0.399	341	1.06e-05	8.64	0.00127	1000
Median	365	0.396	340	1.07e-05	8.59	0.00128	1010
71210ND1210	306	0.333	288	9.6e-06	7.19	0.00107	919
07250ND1212	326	0.356	310	1.14e-05	7.66	0.00119	1040
40250NB1210	432	0.469	397	1.12e-05	10.2	0.00146	1070
73250NB0518	404	0.437	369	1.02e-05	9.53	0.00136	989

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	1050	65.6	979	28.6	0.00396	0.688	22.3	0.0018	0.266	2.68e-05	0.00194	0.0238

Maximum	1230	85.9	1140	34	0.00559	0.861	28.7	0.00216	0.349	2.68e-05	0.00194	0.0238
Mean	1150	74	1070	31.4	0.00478	0.775	25.6	0.00199	0.301	2.68e-05	0.00194	0.0238
Median	1160	72.2	1080	31.4	0.00478	0.776	25.8	0.002	0.295	2.68e-05	0.00194	0.0238
71210ND1210	1050	65.6	979	28.6	0.00396	0.721	22.3	0.0018	0.306	2.68e-05	0.00194	0.0238
07250ND1212	1170	66.1	1110	31.5	0.0043	0.688	28.7	0.00216	0.266	2.68e-05	0.00194	0.0238
40250NB1210	1230	85.9	1140	34	0.00559	0.831	26.9	0.0021	0.284	2.68e-05	0.00194	0.0238
73250NB0518	1140	78.3	1060	31.3	0.00527	0.861	24.6	0.00191	0.349	2.68e-05	0.00194	0.0238

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	335	0.366	318	1.1e-05	7.88	0.00122	1050
Maximum	493	0.534	449	1.2e-05	11.7	0.00165	1150
Mean	417	0.453	385	1.16e-05	9.85	0.00144	1090
Median	420	0.456	386	1.17e-05	9.91	0.00144	1080
04280NB2012	335	0.366	318	1.15e-05	7.88	0.00122	1050
02300NB2012	370	0.404	348	1.2e-05	8.72	0.00133	1090
40300NB1214	493	0.534	449	1.19e-05	11.7	0.00165	1150
73300NB0518	469	0.507	425	1.1e-05	11.1	0.00156	1080

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	1190	67.5	1120	31.9	0.0044	0.699	26.8	0.00205	0.265	2.68e-05	0.00194	0.0238
Maximum	1320	95	1230	36.5	0.00655	0.932	30.3	0.00226	0.351	2.68e-05	0.00194	0.0238
Mean	1250	81.2	1160	34	0.00549	0.816	28.7	0.00217	0.292	2.68e-05	0.00194	0.0238
Median	1240	81	1160	33.7	0.0055	0.816	28.8	0.0022	0.276	2.68e-05	0.00194	0.0238

04280NB2012	1190	67.5	1120	31.9	0.0044	0.699	28.7	0.00216	0.265	2.68e-05	0.00194	0.0238
02300NB2012	1240	72.1	1160	33.2	0.00488	0.734	30.3	0.00226	0.265	2.68e-05	0.00194	0.0238
40300NB1214	1320	95	1230	36.5	0.00655	0.899	28.9	0.00223	0.288	2.68e-05	0.00194	0.0238
73300NB0518	1240	90	1150	34.2	0.00613	0.932	26.8	0.00205	0.351	2.68e-05	0.00194	0.0238

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	333	1.03e-05	8.43	0.00123	985
Maximum	564	0.613	516	1.45e-05	13.4	0.00194	1370
Mean	477	0.519	437	1.25e-05	11.3	0.00163	1180
Median	501	0.545	459	1.24e-05	11.8	0.00172	1170
70320ND2010	358	0.389	333	1.03e-05	8.43	0.00123	985
60320NB2018	501	0.545	459	1.35e-05	11.8	0.00172	1220
01350ND2010	425	0.463	394	1.24e-05	10	0.00149	1140
60350NB2018	564	0.613	516	1.45e-05	13.4	0.00194	1370
73350NB0518	539	0.583	485	1.19e-05	12.8	0.00178	1170

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	1130	74.1	1050	30.9	0.00488	0.755	24.3	0.00193	0.226	2.68e-05	0.00194	0.0238
Maximum	1570	101	1450	42.4	0.00739	1.01	37.2	0.00272	0.354	2.68e-05	0.00194	0.0238
Mean	1350	89.3	1260	36.7	0.00627	0.865	31.5	0.00235	0.28	2.68e-05	0.00194	0.0238
Median	1360	91.5	1250	37.4	0.00649	0.847	31.8	0.00234	0.286	2.68e-05	0.00194	0.0238
70320ND2010	1130	74.1	1050	30.9	0.00488	0.755	24.3	0.00193	0.286	2.68e-05	0.00194	0.0238
60320NB2018	1400	91.5	1310	37.9	0.00649	0.847	35.2	0.00256	0.246	2.68e-05	0.00194	0.0238
01350ND2010	1300	79.8	1220	35.1	0.00551	0.812	31.8	0.00234	0.288	2.68e-05	0.00194	0.0238

60350NB2018	1570	101	1450	42.4	0.00739	0.9	37.2	0.00272	0.226	2.68e-05	0.00194	0.0238
73350NB0518	1360	100	1250	37.4	0.00706	1.01	29.2	0.00221	0.354	2.68e-05	0.00194	0.0238

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	444	0.481	406	1.13e-05	10.5	0.0015	1090
Maximum	634	0.687	574	1.51e-05	15	0.00214	1430
Mean	521	0.565	476	1.32e-05	12.3	0.00177	1260
Median	486	0.528	447	1.33e-05	11.5	0.00168	1250
71360ND1210	444	0.481	406	1.13e-05	10.5	0.0015	1090
13400NB1212	486	0.528	447	1.33e-05	11.5	0.00168	1250
60400NB1224	634	0.687	574	1.51e-05	15	0.00214	1430

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	1260	87.2	1170	34.6	0.0057	0.833	27.1	0.00211	0.24	2.68e-05	0.00194	0.0238
Maximum	1650	114	1530	44.9	0.00824	1	38.9	0.00283	0.308	2.68e-05	0.00194	0.0238
Mean	1450	97.5	1340	39.4	0.00678	0.901	33.3	0.00248	0.267	2.68e-05	0.00194	0.0238
Median	1430	91.3	1330	38.7	0.00639	0.869	33.8	0.0025	0.253	2.68e-05	0.00194	0.0238
71360ND1210	1260	87.2	1170	34.6	0.0057	0.869	27.1	0.00211	0.308	2.68e-05	0.00194	0.0238
13400NB1212	1430	91.3	1330	38.7	0.00639	0.833	33.8	0.0025	0.24	2.68e-05	0.00194	0.0238
60400NB1224	1650	114	1530	44.9	0.00824	1	38.9	0.00283	0.253	2.68e-05	0.00194	0.0238

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	533	0.579	488	1.4e-05	12.6	0.00183	1320
Maximum	656	0.71	592	1.53e-05	15.5	0.00219	1420
Mean	594	0.644	540	1.46e-05	14	0.00201	1370
Median	594	0.644	540	1.46e-05	14	0.00201	1370
13450NB1212	533	0.579	488	1.4e-05	12.6	0.00183	1320
60450NB1224	656	0.71	592	1.53e-05	15.5	0.00219	1420

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	1510	97.2	1410	41	0.00675	0.884	35.6	0.00262	0.235	2.68e-05	0.00194	0.0238
Maximum	1650	115	1520	44.9	0.00863	1	39.8	0.00289	0.241	2.68e-05	0.00194	0.0238
Mean	1580	106	1460	43	0.00769	0.942	37.7	0.00276	0.238	2.68e-05	0.00194	0.0238
Median	1580	106	1460	43	0.00769	0.942	37.7	0.00276	0.238	2.68e-05	0.00194	0.0238
13450NB1212	1510	97.2	1410	41	0.00675	0.884	35.6	0.00262	0.241	2.68e-05	0.00194	0.0238
60450NB1224	1650	115	1520	44.9	0.00863	1	39.8	0.00289	0.235	2.68e-05	0.00194	0.0238

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:

b) 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	581	0.631	530	1.46e-05	13.7	0.00199	1390
Maximum	712	0.771	641	1.62e-05	16.9	0.00239	1540
Mean	646	0.701	586	1.54e-05	15.3	0.00219	1460
Median	646	0.701	586	1.54e-05	15.3	0.00219	1460
13500ND1210	581	0.631	530	1.46e-05	13.7	0.00199	1390
60500NB2018	712	0.771	641	1.62e-05	16.9	0.00239	1540

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	1590	108	1480	43.1	0.00748	0.932	37.4	0.00274	0.238	2.68e-05	0.00194	0.0238
Maximum	1780	126	1650	48.5	0.00899	1.07	42.1	0.00303	0.244	2.68e-05	0.00194	0.0238
Mean	1680	117	1560	45.8	0.00823	1	39.8	0.00288	0.241	2.68e-05	0.00194	0.0238
Median	1680	117	1560	45.8	0.00823	1	39.8	0.00288	0.241	2.68e-05	0.00194	0.0238
13500ND1210	1590	108	1480	43.1	0.00748	0.932	37.4	0.00274	0.238	2.68e-05	0.00194	0.0238
60500NB2018	1780	126	1650	48.5	0.00899	1.07	42.1	0.00303	0.244	2.68e-05	0.00194	0.0238

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	627	0.68	569	1.51e-05	14.8	0.00213	1450
Maximum	742	0.803	668	1.67e-05	17.6	0.00248	1590
Mean	684	0.742	618	1.59e-05	16.2	0.0023	1520
Median	684	0.742	618	1.59e-05	16.2	0.0023	1520
13550ND1212	627	0.68	569	1.51e-05	14.8	0.00213	1450
60550NB2018	742	0.803	668	1.67e-05	17.6	0.00248	1590

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	1660	114	1550	45.2	0.00812	0.984	38.8	0.00283	0.237	2.68e-05	0.00194	0.0238
Maximum	1840	130	1700	50.2	0.00956	1.1	43.5	0.00313	0.242	2.68e-05	0.00194	0.0238
Mean	1750	122	1620	47.7	0.00884	1.04	41.2	0.00298	0.24	2.68e-05	0.00194	0.0238
Median	1750	122	1620	47.7	0.00884	1.04	41.2	0.00298	0.24	2.68e-05	0.00194	0.0238
13550ND1212	1660	114	1550	45.2	0.00812	0.984	38.8	0.00283	0.242	2.68e-05	0.00194	0.0238
60550NB2018	1840	130	1700	50.2	0.00956	1.1	43.5	0.00313	0.237	2.68e-05	0.00194	0.0238

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	0.734	612	1.58e-05	16	0.00228	1520

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	1760	121	1620	47.5	0.00872	1.04	40.6	0.00295	0.244	2.68e-05	0.00194	0.0238

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.