GRUPO COMOSA

Environmental Product Declaration

Environmental Product Declaration for ready mix concrete products produced by Concreto de Morelos S.A. de C.V. at their Xochitepec facility in Morelos

ADMINISTRATIVE INFORMATION

International Certified Environmental Product Declaration

Declared Product:	This Environmental Product Declaration (EPD) covers ready mix concrete products produced by Concreto de Morelos S.A de C.V.. Declared unit: 1 m3 of concrete
Declaration Owner:	Concreto de Morelos S.A. de C.V. km 1.5 Paseo Cuauhnahuac, Colonia Alegria Cuernavaca, Morelos www.grupocomosa.com
Program Operator:	Labeling Sustainability Address, 11670 W Sunset Blvd. City, State, Los Angeles, CA www.labelingsustainability.com/
Product Category Rule:	Core PCR: ISO 21930:2017 Sustainability in buildings and civil engineering works – Core rules for environmental product declarations of construction products and services SubPCR: NSF International (March 2020). Product Category Rul (PCR) for Environmental Product Declarations (EPD) PCR for Concrete, v2.1 Sub PCR Program Operator: NSF International Sub-category PCR review was conducted by: Thomas P. Gloria, Ph. D. of Industrial Ecology Consultants: 35 Bracebridge, Rd., Newton, MA 02459-1728, t.gloria@industrial-ecology.com. Dr. Michael Overcash of Environmental Clarity: 2908 Chipmunk Lane, Raleigh, NC 27607-3117, mrovercash@earthlink.net. Mr. Bill Stough of Sustainable Research Group: PO Box 1684, Grand Rapids, MI 49501-1684, bstough@sustainableresearchgroup.com. Mr. Jack Geilbig, EcoForm: 2624 Abelia Way, Suite 611, Knoxville, TN 37931, jgeilbig@ecoform.com.
Independent LCA Reviewer and EPD Verifier:	This EPD was independently verified in accordance with ISO 14025 and ISO 21930. The life cycle assessment was independently reviewed in accordance ISO 14044 and the referenced PCR. Independent verification of the declaration, according to ISO 14025:2006 Internal ☐ ; External X Third Party Verifier Geoffrey Guest, Certified 3rd Party Verifier under the International EPD Program (www.environdec.com), CSA Group (www.csaregistries.ca)
Date of Issue:	23 August 2023
Period of Validity:	5 years; valid until 22 August 2028
EPD Number:	b813fc3d-d0aa-41e9-984b-912b414aaf70

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COMPANY DESCRIPTION

GRUPO COMOSA , since 1968, which opened its doors, has produced Ready-Mix Concrete with quality and service to meet the highest standards.

Since its inception, GRUPO COMOSA has successfully participated in the ready-mix concrete industry, which has allowed us to actively participate in the most important infrastructure, housing, and industrial projects in our country.

At GRUPO COMOSA we seek excellence in our products, which is why we have the following standards:

- "Quality Concrete" Certification from the RMX Allies Network,
- ISO 9001:2015 Certification in the Sales Manufacturing and Distribution process of Ready-Mixed Concrete; and·
- Accreditation of the Central Laboratory in NMX-EC-17025-IMNC-2018.

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 Concreto de Morelos 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 Concreto de Morelos 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 Concreto de Morelos S.A. de C.V's license to operate in the community. The intended audience for this LCA report is Concreto de Morelos 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 26 concrete mixes manufactured at Concreto de Morelos S.A. de C.V. Xochitepec concrete facility in Xochitepec, Morelos, 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 cement products considered in this EPD along with key performance parameters.

All Declared Products

Table 1: **All Declared products are considered in this environmental product declaration**

Mix#	Unique name/ID	Short description	Product type	1 day strength, MPa	3 day strength, MPa	7 day strength, MPa	28 day strength, MPa	H2O to cement ratio
1	CCV150N2AD	16.84 MPa 28d strength Ready Mix Concrete	Ready Mix Concrete				16.84	0.818
2	CCV150N2BD	16.49 MPa 28d strength Ready Mix Concrete	Ready Mix Concrete				16.49	0.804
3	CE2200N2AD	21.45 MPa 28d strength Ready Mix Concrete	Ready Mix Concrete				21.45	0.720
4	CE2200N2BD	21.05 MPa 28d strength Ready Mix Concrete	Ready Mix Concrete				21.05	0.711
5	CE2200N2BB	21.76 MPa 28d strength Ready Mix Concrete	Ready Mix Concrete				21.76	0.711
6	CE1250N2AD	26.4 MPa 28d strength Ready Mix Concrete	Ready Mix Concrete				26.40	0.632
7	CE1250N2BD	25.75 MPa 28d strength Ready Mix Concrete	Ready Mix Concrete				25.75	0.638

8	CE1250N2BB	26.3 MPa 28d strength Ready Mix Concrete	Ready Mix Concrete				26.30	0.638
9	CE1300N2BD	31.47 MPa 28d strength Ready Mix Concrete	Ready Mix Concrete				31.47	0.536
10	CE1250N1BB	25.77 MPa 28d strength Ready Mix Concrete	Ready Mix Concrete				25.77	0.600
11	CUR20032AD	22.15 MPa 28d strength Ready Mix Concrete	Ready Mix Concrete		22.15			0.500
12	CUR25072AD	26.19 MPa 28d strength Ready Mix Concrete	Ready Mix Concrete			26.19		0.514
13	CUR25072BB	26.36 MPa 28d strength Ready Mix Concrete	Ready Mix Concrete			26.36		0.514
14	CMR035N4AD	3.62 MPa 28d strength Ready Mix Concrete	Ready Mix Concrete				3.62	0.679
15	CMR040N4AD	4.14 MPa 28d strength Ready Mix Concrete	Ready Mix Concrete				4.14	0.600
16	CMR042N4AD	4.34 MPa 28d strength Ready Mix Concrete	Ready Mix Concrete				4.34	0.571
17	CMR045N4AD	4.61 MPa 28d strength Ready Mix Concrete	Ready Mix Concrete				4.61	0.534
18	C80350S2CD	35.43 MPa 28d strength Ready Mix Concrete	Ready Mix Concrete	35.43				0.367
19	C80350S1CD	36.65 MPa 28d strength Ready Mix Concrete	Ready Mix Concrete	36.65				0.373
20	C80350S10D	34.58 MPa 28d strength Ready Mix Concrete	Ready Mix Concrete	34.58				0.320

21	C80400S2CD	40.09 MPa 28d strength Ready Mix Concrete	Ready Mix Concrete	40.09				0.364
22	C80400S1CD	40.35 MPa 28d strength Ready Mix Concrete	Ready Mix Concrete	40.35				0.352
23	C80400S1ED	36.9 MPa 28d strength Ready Mix Concrete	Ready Mix Concrete	36.90				0.385
24	C80450S1CD	44.58 MPa 28d strength Ready Mix Concrete	Ready Mix Concrete	44.58				0.333
25	C80450S1ED	44 MPa 28d strength Ready Mix Concrete	Ready Mix Concrete	44.00				0.364
26	C80500S1ED	47.1 MPa 28d strength Ready Mix Concrete	Ready Mix Concrete	47.1				0.724

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 2: **Ready mix concrete composition**

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

A1 RAW MATERIAL RECYCLED CONTENT AND MATERIAL LOSSES

The following table provides a list of the raw material inputs (module A1) across all products considered, their recyclability content and assumed material losses.

Table 3: **Module A1 raw material inputs, the recyclability content and assumed material losses (dry basis)**

product.name	mix.category	primary.content	post.industrial.content	post.consumer.content	material.losses
Cement CPC 40	cement, Portland	1	0	0	0

Water	tap water	1	0	0	0.05
Limestone Gravel	limestone, unprocessed	1	0	0	0.05
Sand	sand	1	0	0	0.05
Additives	chemical, organic	1	0	0	0.05
Cement CPC 40R	cement, Portland	1	0	0	0

SYSTEM BOUNDARIES

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

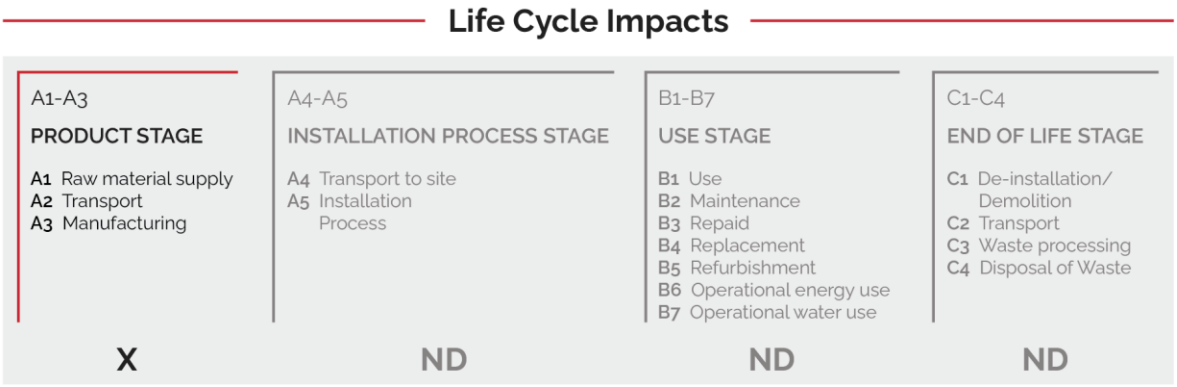

Figure 1: **General life cycle phases for consideration in a construction works system**

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

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

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

System Boundary

Raw Material Supply (A1)	Transport (A2)	Manufacturing (A3)
Cements & SCMs Aggregates Admixtures Batch Water Fibers & Pigments	Truck, Rail, Ship Energy Carriers (fuels)	Energy Carriers (electricity and fuels) Ancillary Materials (lubricants, motor oil, cleaning chemicals, other consumables) Water (manufacturing water, including wash water for cement trucks, but excluding batch water) Waste (end of life treatment of ancillary materials and any packaging) 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 Concreto de Morelos S.A de C.V., is located at their Xochitepec facility in Mexico. All operating data is formulated using the actual data from Concreto de Morelos 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 Concreto de Morelos 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

The following table summarizes the facility's (i.e. A3) electricity consumption and on-site generation or off-site contractual procurement (if applicable), process/space heating requirements, fuel inputs for on-site machinery, and waste generation.

Table 4: **Inputs required by facility from 2022-01-01 to 2022-12-31 (364 days) to produce 36551.5 m3 of concrete**

Activity	Value	Units
Electricity consumption and on-site generation or off-site contractual procurement (if applicable)		
Gross grid electricity:	46480	kWh
Fuel requirements for machinery		
Diesel	11031	L
Waste generation		
Wash water	3289.635	m3
Hazardous waste	551	kg
Non-hazardous waste	1080000	kg
High-level radioactive waste	NA	kg

No recovered on-site energy occurs at this facility.

Table 5: **Reused or recycled components/materials at the A3 facility site**

Component/material for re-use/recycling	Value	Units	Re-used/recycled on-site or off-site
Returned concrete	49	m3	On-Site

The following statements explain how the above facility requirements/generation were derived:

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 COMOSA in calendar year 2022. These values were direct reported from COMOSA 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 COMOSA 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 COMOSA operations for bulk waste. No hazardous or high-level radioactive waste is generated on-site at this facility. Wash water for trucks was also primary reported data for 2022.

Recovered energy: Not applicable.

Recycled/reused material/components: The amount of returned concrete is based on COMOSA primary data for the reference year, 2022.

Module A1 material losses: Due to lack of data, default loss factors were assumed.

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 COMOSA reporting for the reference year 2022.

Product transport requirements: The diesel fuel used by the mixing trucks is direct primary information reported from Concreto de Morelos S.A de C.V. records for the year 2022. The concrete PCR allots 30% of the overall mixing truck total for stage A3 (manfacturing) 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 6: **LCI inputs assumed for module A1 (i.e. raw material supply)** ***Data Quality Assessment Key Fair=1, Good=2, Very Good =3.***

Input	LCI.activity	Data.source	Geo	Year	Technology	Time	Geography	Reliability	Completeness
Water	tap water production, conventional with biological treatment/tap water/RoW/kg	ecoinvent v3.8	Morelos	v3.8 in 2021	2	3	2	3	3
Limestone Gravel	limestone quarry operation/limestone, unprocessed/RoW/kg	ecoinvent v3.8	Morelos	v3.8 in 2021	2	3	2	3	3
Additives	market for chemical, organic/chemical, organic/GLO/kg	ecoinvent v3.8	Estado de Mexico	v3.8 in 2021	2	3	2	3	3
Cement CPC 40	CPC 40	Progam Operator: Labeling Sustainability-EPD ID: e38f688d-1fa5-41b0-	Hidalgo	very good, 3rd party verfied facility-specific	3	3	3	3	3

		a9b1-e5b1422ea654		EPD dataset					
Cement CPC 40R	CPC 40R	Progam Operator: Labeling Sustainability-EPD ID: e38f688d-1fa5-41b0-a9b1-e5b1422ea654	HIDALGO	very good, 3rd party verfied facility-specific EPD dataset	3	NA	3	3	3
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

Table 7: **LCI inputs assumed for module A2 (i.e. transport of A1 inputs)**

Input	LCI.activity	Data.source	Geo	Year	Technology	Time	Geography	Reliability	Completeness
Additives-freight transport via Truck	market for transport, freight, lorry 7.5-16 metric ton, EURO6/transport, freight, lorry 7.5-16 metric ton, EURO6/RoW/tkm	ecoinvent v3.8	RoW	v3.8 in 2021	2	3	1	3	3
Cement CPC 40- freight transport via Truck	market for transport, freight, lorry 7.5-16 metric ton, EURO6/transport, freight, lorry 7.5-16 metric ton, EURO6/RoW/tkm	ecoinvent v3.8	RoW	v3.8 in 2021	2	3	1	3	3
Cement CPC 40R- freight transport via Truck	market for transport, freight, lorry 7.5-16 metric ton, EURO6/transport, freight, lorry 7.5-16 metric ton, EURO6/RoW/tkm	ecoinvent v3.8	RoW	v3.8 in 2021	2	3	1	3	3
Limestone gravel-freight transport via Truck	market for transport, freight, lorry 7.5-16 metric ton, EURO6/transport, freight, lorry 7.5-16	ecoinvent v3.8	RoW	v3.8 in 2021	2	3	1	3	3

	metric ton, EURO6/RoW/tkm								
Sand-freight transport via Truck	market for transport, freight, lorry 16-32 metric ton, EURO6/transport, freight, lorry 16-32 metric ton, EURO6/RoW/tkm	ecoinvent v3.8	RoW	v3.8 in 2021	2	3	1	3	3

Table 8: **LCI inputs assumed for module A3**

Input	LCI.activity	Data.source	Geo	Year	Technology	Time	Geography	Reliability	Completeness
Diesel	diesel, burned in building machine/diesel, burned in building machine/GLO/MJ	ecoinvent v3.8	GLO	v3.8 in 2021	1	3	1	3	3
Diesel used for mixing trucks	transport, freight, lorry 7.5-16 metric ton, EURO6/transport, freight, lorry 7.5-16 metric ton, EURO6/RoW/tkm	ecoinvent v3.8	RoW	v3.8 in 2021	2	3	2	3	3
Grid electricity	market for electricity, medium voltage/electricity, medium voltage/SV/kWh	ecoinvent v3.8	SV	v3.8 in 2021	2	3	2	3	3
Hazardous waste	treatment of hazardous waste, hazardous waste incineration/hazardous waste, for incineration/RoW/kg	ecoinvent v3.8	RoW	v3.8 in 2021	2	3	1	3	3
Non-hazardous waste	treatment of municipal solid waste, sanitary landfill/municipal solid waste/RoW/kg	ecoinvent v3.8	RoW	v3.8 in 2021	1	3	1	3	3
Transport of Hazardous waste	transport, freight, lorry, all sizes, EURO4 to generic market for transport, freight, lorry, unspecified/transport, freight, lorry, unspecified/RoW/tkm	ecoinvent v3.8	RoW	v3.8 in 2021	2	3	1	3	3k
Transport of Non-	transport, freight, lorry, all sizes, EURO5 to	ecoinvent v3.8	RoW	v3.8 in 2021	2	3	1	3	3

hazardous waste	generic market for transport, freight, lorry, unspecified/transport, freight, lorry, unspecified/RoW/tkm								
Transport of Returned concrete	transport, freight, lorry >32 metric ton, EURO6/transport, freight, lorry >32 metric ton, EURO6/RoW/tkm	ecoinvent v3.8	RoW	v3.8 in 2021	2	3	1	3	3
Transport of Wash water	transport, freight, lorry >32 metric ton, EURO6/transport, freight, lorry >32 metric ton, EURO6/RoW/tkm	ecoinvent v3.8	RoW	v3.8 in 2021	2	3	1	3	3
Wash water	tap water production, conventional with biological treatment/tap water/RoW/kg	ecoinvent v3.8	RoW	v3.8 in 2021	2	3	1	3	3

Table 9: **All technosphere input changes made to any ecoinvent activities used in the system model**

ID	Product	Update Type	Activity name to Change	Name_inputActivity	Value	Units	Explanation
1	Gravel	Remove	limestone quarry operation/limestone, unprocessed/RoW/kg	market group for electricity, medium voltage/electricity, medium voltage/GLO/kWh	0.00274	kWh	Regarding activity 'limestone quarry operation/limestone, unprocessed/RoW/kg', the input 'market group for electricity, medium voltage/electricity, medium voltage/GLO/kWh', was removed assuming 2.74E-3 kWh
2	Gravel	Add	limestone quarry operation/limestone, unprocessed/RoW/kg	market for electricity, medium voltage/electricity, medium voltage/MX/kWh	0.00274	kWh	Regarding activity 'limestone quarry operation/limestone, unprocessed/RoW/kg', the input 'market for electricity, medium voltage/electricity, medium voltage/MX/kWh',

							was added assuming 2.74E-3 kWh
3	Sand	Remove	sand quarry operation, extraction from river bed/sand/BR/kg	market group for electricity, medium voltage/electricity, medium voltage/BR/kWh	0.00013	kWh	Regarding activity 'sand quarry operation, extraction from river bed/sand/BR/kg', the input 'market group for electricity, medium voltage/electricity, medium voltage/BR/kWh', was removed assuming 1.30E-4 kWh
4	Sand	Add	sand quarry operation, extraction from river bed/sand/BR/kg	market for electricity, medium voltage/electricity, medium voltage/MX/kWh	0.00013	kWh	Regarding activity 'sand quarry operation, extraction from river bed/sand/BR/kg', the input 'market for electricity, medium voltage/electricity, medium voltage/MX/kWh', was added assuming 1.30E-4 kWh

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).

Table 10: **Life cycle impact categories and life cycle inventory metrics**

ID	LCIA.indicators	Abbreviations	Units
1	environmental impact: acidification	AP	moles of H+-Eq
2	environmental impact: eutrophication	EP	kg N
3	environmental impact: global warming	GWP	kg CO2-Eq
4	environmental impact: ozone depletion	ODP	kg CFC-11-Eq
5	environmental impact: photochemical oxidation	PCOP	kg NOx-Eq
6	material resources: metals/minerals: abiotic depletion potential (ADP): elements (ultimate reserves)	ADPe	kg Sb-Eq
7	energy resources: non-renewable: abiotic depletion potential (ADP): fossil fuels	ADPf	MJ, net calorific value
Inventory metrics			
8	Total primary energy	TPE	MJ-Eq
9	Renewable energy	RE	MJ-Eq
10	Non-renewable energy	NRE	MJ-Eq
11	Non-Renewable Resources	NRR	kg
12	Renewable Resources	RR	m3
13	water depletion: WDP	WDP	m3
14	land filling: bulk waste	LFW	kg waste
15	land filling: hazardous waste	LFHW	kg waste
16	Concrete batching water consumption	CBWC	m3
17	Concrete washing water consumption	CWWC	m3
18	Concrete hazardous waste	CHW	kg
19	Concrete non-hazardous waste	CNHW	kg

A summary description of each of the impact categories and inventory metrics is provided in the following table:

Table 11: **Definitions of life cycle impact categories and life cycle inventory metrics**

Midpoint impact categories	
Global Warming Potential (GWP) (units: kg CO2-eq)	Global Warming Potential or climate change can be defined as the change in global temperature caused by the greenhouse effect that the release of greenhouse gases by human activity creates. The Environmental Profiles characterization model is based on factors developed by the United Nations Intergovernmental Panel on Climate Change (IPCC). Factors are expressed as Global Warming Potential over the time horizon of different years, being the most common 100 years (GWP100), measured in the reference unit, kg CO2 equivalent.
Ozone Depletion Potential (ODP) (kg CFC-11-eq)	Ozone-depleting gases cause damage to stratospheric ozone or the ozone layer. CFCs, halons and HCFCs are the major causes of ozone depletion. The characterization model has been developed by the World Meteorological Organization (WMO) and defines the ozone depletion potential of different gases relative to the reference substance chlorofluorocarbon-11 (CFC-11), expressed in kg CFC-11 equivalent.
Acidification Potential (AP) (kg SO2-eq)	Acidic gases such as Sulphur dioxide (SO2) react with water in the atmosphere to form acid rain, a process known as acid deposition. Acidification potential is expressed using the reference unit, kg SO2 equivalent. The model does not take account of regional differences in terms of which areas are more or less susceptible to acidification. It

	accounts only for acidification caused by SO2 and NOx. This includes acidification due to fertilizer use, according to the method developed by the Intergovernmental Panel on Climate Change (IPCC). CML has based the characterization factor on the RAINS model developed by the University of Amsterdam.
Eutrophication Potential (EP) (PO4 3- -eq)	Eutrophication is the build-up of a concentration of chemical nutrients in an ecosystem which leads to abnormal productivity. This causes excessive plant growth like algae in rivers which causes severe reductions in water quality and animal populations. This category is based on the work of Heijungs, and is expressed using the reference unit, kg PO4 3- equivalents. Direct and indirect impacts of fertilizers are included in the method. The direct impacts are from production of the fertilizers and the indirect ones are calculated using the IPCC method to estimate emissions to water causing eutrophication.
Photochemical Ozone Creation/Smog Potential (POCP) (kg O3-eq)	Ozone is protective in the stratosphere, but on the ground-level, it is toxic to humans in high concentration. Photochemical ozone, also called ground-level ozone, is formed by the reaction of volatile organic compounds and nitrogen oxides in the presence of heat and sunlight. The impact category depends largely on the amounts of carbon monoxide (CO), Sulphur dioxide (SO2), nitrogen oxide (NO), ammonium and NMVOC (non-methane volatile organic compounds). Photochemical ozone creation potential (also known as summer smog) for emission of substances to air is calculated with the United Nations Economic Commission for 22 Europe (UNECE) trajectory model (including fate) and expressed using the reference unit, kg ethylene (C2H4) equivalent.
Abiotic Depletion Potential (ADPel and ADPff) (kg Sb-eq)	The main concern of this category is the health of humans and the ecosystem and how it is affected by the extraction of minerals and fossil fuels, which are inputs into the system. For each extraction of minerals and fossil fuels, the abiotic depletion factor is determined. This indicator is on a global scale and is based on the concentration reserves and rate of deaccumulation. The results are presented in units of the reference element strontium (i.e. Sb). For the purposes of this EPD, this impact category is split between mineral elements (i.e. ADPel) and fossil fuels (i.e. ADPff).
Inventory metrics	
Depletion of non-renewable material resources (NRM) (kg)	This indicator covers the cumulative life cycle consumption of non-renewable resources that are extracted from the ground but not including energy resources like coal, oil and natural gas. This indicator includes the consumption of metallic ores, aggregates, and other minerals. The units of measure are in terms of kilograms material extracted and utilized/wasted in the life cycle system considered.
Use of renewable material resources (RM) (kg)	This indicator covers the cumulative life cycle consumption of renewable resources that are extracted from nature like sustainably harvested biomass. The units of measure are in terms of kilograms material extracted and utilized/wasted in the life cycle system considered.
Depletion of non-renewable energy resources (NRE) (MJ HHV)	This indicator considers the cumulative life cycle consumption of non-renewable energy resources like oil, natural gas, and coal. The units of measure are in terms of Mega-Joules of energy resource extracted and utilized/wasted in the life cycle system considered.
Use of renewable primary energy (RE) (MJ HHV)	This indicator considers the cumulative life cycle extraction of renewable energy resources from nature like solar and wind energy as well as biomass for energy purposes. The units of measure are in terms of Mega-Joules of

	energy resource extracted and utilized/wasted in the life cycle system considered.
Total primary energy consumption (PEC) (MJ HHV)	This indicator is the summation of non-renewable and renewable energy extracted from nature, where the units of measure are in terms of Mega-Joules of energy resource extracted/utilized/wasted in the life cycle system considered.
Water Depletion Potential (WDP) (m3)	This indicator considers the cumulative life cycle consumption of water required to produced the declared functional unit of a given product. The units of measure are in cubic meters of water consumed.
Concrete batching water consumption (CBWC) (m3)	This indicator is defined as the direct water used in concrete mix batches. The units of measure are in cubic meters of water consumed.
Concrete washing water consumption (CWWC) (m3)	This indicator is defined as the direct washing water used at the facility. The units of measure are in cubic meters of wash water consumed.
Concrete hazardous waste (CHW) (kg)	This indicator considers the amount of hazardous waste waste generated at the concrete facility. The units of measure are in kilograms of waste generated.
Concrete non-hazardous waste (CNHW) (kg)	This indicator considers the direct amount of non-hazardous waste generated at the concrete facility. The units of measure are in kilograms of waste generated.

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.

- Renewable primary energy resources as energy (fuel);
- Renewable primary resources as material;
- Non-renewable primary resources as energy (fuel);
- Non-renewable primary resources as material;
- Secondary Materials;
- Renewable secondary fuels;
- Non-renewable secondary fuels;
- Recovered energy;
- Abiotic depletion potential for non-fossil mineral resources.
- Land use related impacts, for example on biodiversity and/or soil fertility;
- Toxicological aspects;
- Emissions from land use change [GWP 100 (land-use change)];
- Hazardous waste disposed;
- Non-hazardous waste disposed;
- High-level radioactive waste;
- Intermediate and low-level radioactive waste;
- Components for reuse;
- Materials for recycling;
- Materials for energy recovery;
- Recovered energy exported from the product system.

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.

All Declared Products

Table 12: **Total life cycle (across modules in scope) impact results for all declared products, assuming the geometric mean point values on a per 1 m3 of concrete basis.**

a) Midpoint Impact Categories:

Indicator/LCI Metric	AP	EP	GWP	ODP	PCOP	ADPe	ADPf
Unit	**moles of H+-Eq**	**kg N**	**kg CO2-Eq**	**kg CFC-11-Eq**	**kg NOx-Eq**	**kg Sb-Eq**	**MJ, net calorific value**
Minimum	253	0.329	262	1.03E-05	5.95	0.000951	878
Maximum	665	0.772	653	1.75E-05	15.7	0.00239	1640
Mean	387.5	0.473	379	1.24E-05	9.135	0.00138	1095
Median	426.77	0.516	423	1.32E-05	10.07	0.001542	1177.5
CCV150N2AD	253	0.329	262	1.03e-05	5.95	0.000951	878
CCV150N2BD	264	0.341	273	1.08e-05	6.22	0.000993	919
CE2200N2AD	286	0.365	291	1.08e-05	6.74	0.00106	931
CE2200N2BD	298	0.377	302	1.13e-05	7.01	0.0011	969
CE2200N2BB	298	0.377	302	1.13e-05	7.01	0.0011	969
CE1250N2AD	325	0.406	324	1.14e-05	7.66	0.00118	988
CE1250N2BD	331	0.413	331	1.18e-05	7.8	0.00121	1020
CE1250N2BB	331	0.413	331	1.18e-05	7.8	0.00121	1020
CE1300N2BD	392	0.478	384	1.26e-05	9.24	0.0014	1120
CE1250N1BB	370	0.454	365	1.24e-05	8.72	0.00133	1090
CUR20032AD	397	0.484	388	1.26e-05	9.38	0.00142	1140
CUR25072AD	397	0.484	387	1.24e-05	9.37	0.00141	1100
CUR25072BB	408	0.496	398	1.29e-05	9.64	0.00145	1140
CMR035N4AD	303	0.382	305	1.1e-05	7.14	0.00111	944
CMR040N4AD	342	0.424	338	1.15e-05	8.06	0.00123	997
CMR042N4AD	358	0.442	353	1.18e-05	8.45	0.00128	1020
CMR045N4AD	383	0.468	374	1.21e-05	9.03	0.00136	1060
C80350S2CD	526	0.622	521	1.46e-05	12.4	0.0019	1320
C80350S1CD	576	0.676	569	1.57e-05	13.6	0.00207	1430
C80350S10D	576	0.676	569	1.57e-05	13.6	0.00207	1430
C80400S2CD	559	0.658	552	1.52e-05	13.2	0.00201	1380
C80400S1CD	609	0.712	598	1.61e-05	14.4	0.00218	1470
C80400S1ED	587	0.689	584	1.67e-05	13.9	0.00214	1540
C80450S1CD	642	0.747	629	1.65e-05	15.2	0.00229	1520
C80450S1ED	620	0.725	613	1.71e-05	14.7	0.00225	1580
C80500S1ED	665	0.772	653	1.75e-05	15.7	0.00239	1640

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	992	48.5	943	25.9	0.0034	5.9	60.3	0.00204	0.147	0.00009	0.0151	29.5
Maximum	1890	119	1770	50.6	0.00845	8.98	80.3	0.00332	0.22	0.00009	0.0151	29.5
Mean	1340.85	76.39	1259.73	35.51	0.00551	7.21	68.47	0.002557	0.193	0.00009	0.0151	29.5
Median	1250	70.1	1175	32.95	0.005135	7.3	66.4	0.002425	0.194	0.00009	0.0151	29.5
CCV150N2AD	992	48.5	943	25.9	0.0034	7.34	60.3	0.00204	0.189	9e-05	0.0151	29.5
CCV150N2BD	1040	50.7	985	27.1	0.00353	8.35	61.7	0.00213	0.194	9e-05	0.0151	29.5
CE2200N2AD	1050	54.8	995	27.6	0.00373	7.18	61.8	0.00213	0.189	9e-05	0.0151	29.5
CE2200N2BD	1100	56.5	1040	28.8	0.00396	8.04	63.1	0.00221	0.194	9e-05	0.0151	29.5
CE2200N2BB	1100	56.4	1040	28.8	0.00392	8.04	63.1	0.00221	0.194	9e-05	0.0151	29.5
CE1250N2AD	1100	56.4	1040	28.8	0.00392	8.04	63.1	0.00221	0.194	9e-05	0.0151	29.5
CE1250N2BD	1160	62.1	1090	30.5	0.00431	7.87	64.6	0.00231	0.194	9e-05	0.0151	29.5
CE1250N2BB	1160	62.4	1090	30.6	0.0045	7.87	64.6	0.00231	0.194	9e-05	0.0151	29.5
CE1300N2BD	1280	71.8	1190	33.6	0.00514	7.3	67.1	0.00246	0.194	9e-05	0.0151	29.5
CE1250N1BB	1240	68.4	1170	32.6	0.00484	7.75	66.4	0.00243	0.205	9e-05	0.0151	29.5
CUR20032AD	1290	72.8	1220	34.2	0.00517	6.42	66.8	0.00245	0.184	9e-05	0.0151	29.5
CUR25072AD	1260	72.1	1180	33.3	0.00519	6.2	66.4	0.00242	0.189	9e-05	0.0151	29.5
CUR25072BB	1310	74.1	1230	34.6	0.00537	7.3	67.9	0.00252	0.194	9e-05	0.0151	29.5
CMR035N4AD	1070	56.2	1010	28.1	0.00406	6.78	62.4	0.00217	0.189	9e-05	0.0151	29.5
CMR040N4AD	1140	62.7	1070	29.8	0.00457	6.28	63.8	0.00226	0.189	9e-05	0.0151	29.5
CMR042N4AD	1160	65.6	1100	30.8	0.0047	6.19	64.6	0.0023	0.189	9e-05	0.0151	29.5
CMR045N4AD	1210	68.3	1140	32	0.00513	6.07	65.7	0.00237	0.189	9e-05	0.0151	29.5
C80350S2CD	1520	91.9	1420	40.5	0.0067	5.92	72.2	0.00279	0.189	9e-05	0.0151	29.5

C80350S1CD	1640	102	1530	43.9	0.00733	6.77	75.3	0.00299	0.2	9e-05	0.0151	29.5
C80350S10D	1510	87.1	1420	40.4	0.00631	8.98	73.9	0.00292	0.147	9e-05	0.0151	29.5
C80400S2CD	1600	98.3	1490	42.5	0.00712	5.99	73.9	0.0029	0.189	9e-05	0.0151	29.5
C80400S1CD	1690	106	1580	45.6	0.00795	6.25	76.5	0.00306	0.2	9e-05	0.0151	29.5
C80400S1ED	1770	105	1660	47.1	0.00763	8.91	78	0.00318	0.21	9e-05	0.0151	29.5
C80450S1CD	1760	109	1640	47.1	0.00826	5.9	77.8	0.00314	0.2	9e-05	0.0151	29.5
C80450S1ED	1820	108	1710	48.5	0.00808	8.24	79	0.00324	0.21	9e-05	0.0151	29.5
C80500S1ED	1890	119	1770	50.6	0.00845	7.48	80.3	0.00332	0.22	9e-05	0.0151	29.5

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
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- 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.