Environmental Product Declaration

Environmental Product Declaration for various ready mix concrete products produced by Holcim México Operaciones S.A. de C.V. at their Huixquilucan facility in Huixquilucan, 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)
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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 48 concrete mixes manufactured at the Holcim Mexico Operaciones S.A. de C.V. Huixquilucan 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	24005NB0520	0.49 MPa 28d strength mortars and fillers	Mortars and fillers	0.49	3.57
2	24007NB0520	0.69 MPa 28d strength mortars and fillers	Mortars and fillers	0.69	3.57
3	24010NB0518	0.98 MPa 28d strength mortars and fillers	Mortars and fillers	0.98	3.24
4	24015NB0518	1.47 MPa 28d strength mortars and fillers	Mortars and fillers	1.47	2.77
5	24020NB0520	1.96 MPa 28d strength mortars and fillers	Mortars and fillers	1.96	2.53
6	24025NB0518	2.45 MPa 28d strength mortars and fillers	Mortars and fillers	2.45	2.33
7	24030NB0520	2.94 MPa 28d strength mortars and fillers	Mortars and fillers	2.94	2.16
8	39035ND2012	3.43 MPa 28d strength Ready mix concrete	Ready mix concrete	3.43	0.65
9	24035NB0520	3.43 MPa 28d strength mortars and fillers	Mortars and fillers	3.43	2.01
10	39036ND2012	3.53 MPa 28d strength Ready mix concrete	Ready mix concrete	3.53	0.63

11	77038ND2010	3.73 MPa 28d strength Ready mix concrete	Ready mix concrete	3.73	0.69
12	39040NB2012	3.93 MPa 28d strength Ready mix concrete	Ready mix concrete	3.93	0.58
13	24040NB0520	3.93 MPa 28d strength mortars and fillers	Mortars and fillers	3.93	1.94
14	77042ND2010	4.12 MPa 28d strength Ready mix concrete	Ready mix concrete	4.12	0.62
15	39045NB2012	4.42 MPa 28d strength Ready mix concrete	Ready mix concrete	4.42	0.53
16	77048ND4006	4.71 MPa 28d strength Ready mix concrete	Ready mix concrete	4.71	0.51
17	77050ND4006	4.91 MPa 28d strength Ready mix concrete	Ready mix concrete	4.91	0.49
18	24050NB0514	4.91 MPa 28d strength mortars and fillers	Mortars and fillers	4.91	1.79
19	70100NB2018	9.81 MPa 28d strength Ready mix concrete	Ready mix concrete	9.81	1.27
20	27100NB1200	9.81 MPa 28d strength special concrete ,dry mix only	Special concrete	9.81	0.00
21	73100NB0518	9.81 MPa 28d strength mortars and fillers	Mortars and fillers	9.81	1.63
22	70150NB2018	14.72 MPa 28d strength Ready mix concrete	Ready mix concrete	14.72	1.09
23	40150NB1214	14.72 MPa 28d strength special concrete	Special concrete	14.72	1.01
24	73150NB0514	14.72 MPa 28d strength mortars and fillers	Mortars and fillers	14.72	1.30

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
25	71175ND1210	17.17 MPa 28d strength Ready mix concrete	Ready mix concrete	17.17	0.97
26	70200NB2018	19.63 MPa 28d strength Ready mix concrete	Ready mix concrete	19.63	0.94
27	40200NB1214	19.63 MPa 28d strength special concrete	Special concrete	19.63	0.89
28	73200NB0514	19.63 MPa 28d strength mortars and fillers	Mortars and fillers	19.63	1.07

Mix designs: 21 to 25 MPa

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

Mix#	Unique name/ID	Short description	Product type	28 day strength, MPa	H2O to cement ratio
29	71210ND1210	20.61 MPa 28d strength Ready mix concrete	Ready mix concrete	20.61	0.89
30	01250NB2018	24.53 MPa 28d strength Ready mix concrete	Ready mix concrete	24.53	0.91
31	40250NB1214	24.53 MPa 28d strength special concrete	Special concrete	24.53	0.80
32	73250NB0514	24.53 MPa 28d strength mortars and fillers	Mortars and fillers	24.53	0.93

Mix designs: 26 to 30 MPa

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

Mix#	Unique name/ID	Short description	Product type	28 day strength, MPa	H2O to cement ratio
33	04280NB2018	27.48 MPa 28d strength Ready mix concrete	Ready mix concrete	27.48	0.74
34	02300NB2012	29.44 MPa 28d strength Ready mix concrete	Ready mix concrete	29.44	0.72
35	40300NB1214	29.44 MPa 28d strength special concrete	Special concrete	29.44	0.71
36	73300NB0518	29.44 MPa 28d strength mortars and fillers	Mortars and fillers	29.44	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
37	70320ND2010	31.4 MPa 28d strength Ready mix concrete	Ready mix concrete	31.40	0.69
38	02350ND2012	34.35 MPa 28d strength Ready mix concrete	Ready mix concrete	34.35	0.63
39	40350NB1214	34.35 MPa 28d strength special concrete	Special concrete	34.35	0.65
40	73350NB0514	34.35 MPa 28d strength mortars and fillers	Mortars and fillers	34.35	0.75

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
41	04360NB2018	35.33 MPa 28d strength Ready mix concrete	Ready mix concrete	35.33	0.60
42	13400ND2010	39.25 MPa 28d strength Ready mix concrete	Ready mix concrete	39.25	0.44

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	60420NB1212	41.22 MPa 28d strength special concrete	Special concrete	41.22	0.41
44	13450NB1212	44.16 MPa 28d strength Ready mix concrete	Ready mix concrete	44.16	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
45	13500ND2012	49.07 MPa 28d strength Ready mix concrete	Ready mix concrete	49.07	0.38

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
46	13550ND2012	53.97 MPa 28d strength Ready mix concrete	Ready mix concrete	53.97	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
47	13600ND2012	58.88 MPa 28d strength Ready mix concrete	Ready mix concrete	58.88	0.3

Mix designs: >60 MPa

Table 11: **Declared products with Mix designs: >60MPa considered in this environmental product declaration**

Mix#	Unique name/ID	Short description	Product type	28 day strength, MPa	H2O to cement ratio
48	60650NB2018	63.79 MPa 28d strength special concrete	Special concrete	63.79	0.33

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 12: **Design composition**

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

SYSTEM BOUNDARIES

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

Life Cycle Impacts

A1-A3	A4-A5	B1-B7	C1-C4
PRODUCT STAGE	**INSTALLATION PROCESS STAGE**	**USE STAGE**	**END OF LIFE STAGE**
A1 Raw material supply	**A4** Transport to site	**B1** Use	**C1** De-installation/ Demolition
A2 Transport	**A5** Installation Process	**B2** Maintenance	**C2** Transport
A3 Manufacturing		**B3** Repaid	**C3** Waste processing
		B4 Replacement	**C4** Disposal of Waste
		B5 Refurbishment	
		B6 Operational energy use	
		B7 Operational water use	
X			

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

Raw Material Supply	Transport	Manufacturing
(A1)	**(A2)**	**(A3)**
Cements & SCMs	Truck, Rail, Ship	Energy Carriers (electricity and fuels)
Aggregates	Energy Carriers (fuels)	Ancillary Materials (lubricants, motor oil, cleaning chemicals, other consumables)
Admixtures		Water (manufacturing water, including wash water for cement trucks, but excluding batch water)
Batch Water		Waste (end of life treatment of ancillary materials and any packaging)
Fibers & Pigments		30% total fleet energy transit mix plants only

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 Huixquilucan 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 13: **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) -	CPC 40	Progam Operator:	Estado de México	very good,	3	3	3	3	3

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

DATA QUALITY ASSESSMENT

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

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

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

Consistency: To ensure consistency, the same modeling structure across the respective product systems was utilized for all inputs, which consisted of raw material inputs and ancillary material, energy flows, water resource inputs, product, and co-products outputs, returned and recovered Ready Mix Concrete materials, emissions to air, water and soil, and waste recycling and treatment.

The same background LCI datasets from the ecoinvent v3.8 database were used across all product systems. Crosschecks concerning the plausibility of mass and energy flows were continuously conducted. The LCA team conducted mass and energy balances at the plant and selected process level to maintain a high level of consistency.

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

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

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

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

ENVIRONMENTAL INDICATORS AND INVENTORY METRICS

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

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

TOTAL IMPACT SUMMARY

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

Mix designs: 0 to 15 MPa

Table 14: **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	113	0.126	126	7.85e-06	2.59	0.000501	698
Maximum	424	0.463	399	1.37e-05	10	0.00154	1210
Mean	253	0.278	247	1.01e-05	5.93	0.000954	897
Median	232	0.256	232	1.01e-05	5.44	0.000904	906
24005NB0520	113	0.126	126	7.85e-06	2.59	0.000501	698
24007NB0520	113	0.126	126	7.85e-06	2.59	0.000501	698
24010NB0518	121	0.135	134	8.02e-06	2.79	0.000529	715
24015NB0518	138	0.154	148	8.23e-06	3.2	0.000583	737
24020NB0520	151	0.167	159	8.32e-06	3.5	0.000621	748
24025NB0518	160	0.177	167	8.5e-06	3.72	0.000651	766
24030NB0520	173	0.191	178	8.59e-06	4.03	0.00069	777
39035ND2012	320	0.35	299	1.03e-05	7.55	0.00114	906
24035NB0520	184	0.203	187	8.72e-06	4.29	0.000724	791
39036ND2012	326	0.357	305	1.05e-05	7.71	0.00116	918
77038ND2010	343	0.376	329	1.27e-05	8.07	0.00128	1090
39040NB2012	364	0.397	337	1.07e-05	8.6	0.00128	959
24040NB0520	191	0.21	193	8.79e-06	4.45	0.000744	799
77042ND2010	376	0.411	357	1.3e-05	8.85	0.00138	1120
39045NB2012	397	0.432	365	1.12e-05	9.39	0.00138	997
77048ND4006	407	0.445	385	1.36e-05	9.6	0.00149	1190
77050ND4006	424	0.463	399	1.37e-05	10	0.00154	1210
24050NB0514	198	0.217	200	9.09e-06	4.61	0.00077	826
70100NB2018	197	0.219	204	1.08e-05	4.59	0.000825	907
27100NB1200	339	0.37	322	1.13e-05	7.99	0.0012	976
73100NB0518	234	0.257	230	9.33e-06	5.49	0.000879	856
70150NB2018	230	0.255	233	1.12e-05	5.38	0.000929	951
40150NB1214	290	0.317	280	1.07e-05	6.8	0.00107	971
73150NB0514	281	0.307	270	9.93e-06	6.61	0.00102	921

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	769	33.7	733	20.6	0.00159	0.432	19	0.00154	0	8.33e-06	0.000056	0.0167
Maximum	1370	79.4	1280	36.5	0.00548	7.17	37.3	0.00269	0.382	8.33e-06	0.000056	0.0167
Mean	1010	53.4	948	27	0.00338	1.71	25.8	0.00198	0.298	8.33e-06	0.000056	0.0167
Median	1020	51	960	26.8	0.00314	0.654	25.4	0.00196	0.328	8.33e-06	0.000056	0.0167
24005NB0520	769	33.7	733	20.7	0.00159	0.584	19	0.00154	0.379	8.33e-06	0.000056	0.0167
24007NB0520	770	34.1	733	20.6	0.0016	0.584	19	0.00154	0.379	8.33e-06	0.000056	0.0167
24010NB0518	790	35.5	749	21.3	0.00172	0.588	19.4	0.00157	0.373	8.33e-06	0.000056	0.0167
24015NB0518	816	38.3	775	21.9	0.00195	0.603	20	0.00161	0.37	8.33e-06	0.000056	0.0167
24020NB0520	829	40.2	792	22.4	0.00209	0.619	20.3	0.00162	0.372	8.33e-06	0.000056	0.0167
24025NB0518	852	41.3	804	23	0.00225	0.623	20.7	0.00166	0.365	8.33e-06	0.000056	0.0167
24030NB0520	866	43.9	819	23.4	0.00239	0.639	21	0.00167	0.368	8.33e-06	0.000056	0.0167
39035ND2012	1030	57.1	961	27.2	0.00411	7.17	26.1	0.002	0.229	8.33e-06	0.000056	0.0167
24035NB0520	882	45.2	835	23.8	0.00252	0.649	21.4	0.0017	0.366	8.33e-06	0.000056	0.0167
39036ND2012	1040	58.5	972	27.6	0.0043	7.09	26.4	0.00202	0.228	8.33e-06	0.000056	0.0167
77038ND2010	1230	64.4	1150	32.7	0.00459	0.685	34.3	0.00249	0.253	8.33e-06	0.000056	0.0167
39040NB2012	1090	64.5	1020	29.1	0.00482	7.13	27.1	0.00207	0.233	8.33e-06	0.000056	0.0167
24040NB0520	895	46.2	842	24.2	0.00263	0.656	21.6	0.00171	0.366	8.33e-06	0.000056	0.0167
77042ND2010	1270	70.2	1190	33.8	0.00491	0.718	35.2	0.00255	0.252	8.33e-06	0.000056	0.0167
39045NB2012	1140	69.4	1060	30.4	0.00515	6.74	28.5	0.00216	0.234	8.33e-06	0.000056	0.0167
77048ND4006	1340	75.2	1260	35.9	0.00541	0.728	36.9	0.00266	0.228	8.33e-06	0.000056	0.0167
77050ND4006	1370	79.4	1280	36.5	0.00548	0.746	37.3	0.00269	0.229	8.33e-06	0.000056	0.0167
24050NB0514	923	47.9	874	24.9	0.00272	0.651	22.3	0.00177	0.352	8.33e-06	0.000056	0.0167

70100NB2018	1000	44.1	958	26.5	0.00263	0.541	28.8	0.00215	0.26	8.33e-06	0.00056	0.0167
27100NB1200	1100	67.6	1030	30.2	0.00449	0.432	29.2	0.00222	0	8.33e-06	0.00056	0.0167
73100NB0518	967	52.8	911	26.3	0.00318	0.72	23	0.00181	0.382	8.33e-06	0.00056	0.0167
70150NB2018	1060	49.2	1010	28	0.00309	0.58	30	0.00223	0.264	8.33e-06	0.00056	0.0167
40150NB1214	1090	61.7	1030	29.6	0.00381	0.697	27	0.00207	0.303	8.33e-06	0.00056	0.0167
73150NB0514	1040	62.2	972	28.3	0.00379	0.758	24.7	0.00192	0.37	8.33e-06	0.00056	0.0167

Mix designs: 15 to 20 MPa

Table 15: **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	269	0.296	265	1.05e-05	6.29	0.00105	986
Maximum	336	0.366	317	1.16e-05	7.92	0.00119	1010
Mean	301	0.33	290	1.12e-05	7.06	0.00112	998
Median	300	0.328	290	1.14e-05	7.02	0.00112	998
71175ND1210	277	0.305	272	1.16e-05	6.49	0.00107	998
70200NB2018	269	0.296	265	1.16e-05	6.29	0.00105	997
40200NB1214	322	0.351	307	1.11e-05	7.56	0.00117	1010
73200NB0514	336	0.366	317	1.05e-05	7.92	0.00119	986

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	1110	56	1050	29.5	0.00359	0.624	26.3	0.00202	0.267	8.33e-06	0.00056	0.0167
Maximum	1140	69.7	1070	30.9	0.00446	0.814	31.2	0.0023	0.368	8.33e-06	0.00056	0.0167
Mean	1120	62.2	1060	30.2	0.00402	0.703	29.2	0.00219	0.304	8.33e-06	0.00056	0.0167
Median	1120	61.4	1060	30.2	0.00402	0.686	29.6	0.00222	0.29	8.33e-06	0.00056	0.0167
71175ND1210	1110	56.9	1060	29.7	0.00374	0.647	31.1	0.00229	0.282	8.33e-06	0.00056	0.0167
70200NB2018	1110	56	1050	29.5	0.00359	0.624	31.2	0.0023	0.267	8.33e-06	0.00056	0.0167

40200NB1214	1140	66	1070	30.9	0.0043	0.726	28.1	0.00214	0.299	8.33e-06	0.000556	0.0167
73200NB0514	1120	69.7	1050	30.6	0.00446	0.814	26.3	0.00202	0.368	8.33e-06	0.000556	0.0167

Mix designs: 21 to 25 MPa

Table 16: **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	300	0.33	292	1.1e-05	7.04	0.00114	1030
Maximum	386	0.419	359	1.19e-05	9.1	0.00134	1050
Mean	338	0.369	322	1.15e-05	7.95	0.00123	1040
Median	333	0.364	318	1.16e-05	7.82	0.00122	1040
71210ND1210	300	0.33	292	1.19e-05	7.04	0.00114	1030
01250NB2018	311	0.341	300	1.17e-05	7.3	0.00116	1030
40250NB1214	355	0.387	335	1.14e-05	8.35	0.00127	1050
73250NB0514	386	0.419	359	1.1e-05	9.1	0.00134	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	1150	58.8	1090	30.6	0.004	0.67	27.6	0.00211	0.28	8.33e-06	0.000556	0.0167
Maximum	1180	77.3	1110	32.3	0.00516	0.866	31.8	0.00234	0.369	8.33e-06	0.000556	0.0167
Mean	1170	67.4	1100	31.6	0.00447	0.749	29.8	0.00224	0.31	8.33e-06	0.000556	0.0167
Median	1170	66.7	1100	31.8	0.00435	0.73	30	0.00226	0.296	8.33e-06	0.000556	0.0167
71210ND1210	1150	58.8	1090	30.6	0.004	0.67	31.8	0.00234	0.28	8.33e-06	0.000556	0.0167
01250NB2018	1160	61.9	1090	31.3	0.00406	0.703	30.8	0.0023	0.295	8.33e-06	0.000556	0.0167
40250NB1214	1180	71.5	1110	32.2	0.00465	0.757	29.2	0.00221	0.296	8.33e-06	0.000556	0.0167
73250NB0514	1180	77.3	1100	32.3	0.00516	0.866	27.6	0.00211	0.369	8.33e-06	0.000556	0.0167

Mix designs: 26 to 30 MPa

Table 17: **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	339	0.371	324	1.15e-05	7.97	0.00126	1070
Maximum	443	0.481	407	1.27e-05	10.5	0.00151	1180
Mean	387	0.422	363	1.21e-05	9.13	0.00138	1110
Median	382	0.418	361	1.21e-05	9.02	0.00138	1090
04280NB2018	339	0.371	324	1.23e-05	7.97	0.00126	1070
02300NB2012	369	0.404	352	1.27e-05	8.69	0.00137	1180
40300NB1214	396	0.431	370	1.18e-05	9.35	0.00139	1090
73300NB0518	443	0.481	407	1.15e-05	10.5	0.00151	1090

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	1200	65.8	1140	32.2	0.0044	0.696	29	0.00219	0.266	8.33e-06	0.000556	0.0167
Maximum	1320	84.2	1250	35.6	0.00574	0.937	33.2	0.00246	0.38	8.33e-06	0.000556	0.0167
Mean	1250	75.1	1170	33.9	0.00508	0.798	31.4	0.00233	0.306	8.33e-06	0.000556	0.0167
Median	1240	75.2	1150	33.9	0.0051	0.779	31.7	0.00234	0.29	8.33e-06	0.000556	0.0167
04280NB2018	1200	65.8	1140	32.2	0.0044	0.696	33	0.00241	0.266	8.33e-06	0.000556	0.0167
02300NB2012	1320	72.6	1250	35.6	0.00494	0.757	33.2	0.00246	0.282	8.33e-06	0.000556	0.0167
40300NB1214	1230	77.8	1150	33.6	0.00526	0.801	30.4	0.00228	0.297	8.33e-06	0.000556	0.0167
73300NB0518	1250	84.2	1150	34.2	0.00574	0.937	29	0.00219	0.38	8.33e-06	0.000556	0.0167

Mix designs: 31 to 35 MPa

Table 18: **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	351	0.384	335	1.2e-05	8.26	0.0013	1090
Maximum	484	0.525	449	1.3e-05	11.5	0.00166	1150
Mean	431	0.468	405	1.24e-05	10.2	0.00152	1130
Median	444	0.483	418	1.24e-05	10.5	0.00156	1140
70320ND2010	351	0.384	335	1.26e-05	8.26	0.0013	1090
02350ND2012	420	0.458	393	1.3e-05	9.91	0.00149	1150
40350NB1214	468	0.507	449	1.22e-05	11	0.00166	1150
73350NB0514	484	0.525	442	1.2e-05	11.5	0.00163	1130

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	1230	66.9	1160	32.8	0.00472	0.701	30.3	0.00228	0.259	8.33e-06	0.000556	0.0167
Maximum	1310	93.1	1220	36.2	0.0063	0.973	34.6	0.00253	0.373	8.33e-06	0.000556	0.0167
Mean	1290	82.1	1200	35	0.00567	0.805	32.3	0.0024	0.308	8.33e-06	0.000556	0.0167
Median	1300	84.2	1210	35.6	0.00583	0.773	32.2	0.00239	0.299	8.33e-06	0.000556	0.0167
70320ND2010	1230	66.9	1160	32.8	0.00472	0.701	34	0.00248	0.259	8.33e-06	0.000556	0.0167
02350ND2012	1310	79.8	1220	35.2	0.00559	0.802	34.6	0.00253	0.281	8.33e-06	0.000556	0.0167
40350NB1214	1310	88.6	1220	36.2	0.00607	0.744	30.3	0.0023	0.317	8.33e-06	0.000556	0.0167
73350NB0514	1300	93.1	1200	35.9	0.0063	0.973	30.3	0.00228	0.373	8.33e-06	0.000556	0.0167

Mix designs: 36 to 40 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	426	0.465	398	1.31e-05	10.1	0.00152	1150
Maximum	474	0.516	436	1.32e-05	11.2	0.00165	1180
Mean	450	0.491	417	1.32e-05	10.6	0.00158	1160
Median	450	0.491	417	1.32e-05	10.6	0.00158	1160
04360NB2018	426	0.465	398	1.31e-05	10.1	0.00152	1150
13400ND2010	474	0.516	436	1.32e-05	11.2	0.00165	1180

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	1310	79.2	1220	35.2	0.00549	0.795	35.1	0.00256	0.231	8.33e-06	0.000556	0.0167
Maximum	1350	84.2	1260	36.1	0.00602	3.98	35.3	0.00256	0.273	8.33e-06	0.000556	0.0167
Mean	1330	81.7	1240	35.7	0.00576	2.39	35.2	0.00256	0.252	8.33e-06	0.000556	0.0167
Median	1330	81.7	1240	35.7	0.00576	2.39	35.2	0.00256	0.252	8.33e-06	0.000556	0.0167
04360NB2018	1310	79.2	1220	35.2	0.00549	0.795	35.3	0.00256	0.273	8.33e-06	0.000556	0.0167
13400ND2010	1350	84.2	1260	36.1	0.00602	3.98	35.1	0.00256	0.231	8.33e-06	0.000556	0.0167

Mix designs: 41 to 45 MPa

Table 20: **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:

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	545	0.593	500	1.47e-05	12.9	0.00191	1340
Maximum	546	0.594	502	1.49e-05	12.9	0.00192	1350
Mean	546	0.593	501	1.48e-05	12.9	0.00192	1340
Median	546	0.593	501	1.48e-05	12.9	0.00192	1340
60420NB1212	545	0.593	500	1.47e-05	12.9	0.00191	1340
13450NB1212	546	0.594	502	1.49e-05	12.9	0.00192	1350

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	1520	95.7	1420	40.9	0.00703	0.873	40.1	0.00284	0.233	8.33e-06	0.000556	0.0167
Maximum	1550	96.1	1430	41.3	0.00719	0.882	40.7	0.00289	0.244	8.33e-06	0.000556	0.0167
Mean	1540	95.9	1420	41.1	0.00711	0.878	40.4	0.00287	0.238	8.33e-06	0.000556	0.0167
Median	1540	95.9	1420	41.1	0.00711	0.878	40.4	0.00287	0.238	8.33e-06	0.000556	0.0167
60420NB1212	1520	95.7	1420	40.9	0.00719	0.882	40.1	0.00284	0.244	8.33e-06	0.000556	0.0167
13450NB1212	1550	96.1	1430	41.3	0.00703	0.873	40.7	0.00289	0.233	8.33e-06	0.000556	0.0167

Mix designs: 46 to 50 MPa

Table 21: **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**
13500ND2012	585	0.635	531	1.45e-05	13.9	0.002	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
13500ND2012	1530	101	1430	41.2	0.00741	3.72	38.4	0.00278	0.244	8.33e-06	0.000556	0.0167

Mix designs: 51 to 55 MPa

Table 22: **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
13550ND2012	635	0.689	574	1.51e-05	15	0.00216	1410

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
13550ND2012	1610	110	1500	43.6	0.00821	3.61	40	0.00289	0.238	8.33e-06	0.000556	0.0167

Mix designs: 56 to 60 MPa

Table 23: **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
13600ND2012	690	0.748	621	1.57e-05	16.4	0.00233	1480

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
13600ND2012	1710	117	1580	46.2	0.00879	3.51	41.7	0.00301	0.233	8.33e-06	0.000556	0.0167

Mix designs: >60 MPa

Table 24: **Total life cycle (across modules in scope) impact results for Mix designs: >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
60650NB2018	730	0.793	664	1.77e-05	17.3	0.00254	1750

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
60650NB2018	2010	127	1860	53.8	0.00929	1.11	47.3	0.00337	0.259	8.33e-06	0.000556	0.0167

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.