

Environmental Product Declaration



Environmental Product Declaration for various ready mix concrete products produced by Holcim México Operaciones S.A. de C.V. at their Los Reyes facility in Alvaro Obregon

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 <input type="checkbox"/> ; External <input checked="" type="checkbox"/> Third Party Verifier Geoffrey Guest, Certified 3rd Party Verifier under the International EPD Program (www.environdec.com), CSA Group (www.csaregistry.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 34 concrete mixes manufactured at the Holcim Mexico Operaciones S.A. de C.V. Los Reyes concrete facility in Ciudad de Mexico, 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	H ₂ O to cement ratio
1	3740NB2012	0.039 MPa 28d strength Ready mix concrete	Ready mix concrete	0.039	0.36
2	24005NB0520	0.491 MPa 28d strength mortars and fillers	mortars and fillers	0.491	5.18
3	24007NB0520	0.687 MPa 28d strength mortars and fillers	mortars and fillers	0.687	5.18
4	24010NB0518	0.981 MPa 28d strength mortars and fillers	mortars and fillers	0.981	4.49
5	24015NB0518	1.472 MPa 28d strength mortars and fillers	mortars and fillers	1.472	3.62
6	24020NB0520	1.963 MPa 28d strength mortars and fillers	mortars and fillers	1.963	3.20
7	24025NB0520	2.453 MPa 28d strength mortars and fillers	mortars and fillers	2.453	2.88
8	24030NB0518	2.944 MPa 28d strength mortars and fillers	mortars and fillers	2.944	2.61
9	77035ND2010	3.435 MPa 28d strength Ready mix concrete	Ready mix concrete	3.435	0.85
10	24035NB0518	3.435 MPa 28d strength mortars and fillers	mortars and fillers	3.435	2.39



11	77036ND2010	3.533 MPa 28d strength Ready mix concrete	Ready mix concrete	3.533	0.80
12	77038ND2010	3.729 MPa 28d strength Ready mix concrete	Ready mix concrete	3.729	0.75
13	77040ND2010	3.925 MPa 28d strength Ready mix concrete	Ready mix concrete	3.925	0.71
14	24040NB0518	3.925 MPa 28d strength mortars and fillers	mortars and fillers	3.925	2.27
15	77042ND2010	4.122 MPa 28d strength Ready mix concrete	Ready mix concrete	4.122	0.67
16	77045ND2010	4.416 MPa 28d strength Ready mix concrete	Ready mix concrete	4.416	0.64
17	77048ND2010	4.711 MPa 28d strength Ready mix concrete	Ready mix concrete	4.711	0.62
18	77050ND2010	4.907 MPa 28d strength Ready mix concrete	Ready mix concrete	4.907	0.59
19	24050NB0518	4.907 MPa 28d strength mortars and fillers	mortars and fillers	4.907	2.07
20	71100NB1218	9.814 MPa 28d strength Ready mix concrete	Ready mix concrete	9.814	1.52
21	71150NB1218	14.72 MPa 28d strength Ready mix concrete	Ready mix concrete	14.720	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	H ₂ O to cement ratio
22	71175NB1218	17.174 MPa 28d strength Ready mix concrete	Ready mix concrete	17.174	1.21
23	71200NB1218	19.627 MPa 28d strength Ready mix concrete	Ready mix concrete	19.627	1.13
24	60200ND1012	19.627 MPa 28d strength special concrete	special concrete	19.627	0.45

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	H ₂ O to cement ratio
25	71210NB1218	20.608 MPa 28d strength Ready mix concrete	Ready mix concrete	20.608	1.10
26	04250ND2012	24.534 MPa 28d strength Ready mix concrete	Ready mix concrete	24.534	0.78
27	60250NB2012	24.534 MPa 28d strength special concrete	special concrete	24.534	0.79



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
28	04280ND2010	27.478 MPa 28d strength Ready mix concrete	Ready mix concrete	27.478	0.69
29	04300ND2012	29.441 MPa 28d strength Ready mix concrete	Ready mix concrete	29.441	0.65

Mix designs: 31 to 35 MPa

Table 5: 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
30	70320ND2010	31.403 MPa 28d strength Ready mix concrete	Ready mix concrete	31.403	0.66
31	07350NB1218	34.347 MPa 28d strength Ready mix concrete	Ready mix concrete	34.347	0.66
32	60350NB2012	34.347 MPa 28d strength special concrete	special concrete	34.347	0.59

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
33	70360ND2010	35.329 MPa 28d strength Ready mix concrete	Ready mix concrete	35.329	0.60
34	70400ND2014	39.254 MPa 28d strength Ready mix concrete	Ready mix concrete	39.254	0.55

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 7: 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:

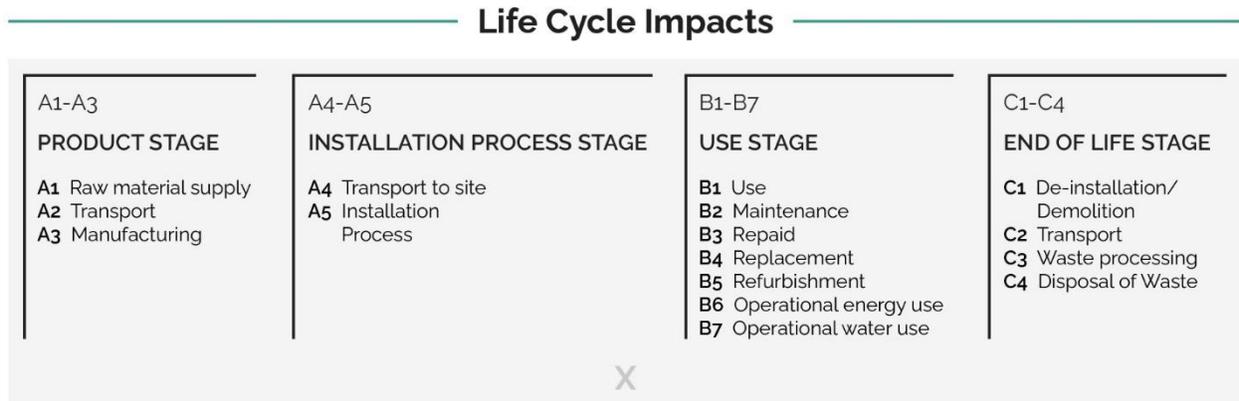


Figure 1: General life cycle phases for consideration in a construction works system

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.

System Boundary

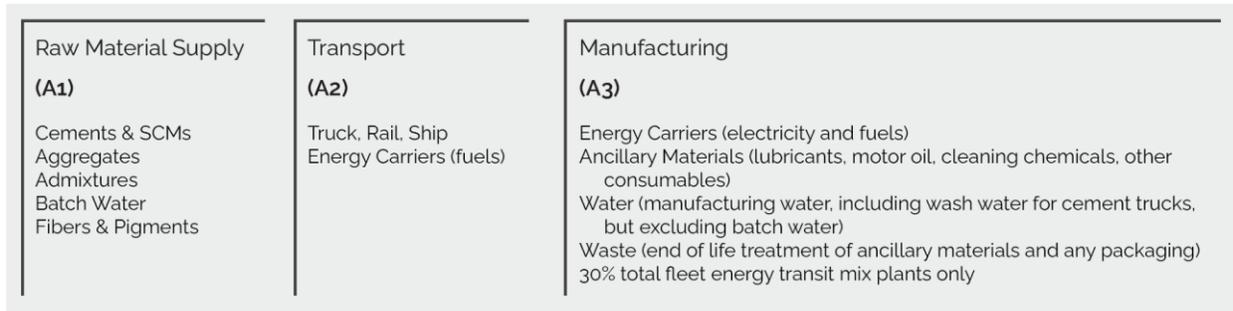


Figure 2: General system inputs considered in the product system and categorized by modules in scope

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.

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 Los Reyes 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 8 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	Estado de México	v3.8 in 2021	2	3	1	3	3
Water	tap water production, conventional with biological treatment/tap water/RoW/kg	ecoinvent v3.8	Estado de Mexico	v3.8 in 2021	2	3	1	3	3
Limestone Gravel	limestone quarry operation/limestone, unprocessed/RoW/kg;	ecoinvent v3.8	Estado de Mexico	v3.8 in 2021	2	3	1	3	3



	Note: modifications made (see ecoinvent activity changes table)								
Additives	market for chemical, organic/chemical, organic/GLO/kg	ecoinvent v3.8	Estado de Mexico	v3.8 in 2021	2	3	1	3	3
Cement (CPC 40) Apaxco	CPC 40	Progam Operator: Labeling Sustainability - EPD ID: e38f688d-1fa5-41b0-a9b1-e5b1422ea654	Estado de México	very good, 3rd party verified facility-specific EPD dataset	3	3	3	3	3
CPC 40R CEMENT PORTLAND GRANEL: Apaxco	CPC 40R	Progam Operator: Labeling Sustainability - EPD ID: e38f688d-1fa5-41b0-a9b1-e5b1422ea654	Estado de México	very good, 3rd party verified facility-specific EPD dataset	3	N A	3	3	3
Cement (CPO 30R R) PROVEEDOR : HOLCI Orizaba	CPC 30R	Progam Operator: Labeling Sustainability - EPD ID: 565b7deb-ebd6-4cb3-9aa6-a585381c41f3	Veracruz	25 February 2023	3	3	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.

LIMITATIONS

This EPD is a declaration of potential environmental impact and does not support or provide definitive comparisons of the environmental performance of specific products. Only EPDs prepared from cradle-to-grave life cycle results and based on the same function and reference service life and quantified by the same functional unit can be used to assist purchasers and users in making informed comparisons between products.

LCIA results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks. Further, LCA offers a wide array of environmental impact indicators, and this EPD reports a collection of those, as specified by the PCR.

In addition to the impact results, this EPD provides several metrics related to resource consumption and waste generation. While these data may be informational in other ways, they do not provide a measure of impact on the environment

TOTAL IMPACT SUMMARY

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

Mix designs: 0 to 15 MPa

Table g: **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 CO ₂ -Eq	kg CFC-11-Eq	kg NO _x -Eq	kg Sb-Eq	MJ, net calorific value



Minimum	77.3	0.0857	86.9	5.22e-06	1.75	0.000327	512
Maximum	626	0.682	586	1.9e-05	14.8	0.00224	1740
Mean	238	0.26	232	9.01e-06	5.58	0.000882	842
Median	211	0.23	212	7.2e-06	4.94	0.000779	716
3740NB2012	626	0.682	586	1.9e-05	14.8	0.00224	1740
24005NB0520	77.3	0.0857	86.9	5.22e-06	1.75	0.000327	512
24007NB0520	77.3	0.0857	86.9	5.22e-06	1.75	0.000327	512
24010NB0518	86.1	0.0952	94.6	5.38e-06	1.96	0.000356	528
24015NB0518	103	0.114	109	5.61e-06	2.37	0.00041	551
24020NB0520	116	0.127	120	5.74e-06	2.67	0.000448	565
24025NB0520	127	0.139	130	5.88e-06	2.94	0.000483	581
24030NB0518	136	0.149	138	6.05e-06	3.16	0.000513	597
77035ND2010	283	0.311	278	1.14e-05	6.64	0.00108	1020
24035NB0518	147	0.161	147	6.19e-06	3.42	0.000547	610
77036ND2010	300	0.329	292	1.16e-05	7.03	0.00113	1040
77038ND2010	316	0.346	306	1.19e-05	7.43	0.00118	1070
77040ND2010	333	0.364	320	1.21e-05	7.82	0.00123	1090
24040NB0518	155	0.169	154	6.28e-06	3.6	0.00057	620
77042ND2010	349	0.382	334	1.23e-05	8.21	0.00128	1100
77045ND2010	366	0.4	348	1.25e-05	8.61	0.00133	1120
77048ND2010	382	0.417	363	1.27e-05	9	0.00139	1150
77050ND2010	399	0.435	377	1.29e-05	9.39	0.00144	1170
24050NB0518	169	0.185	166	6.46e-06	3.95	0.000615	639
71100NB1218	211	0.23	212	7.2e-06	4.94	0.000779	716
71150NB1218	241	0.262	228	7.59e-06	5.65	0.000841	755

b) Inventory Metrics:

Indicator/L CI Metric	TPE	RE	NR E	NR R	RR	WD P	LFW	LFHW	CBW C	CWW C	CH W	CNH W
Unit	MJ- Eq	MJ- Eq	MJ- Eq	kg	m3	m3	kg waste	kg waste	m3	m3	kg	kg
Minimum	657	27.7	630	17.7	0.000702	0.459	15.4	0.00128	0	3.11e-05	0.116	0.0133
Maximum	4020	112	3920	96.7	0.00813	7.74	61.7	0.00475	0.369	3.11e-05	0.116	0.0133
Mean	1380	56.6	1320	35.9	0.00311	2.51	30.8	0.00233	0.292	3.11e-05	0.116	0.0133
Median	1020	53	966	27.4	0.00245	0.692	27	0.00202	0.298	3.11e-05	0.116	0.0133
3740NB2012	1840	112	1720	49.3	0.00813	6.37	48.1	0.0034	0.246	3.11e-05	0.116	0.0133
3742ND2012	1760	102	1640	46.8	0.0075	6.39	46.7	0.0033	0.232	3.11e-05	0.116	0.0133
3745ND2012	1680	91.9	1580	44.8	0.00652	6.77	45.6	0.00323	0.224	3.11e-05	0.116	0.0133
6045NB1218	4020	73.2	3920	96.7	0.00094	5.53	61.7	0.00475	0.238	3.11e-05	0.116	0.0133
3750ND2012	1610	83.1	1530	42.9	0.00608	7.16	44.5	0.00317	0.221	3.11e-05	0.116	0.0133



3755ND2012	1550	76.8	1460	41	0.00546	7.57	43.5	0.00311	0.214	3.11e-05	0.116	0.0133
24005NB0520	657	27.8	630	17.7	0.00118	0.535	15.4	0.00128	0.369	3.11e-05	0.116	0.0133
24007NB0520	661	27.7	634	17.8	0.00116	0.535	15.4	0.00128	0.369	3.11e-05	0.116	0.0133
24010NB0520	677	29.4	645	18.2	0.00128	0.544	15.7	0.00131	0.367	3.11e-05	0.116	0.0133
24015NB0520	704	32.2	669	18.9	0.00145	0.56	16.3	0.00134	0.364	3.11e-05	0.116	0.0133
24020NB0518	724	33.5	689	19.6	0.00157	0.564	16.8	0.00138	0.357	3.11e-05	0.116	0.0133
68025NB0518	732	36.6	699	20	0.0019	0.594	17	0.00138	0.365	3.11e-05	0.116	0.0133
24025NB0520	740	36.2	703	20	0.0018	0.579	17.1	0.00139	0.359	3.11e-05	0.116	0.0133
24030NB0520	752	36.9	715	20.4	0.00192	0.59	17.5	0.00142	0.358	3.11e-05	0.116	0.0133
39035ND4010	2610	46.1	2570	63.6	0.000702	7.74	49.6	0.00378	0.23	3.11e-05	0.116	0.0133
68035NB0514	775	40.3	734	21	0.00214	0.601	18	0.00145	0.352	3.11e-05	0.116	0.0133
24035NB0520	768	39.2	733	20.9	0.00209	0.6	17.8	0.00144	0.356	3.11e-05	0.116	0.0133
77036ND2010	1170	61.9	1100	31.3	0.00416	0.661	31.4	0.0023	0.254	3.11e-05	0.116	0.0133
39038ND2010	2770	49.4	2710	67.7	0.00071	6.76	50.8	0.00387	0.237	3.11e-05	0.116	0.0133
77040ND4010	1230	68.3	1160	32.9	0.00449	0.691	32.9	0.00239	0.249	3.11e-05	0.116	0.0133
68040ND4014	1200	66.8	1130	32.1	0.00439	0.712	32.1	0.00233	0.276	3.11e-05	0.116	0.0133
24040NB0520	779	40.3	737	21.2	0.00218	0.607	18	0.00146	0.356	3.11e-05	0.116	0.0133
39042ND4012	2930	52.8	2890	71.4	0.000746	7.07	52.7	0.00402	0.232	3.11e-05	0.116	0.0133

Mix designs: 15 to 20 MPa

Table 10: 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

a) Midpoint Impact Categories:

Indicator/LCI Metric	AP	EP	GWP	ODP	PCOP	ADPe	ADPf
Unit	moles of H ⁺ -Eq	kg N	kg CO ₂ -Eq	kg CFC-11-Eq	kg NO _x -Eq	kg Sb-Eq	MJ, net calorific value
Minimum	257	0.279	253	7.78e-06	6.04	0.000926	774
Maximum	371	0.401	340	9.55e-06	8.74	0.00122	891
Mean	300	0.325	287	8.44e-06	7.07	0.00104	820



Median	273	0.296	267	7.99e-06	6.42	0.000978	796
71175NB1218	257	0.279	253	7.78e-06	6.04	0.000926	774
71200NB1218	273	0.296	267	7.99e-06	6.42	0.000978	796
60200ND1012	371	0.401	340	9.55e-06	8.74	0.00122	891

b) Inventory Metrics:

Indicator/LCI Metric	TPE	RE	NR E	NR R	RR	WD P	LFW	LFHW	CBW C	CWW C	CH W	CNH W
Unit	MJ-Eq	MJ-Eq	MJ-Eq	kg	m3	m3	kg waste	kg waste	m3	m3	kg	kg
Minimum	887	57.7	827	24.1	0.00337	0.597	17.4	0.00142	0.189	3.94e-05	0	0.089
Maximum	1030	75.9	951	28.4	0.0048	0.671	22.7	0.0018	0.32	3.94e-05	0	0.089
Mean	943	64.6	876	25.8	0.0039	0.625	19.4	0.00156	0.276	3.94e-05	0	0.089
Median	912	60.1	850	24.8	0.00354	0.607	18	0.00146	0.318	3.94e-05	0	0.089
71175NB1218	887	57.7	827	24.1	0.00337	0.597	17.4	0.00142	0.32	3.94e-05	0	0.089
71200NB1218	912	60.1	850	24.8	0.00354	0.607	18	0.00146	0.318	3.94e-05	0	0.089
60200ND1012	1030	75.9	951	28.4	0.0048	0.671	22.7	0.0018	0.189	3.94e-05	0	0.089

Mix designs: 21 to 25 MPa

Table 11: 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

a) Midpoint Impact Categories:

Indicator/LCI Metric	AP	EP	GWP	ODP	PCOP	ADPe	ADPf
Unit	moles of H+-Eq	kg N	kg CO2-Eq	kg CFC-11-Eq	kg NOx-Eq	kg Sb-Eq	MJ, net calorific value
Minimum	33.6	0.0556	274	8.08e-06	0.386	0.000557	805
Maximum	322	0.353	355	2.92e-05	7.57	0.0012	2320
Mean	212	0.238	313	1.64e-05	4.85	0.000919	1400
Median	280	0.304	311	1.18e-05	6.59	0.001	1070
71210NB1218	280	0.304	274	8.08e-06	6.59	0.001	805
04250ND2012	322	0.353	311	1.18e-05	7.57	0.0012	1070
60250NB2012	33.6	0.0556	355	2.92e-05	0.386	0.000557	2320



b) Inventory Metrics:

Indicator/LCI Metric	TPE	RE	NR E	NR R	RR	WD P	LFW	LFHW	CBW C	CWW C	CH W	CNH W
Unit	MJ-Eq	MJ-Eq	MJ-Eq	kg	m3	m3	kg waste	kg waste	m3	m3	kg	kg
Minimum	924	52.4	858	25.1	0.000646	0.565	18.2	0.00147	0.266	3.94e-05	0	0.089
Maximum	2550	67.2	2500	61.6	0.00419	0.695	38.2	0.00296	0.318	3.94e-05	0	0.089
Mean	1560	59.9	1500	39.5	0.00281	0.624	29.4	0.00223	0.285	3.94e-05	0	0.089
Median	1210	60.2	1140	31.9	0.00359	0.611	31.8	0.00226	0.271	3.94e-05	0	0.089
71210NB1218	924	60.2	858	25.1	0.00359	0.611	18.2	0.00147	0.318	3.94e-05	0	0.089
04250ND2012	1210	67.2	1140	31.9	0.00419	0.695	31.8	0.00226	0.266	3.94e-05	0	0.089
60250NB2012	2550	52.4	2500	61.6	0.000646	0.565	38.2	0.00296	0.271	3.94e-05	0	0.089

Mix designs: 26 to 30 MPa

Table 12: 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	353	0.386	337	1.23e-05	8.29	0.00129	1110
Maximum	383	0.418	363	1.26e-05	9.01	0.00138	1150
Mean	368	0.402	350	1.25e-05	8.65	0.00133	1130
Median	368	0.402	350	1.25e-05	8.65	0.00133	1130
04280ND2010	353	0.386	337	1.23e-05	8.29	0.00129	1110
04300ND2012	383	0.418	363	1.26e-05	9.01	0.00138	1150

b) Inventory Metrics:

Indicator/LCI Metric	TPE	RE	NR E	NR R	RR	WD P	LFW	LFHW	CBW C	CWW C	CH W	CNH W
Unit	MJ-Eq	MJ-Eq	MJ-Eq	kg	m3	m3	kg waste	kg waste	m3	m3	kg	kg
Minimum	1260	71.5	1190	33.5	0.00475	0.722	33	0.00234	0.261	3.94e-05	0	0.089



Maximum	1310	76.2	1220	34.6	0.00497	0.76	34	0.0024	0.267	3.94e-05	0	0.089
Mean	1280	73.8	1200	34	0.00486	0.741	33.5	0.00237	0.264	3.94e-05	0	0.089
Median	1280	73.8	1200	34	0.00486	0.741	33.5	0.00237	0.264	3.94e-05	0	0.089
04280ND2010	1260	71.5	1190	33.5	0.00475	0.722	33	0.00234	0.261	3.94e-05	0	0.089
04300ND2012	1310	76.2	1220	34.6	0.00497	0.76	34	0.0024	0.267	3.94e-05	0	0.089

Mix designs: 31 to 35 MPa

Table 13: 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	40.6	0.0678	376	1.22e-05	0.449	0.000674	1120
Maximum	436	0.475	463	3.67e-05	10.3	0.00156	2900
Mean	293	0.327	416	2.06e-05	6.74	0.00122	1760
Median	401	0.437	408	1.28e-05	9.46	0.00142	1250
70320ND2010	401	0.437	376	1.22e-05	9.46	0.00142	1120
07350NB1218	436	0.475	408	1.28e-05	10.3	0.00156	1250
60350NB2012	40.6	0.0678	463	3.67e-05	0.449	0.000674	2900

b) Inventory Metrics:

Indicator/LCI Metric	TPE	RE	NR E	NR R	RR	WD P	LFW	LFHW	CBW C	CWW C	CH W	CNH W
Unit	MJ-Eq	MJ-Eq	MJ-Eq	kg	m3	m3	kg waste	kg waste	m3	m3	kg	kg
Minimum	1280	64.3	1200	34.2	0.000759	0.636	33	0.00233	0.274	3.94e-05	0	0.089
Maximum	3180	86.7	3110	76.6	0.00581	0.856	44.8	0.00347	0.301	3.94e-05	0	0.089
Mea3	1960	76.6	1880	49.6	0.00391	0.76	37.2	0.00273	0.285	3.94e-05	0	0.089
Median	1430	78.8	1340	38	0.00517	0.789	33.8	0.0024	0.28	3.94e-05	0	0.089
70320ND2010	1280	78.8	1200	34.2	0.00517	0.789	33	0.00233	0.28	3.94e-05	0	0.089
07350NB1218	1430	86.7	1340	38	0.00581	0.856	33.8	0.0024	0.301	3.94e-05	0	0.089
60350NB2012	3180	64.3	3110	76.6	0.000759	0.636	44.8	0.00347	0.274	3.94e-05	0	0.089



Mix designs: 36 to 40 MPa

Table 14: 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 CO ₂ -Eq	kg CFC-11-Eq	kg NO _x -Eq	kg Sb-Eq	MJ, net calorific value
Minimum	442	0.481	411	1.27e-05	10.4	0.00155	1170
Maximum	497	0.54	458	1.33e-05	11.8	0.00172	1230
Mean	470	0.51	434	1.3e-05	11.1	0.00164	1200
Median	470	0.51	434	1.3e-05	11.1	0.00164	1200
70360ND2010	442	0.481	411	1.27e-05	10.4	0.00155	1170
70400ND2014	497	0.54	458	1.33e-05	11.8	0.00172	1230

b) Inventory Metrics:

Indicator/LCI Metric	TPE	RE	NR E	NR R	RR	WD P	LFW	LFHW	CBW C	CWW C	CH W	CNH W
Unit	MJ-Eq	MJ-Eq	MJ-Eq	kg	m ³	m ³	kg waste	kg waste	m ³	m ³	kg	kg
Minimum	1340	84.5	1250	36	0.00555	0.832	34.4	0.00242	0.281	3.94e-05	0	0.089
Maximum	1420	94	1320	38.2	0.00644	0.902	36.1	0.00252	0.292	3.94e-05	0	0.089
Mean	1380	89.2	1280	37.1	0.006	0.867	35.2	0.00247	0.286	3.94e-05	0	0.089
Median	1380	89.2	1280	37.1	0.006	0.867	35.2	0.00247	0.286	3.94e-05	0	0.089
70360ND2010	1340	84.5	1250	36	0.00555	0.832	34.4	0.00242	0.281	3.94e-05	0	0.089
70400ND2014	1420	94	1320	38.2	0.00644	0.902	36.1	0.00252	0.292	3.94e-05	0	0.089

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>.

