

Environmental Product Declaration



Environmental Product Declaration for ready mix concrete products produced by Holcim Colombia at their Cali Sur facility in Cali, Colombia

ADMINISTRATIVE INFORMATION

International Certified Environmental Product Declaration

Declared Product:	This Environmental Product Declaration (EPD) covers concrete products produced by Holcim Colombia. Declared unit: 1 m3 of concrete
Declaration Owner:	Holcim Colombia
	7-45 Calle 13, Piso 12, Torre B, Ed. Teleport Business Park
	Bogotá, Colombia
	www.holcim.com.co
Program Operator:	Labeling Sustainability
	Address, 11670 W Sunset Blvd.
	City, State, Los Angeles, CA
	www.labelinsustainability.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 Rule (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)
Date of Issue:	05 April 2023
Period of Validity:	5 years; valid until 04 April 2028
EPD Number:	1f33e09d-55d0-458b-a519-32678cd05c2f





TABLE OF CONTENTS

Administrative Information 1

Company Description 3

Study Goal 3

Description Of Product And Scope 3

Ready Mix Concrete Design Summary 4

Ready Mix Concrete Design Composition 7

System Boundaries 7

Cut-Off Criteria 9

Data Sources And Data Quality Assessment 9

 Raw Material Transport..... 9

 Electricity:..... 9

 Process/Space Heating..... 9

 Fuel Required For Machinery..... 9

 Waste Generation 9

 Recovered Energy..... 9

 Recycled/Reused Material/Components..... 10

 Module A1 Material Losses..... 10

 Direct A3 Emissions Accounting 10

 Waste Transport Requirements..... 10

 Product Transport Requirements..... 10

Data Quality Assessment 11

Environmental Indicators And Inventory Metrics 12

Limitations 12

Total Impact Summary 13

Additional Environmental Info 21

References 28

 Astm Standards..... 28

 Csa Standards 29

 Iso Standards 30

 En Standards 30

 Other References: 30



COMPANY DESCRIPTION

Holcim Colombia, as part of Grupo Holcim, a world leader in innovative and sustainable solutions for construction, is making it possible to have greener cities, smarter infrastructures and improve the standard of living of people around the world. With sustainability at the heart of its strategy, Holcim is becoming a Net Zero company, where its people and communities are the foundation of its success. The company is driving circular construction as a world leader in recycling to build more with less.

Holcim Colombia produces and markets cement, ready-mix concrete, aggregates (gravel and sand) and other products and solutions for construction. Additionally, it offers the GacoFlex TechoProtec waterproofing line and the Tector family of adhesives and mortars. The company has a team passionate about building progress for people and the planet. It has a national presence through 1 cement plant, 10 ready-mix concrete plants, 1 Geocycle platform, 1 aggregates plant, its own network of hardware stores, Disensa, with more than 400 stores nationwide; and offers specialized services for transporting materials or products through Transcem.

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 Colombia 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 Colombia 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 Colombia's license to operate in the community. The intended audience for this LCA report is Holcim Colombia's employees, their suppliers, project specifiers of their products, architects, and engineers. The EPD report is also available for policy makers, government officials interested in sustainability, academic professors, and LCA professionals. This LCA report does not include product comparisons from other facilities.

DESCRIPTION OF PRODUCT AND SCOPE

This EPD reports on 47 concrete mixes manufactured at the Holcim Colombia, Cali Sur concrete facility in Cali, Colombia.



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.

Mix Designs: 0 to 15MPa

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	10062910	3 MPa 28d strength ready mix concrete.	Ready Mix Concrete	3.0	1.111111
2	10062185	3 MPa 28d strength ready mix concrete.	Ready Mix Concrete	3.0	0.909091
3	10046643	3.5 MPa 28d strength ready mix concrete.	Ready Mix Concrete	3.5	0.491803
4	10010936	3.6 MPa 28d strength ready mix concrete.	Ready Mix Concrete	3.6	0.555556
5	10010937	3.8 MPa 28d strength ready mix concrete.	Ready Mix Concrete	3.8	0.447761
6	10063986	3.8 MPa 28d strength ready mix concrete.	Ready Mix Concrete	3.8	0.394737
7	10017091	3.8 MPa 28d strength ready mix concrete.	Ready Mix Concrete	3.8	0.348837
8	10010939	3.9 MPa 28d strength ready mix concrete.	Ready Mix Concrete	3.9	0.434783
9	10061660	3.9 MPa 28d strength ready mix concrete.	Ready Mix Concrete	3.9	0.385542
10	10019751	4 MPa 28d strength ready mix concrete.	Ready Mix Concrete	4.0	0.422535
11	10044700	4 MPa 28d strength ready mix concrete.	Ready Mix Concrete	4.0	0.351648
12	10010938	4.1 MPa 28d strength ready mix concrete.	Ready Mix Concrete	4.1	0.410959
13	10010941	4.2 MPa 28d strength ready mix concrete.	Ready Mix Concrete	4.2	0.400000
14	10011176	4.2 MPa 28d strength ready mix concrete.	Ready Mix Concrete	4.2	0.326087
15	10010944	4.5 MPa 28d strength ready mix concrete.	Ready Mix Concrete	4.5	0.370370
16	10021060	4.5 MPa 28d strength ready mix concrete.	Ready Mix Concrete	4.5	0.309278



17	10068394	10.5 MPa 28d strength ready mix concrete.	Ready Mix Concrete	10.5	0.795455
18	10010709	14 MPa 28d strength ready mix concrete.	Ready Mix Concrete	14.0	0.686275
19	10060409	14 MPa 28d strength ready mix concrete.	Ready Mix Concrete	14.0	0.641791

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
0	10064969	15 MPa 28d strength ready mix concrete.	Ready Mix Concrete	15.0	0.605634
21	10010860	17.5 MPa 28d strength ready mix concrete.	Ready Mix Concrete	17.5	0.603448
22	10065280	17.5 MPa 28d strength ready mix concrete.	Ready Mix Concrete	17.5	0.589041

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
23	10010727	21 MPa 28d strength ready mix concrete.	Ready Mix Concrete	21.0	0.538462
24	10059024	21 MPa 28d strength ready mix concrete.	Ready Mix Concrete	21.0	0.540541
25	10048503	21 MPa 28d strength ready mix concrete.	Ready Mix Concrete	21.0	0.500000
26	10010762	21 MPa 28d strength ready mix concrete.	Ready Mix Concrete	21.0	0.430000
27	10010739	24.5 MPa 28d strength ready mix concrete.	Ready Mix Concrete	24.5	0.514706
28	10065524	24.5 MPa 28d strength ready mix concrete.	Ready Mix Concrete	24.5	0.493333
29	10071405	24.5 MPa 28d strength ready mix concrete.	Ready Mix Concrete	24.5	0.476744
30	10010772	24.5 MPa 28d strength ready mix concrete.	Ready Mix Concrete	24.5	0.387387



Mix Designs: 26 to 30 MPa

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

Mix#	Unique name/ID	Short description	Product type	28 day strength, MPa	H ₂ O to cement ratio
31	10010871	28 MPa 28d strength ready mix concrete.	Ready Mix Concrete	28	0.493333
32	10011040	28 MPa 28d strength ready mix concrete.	Ready Mix Concrete	28	0.493976
33	10073583	28 MPa 28d strength ready mix concrete.	Ready Mix Concrete	28	0.402174
34	10010779	28 MPa 28d strength ready mix concrete.	Ready Mix Concrete	28	0.361345

Mix Designs: 31 to 35 MPa

Table 5: Declared products with Mix designs: 31 to 35 MPa considered in this environmental product declaration

Mix#	Unique name/ID	Short description	Product type	28 day strength, MPa	H ₂ O to cement ratio
35	10010968	31.5 MPa 28d strength ready mix concrete.	Ready Mix Concrete	31.5	0.443038
36	10064968	31.5 MPa 28d strength ready mix concrete.	Ready Mix Concrete	31.5	0.420455
37	10065426	31.5 MPa 28d strength ready mix concrete.	Ready Mix Concrete	31.5	0.412371
38	10062421	35 MPa 28d strength ready mix concrete.	Ready Mix Concrete	35.0	0.425287
39	10062634	35 MPa 28d strength ready mix concrete.	Ready Mix Concrete	35.0	0.364583
40	10064962	35 MPa 28d strength ready mix concrete.	Ready Mix Concrete	35.0	0.398148
41	10062539	35 MPa 28d strength ready mix concrete.	Ready Mix Concrete	35.0	0.336066
42	10058176	35 MPa 28d strength ready mix concrete.	Ready Mix Concrete	35.0	0.211679

Mix Designs: 41 to 45 MPa

Table 6: Declared products with Mix designs: 41 to 45 MPa considered in this environmental product declaration

Mix#	Unique name/ID	Short description	Product type	28 day strength, MPa	H ₂ O to cement ratio
43	10010925	42 MPa 28d strength ready mix concrete.	Ready Mix Concrete	42	0.343137





44	10071858	42 MPa 28d strength ready mix concrete.	Ready Mix Concrete	42	0.345133
45	10070074	42 MPa 28d strength ready mix concrete.	Ready Mix Concrete	42	0.202797

Mix Designs: 46 to 50 MPa

Table 7: Declared products with Mix designs: 46 to 50 MPa considered in this environmental product declaration

Mix#	Unique name/ID	Short description	Product type	28 day strength, MPa	H2O to cement ratio
46	10045182	49 MPa 28d strength ready mix concrete.	Ready Mix Concrete	49	0.37069

Mix Designs: 56 to 60 MPa

Table 8: Declared products with Mix designs: 56 to 60 MPa considered in this environmental product declaration

Mix#	Unique name/ID	Short description	Product type	28 day strength, MPa	H2O to cement ratio
47	10050520	56 MPa 28d strength ready mix concrete.	Ready Mix Concrete	56	0.358333

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 9: Ready mix concrete 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

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

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

<p>Raw Material Supply (A1)</p> <p>Cements & SCMs Aggregates Admixtures Batch Water Fibers & Pigments</p>	<p>Transport (A2)</p> <p>Truck, Rail, Ship Energy Carriers (fuels)</p>	<p>Manufacturing (A3)</p> <p>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</p>
--	---	---

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 Colombia, is located at their Cali Sur facility in Colombia. All operating data is formulated using the actual data from Holcim Colombia'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 Colombia 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 Colombia in calendar year 2021. These values were direct reported from Colombia records. The unit process "market for electricity, medium voltage/electricity, medium voltage/CO/kWh" was used to represent the Colombia 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. This plant does not have electricity therefore it uses diesel to power generators.

Waste generation: Waste generation values are directly reported from Holcim operations for 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 Colombia for 2021.

Recovered energy: Not applicable.



Recycled/reused material/components: The amount of returned concrete is based on Holcim primary data for the reference year, 2021.

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

Direct A3 emissions accounting: Direct emissions for the on-site machinery use the actual fuel consumption and the ecoinvent database to calculate those emissions.

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 2021.

Product transport requirements: The diesel fuel used by the mixing trucks is direct primary information reported from Holcim Colombia records for the year 2021. Holcim records their fuel for their trucks in L/km and therefore the information was converted with the following formula: $(\text{Ave. km to site})^2 \text{ for return L diesel/km} / (\text{ave. m}^3 \text{ of concrete in a load}) \text{ total concrete volume in m}^3 \cdot \text{fraction allocated to A3}$. A4 is outside the scope of this study.

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 10: 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 treatment/tap water/RoW/kg	ecoinvent v3.8	Valle del Cauca	v3.8 in 2021	2	3	2	3	3
Additives	market for chemical, organic/chemical, organic/GLO/kg	ecoinvent v3.8	Cundinamarca	v3.8 in 2021	2	3	2	3	3
Cement	HE Cement	Progam Operator: Labeling Sustainability- EPD ID: 6328e320-6cab-4d85-83f4-dca33374d11b	Boyacá	06 January 2023	3	3	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	Cauca	v3.8 in 2021	2	3	2	3	3
Gravel	gravel production, crushed/gravel, crushed/BR/kg; Note: modifications made (see ecoinvent activity changes table)	ecoinvent v3.8	Valle del Cauca	v3.8 in 2021	2	3	2	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 Cement 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 2021-01-01 to 2021-12-31.
- 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 cement facility on a per 1m³ of concrete basis.

Mix Designs: 0 to 15 MPa

Table 11: 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	ADP _f
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	33.7	0.141	231	2.18e-05	0.51	0.000907	1520
Maximum	78.9	0.212	538	5.1e-05	1.15	0.00232	3590
Mean	61.2	0.183	402	3.82e-05	0.901	0.00171	2690
Median	63.5	0.186	409	3.89e-05	0.937	0.00175	2740
10062910	33.7	0.141	231	2.18e-05	0.51	0.000907	1520
10062185	38.8	0.149	271	2.56e-05	0.582	0.00109	1790
10046643	57.4	0.176	360	3.42e-05	0.853	0.00152	2410
10010936	57.5	0.177	369	3.49e-05	0.851	0.00156	2460
10010937	61.3	0.182	389	3.7e-05	0.907	0.00166	2600
10063986	65.6	0.19	434	4.12e-05	0.964	0.00185	2900
10017091	72.6	0.201	483	4.59e-05	1.06	0.00208	3230
10010939	61.7	0.184	399	3.79e-05	0.911	0.0017	2670
10061660	69.8	0.197	468	4.44e-05	1.02	0.00201	3120
10019751	63.5	0.186	409	3.89e-05	0.937	0.00175	2740
10044700	76	0.207	508	4.82e-05	1.11	0.0022	3390
10010938	64.1	0.187	419	3.98e-05	0.943	0.00179	2800
10010941	66.1	0.19	429	4.07e-05	0.972	0.00184	2870
10011176	76.9	0.208	513	4.87e-05	1.12	0.00222	3430
10010944	69.9	0.197	459	4.36e-05	1.02	0.00197	3070
10021060	78.9	0.212	538	5.1e-05	1.15	0.00232	3590
10068394	44	0.155	274	2.6e-05	0.663	0.00112	1830
10010709	49.1	0.163	309	2.93e-05	0.734	0.00129	2060
10060409	55.4	0.175	385	3.62e-05	0.813	0.00162	2550



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	1710	87.7	1610	41.8	0.00723	6.22	113	0.00263	0.158	6.98e-05	0.011	54.8
Maximum	4040	219	3830	98.4	0.00179	13.8	194	0.00559	0.226	6.98e-05	0.011	54.8
Mean	3030	165	2860	73.6	0.00134	8.22	159	0.00432	0.172	6.98e-05	0.011	54.8
Median	3090	170	2920	75.2	0.00135	7.55	162	0.00441	0.158	6.98e-05	0.011	54.8
10062910	1710	87.7	1610	41.8	0.00723	13.8	113	0.00263	0.21	6.98e-05	0.011	54.8
10062185	2010	104	1910	49	0.00873	13.8	124	0.00302	0.21	6.98e-05	0.011	54.8
10046643	2710	149	2540	65.9	0.00122	7.27	149	0.00395	0.158	6.98e-05	0.011	54.8
10010936	2770	152	2620	67.6	0.00125	7.6	151	0.00401	0.184	6.98e-05	0.011	54.8
10010937	2940	162	2780	71.5	0.00132	6.97	157	0.00422	0.158	6.98e-05	0.011	54.8
10063986	3250	179	3080	79.6	0.00144	8.01	168	0.00463	0.158	6.98e-05	0.011	54.8
10017091	3640	201	3450	88.7	0.00159	6.97	180	0.00509	0.158	6.98e-05	0.011	54.8
10010939	3010	164	2850	72.9	0.00135	7.74	159	0.00431	0.158	6.98e-05	0.011	54.8
10061660	3530	192	3310	85.6	0.00158	7.69	176	0.00494	0.168	6.98e-05	0.011	54.8
10019751	3090	170	2920	75.2	0.00135	7.12	162	0.00441	0.158	6.98e-05	0.011	54.8
10044700	3820	209	3640	92.7	0.00169	6.22	187	0.00532	0.168	6.98e-05	0.011	54.8
10010938	3160	171	2990	76.3	0.00146	7.55	164	0.00449	0.158	6.98e-05	0.011	54.8
10010941	3230	177	3060	78.6	0.00143	6.97	167	0.00459	0.158	6.98e-05	0.011	54.8
10011176	3870	211	3650	93.9	0.00172	6.29	188	0.00539	0.158	6.98e-05	0.011	54.8
10010944	3460	189	3270	84.3	0.00151	6.79	174	0.00488	0.158	6.98e-05	0.011	54.8
10021060	4040	219	3830	98.4	0.00179	7.24	194	0.00559	0.158	6.98e-05	0.011	54.8
10068394	2050	111	1940	50.1	0.00933	9.7	126	0.00311	0.184	6.98e-05	0.011	54.8
10010709	2320	126	2200	56.6	0.00105	8.81	135	0.00344	0.184	6.98e-05	0.011	54.8



10060409	2870	152	2710	69.9	0.00127	9.6	154	0.00407	0.226	6.98e-05	0.011	54.8
----------	------	-----	------	------	---------	-----	-----	---------	-------	----------	-------	------

Mix Designs: 15 to 20 MPa

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 CO ₂ -Eq	kg CFC-11-Eq	kg NO _x -Eq	kg Sb-Eq	MJ, net calorific value
Minimum	52.8	0.17	343	3.25e-05	0.784	0.00144	2290
Maximum	57.3	0.179	415	3.91e-05	0.836	0.00174	2750
Mean	55.3	0.175	388	3.66e-05	0.811	0.00162	2570
Median	55.7	0.177	405	3.82e-05	0.814	0.00169	2680
10064969	55.7	0.177	405	3.82e-05	0.814	0.00169	2680
10010860	52.8	0.17	343	3.25e-05	0.784	0.00144	2290
10065280	57.3	0.179	415	3.91e-05	0.836	0.00174	2750

b) Inventory Metrics:

Indicator/LCI Metric	TPE	RE	NRE	NRR	RR	WDP	LFW	LFH W	CBW C	CW WC	CHW	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	2580	139	2430	62.6	0.00115	9.26	144	0.00375	0.184	6.98e-05	0.011	54.8
Maximum	3090	163	2930	75.2	0.00129	12.6	161	0.00435	0.226	6.98e-05	0.011	54.8
Mean	2890	154	2740	70.3	0.00124	11.4	154	0.00412	0.212	6.98e-05	0.011	54.8
Median	3010	160	2850	73.2	0.00127	12.2	158	0.00425	0.226	6.98e-05	0.011	54.8
10064969	3010	160	2850	73.2	0.00127	12.6	158	0.00425	0.226	6.98e-05	0.011	54.8
10010860	2580	139	2430	62.6	0.00115	9.26	144	0.00375	0.184	6.98e-05	0.011	54.8
10065280	3090	163	2930	75.2	0.00129	12.2	161	0.00435	0.226	6.98e-05	0.011	54.8



Mix Designs: 21 to 25 MPa

Table 13: 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 CO ₂ -Eq	kg CFC-11-Eq	kg NO _x -Eq	kg Sb-Eq	MJ, net calorific value
Minimum	57.1	0.177	378	3.58e-05	0.843	0.00159	2520
Maximum	86.8	0.225	605	5.73e-05	1.25	0.00263	4030
Mean	68.4	0.195	465	4.4e-05	0.998	0.00199	3090
Median	65.4	0.19	444	4.19e-05	0.956	0.0019	2940
10010727	57.1	0.177	378	3.58e-05	0.843	0.00159	2520
10059024	62.5	0.186	422	3.99e-05	0.916	0.00179	2810
10048503	67.5	0.194	461	4.35e-05	0.984	0.00197	3060
10010762	79.7	0.213	551	5.2e-05	1.15	0.00238	3660
10010739	58.9	0.18	393	3.72e-05	0.868	0.00166	2620
10065524	63.4	0.187	426	4.03e-05	0.929	0.00182	2830
10071405	71.7	0.2	482	4.56e-05	1.04	0.00207	3210
10010772	86.8	0.225	605	5.73e-05	1.25	0.00263	4030

b) Inventory Metrics:

Indicator/LCI Metric	TPE	RE	NRE	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	2840	153	2680	68.8	0.00125	5.77	153	0.00408	0.184	6.98e-05	0.011	54.8
Maximum	4550	246	4300	110	0.00203	9.13	211	0.00618	0.226	6.98e-05	0.011	54.8
Mean	3480	189	3290	84.7	0.00155	7.36	175	0.00487	0.207	6.98e-05	0.011	54.8
Median	3320	180	3140	80.8	0.00147	7.12	170	0.00465	0.212	6.98e-05	0.011	54.8
10010727	2840	153	2680	68.8	0.00125	9.13	153	0.00408	0.184	6.98e-05	0.011	54.8
10059024	3170	172	2980	76.9	0.00142	8.15	164	0.00446	0.21	6.98e-05	0.011	54.8
10048503	3450	188	3260	83.8	0.00152	6.96	174	0.00481	0.215	6.98e-05	0.011	54.8
10010762	4120	224	3900	100	0.00184	6.27	197	0.00566	0.226	6.98e-05	0.011	54.8
10010739	2940	159	2790	71.8	0.00131	9.08	157	0.00421	0.184	6.98e-05	0.011	54.8
10065524	3190	172	3010	77.9	0.00142	7.29	165	0.0045	0.194	6.98e-05	0.011	54.8



10071405	361 0	197	342 0	88.1	0.0015 9	6.21	180	0.0050 4	0.215	6.98e- 05	0.01 1	54.8
10010772	455 0	24 6	430 0	110	0.0020 3	5.77	211	0.0061 8	0.226	6.98e- 05	0.01 1	54.8

Mix Designs: 26 to 30 MPa

Table 14: 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 CO ₂ -Eq	kg CFC-11-Eq	kg NO _x -Eq	kg Sb-Eq	MJ, net calorific value
Minimum	63	0.187	427	4.04e-05	0.923	0.00182	2840
Maximum	92.3	0.233	645	6.1e-05	1.33	0.00281	4290
Mean	74.3	0.205	512	4.84e-05	1.08	0.00221	3410
Median	71	0.2	488	4.62e-05	1.03	0.0021	3250
10010871	63	0.187	427	4.04e-05	0.923	0.00182	2840
10011040	68.2	0.195	466	4.41e-05	0.994	0.002	3100
10073583	73.8	0.204	511	4.83e-05	1.07	0.0022	3400
10010779	92.3	0.233	645	6.1e-05	1.33	0.00281	4290

b) Inventory Metrics:

Indicator/LCI Metric	TPE	RE	NRE	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	319 0	174	304 0	77.7	0.0014 1	4.98	165	0.0045 2	0.194	6.98e- 05	0.01 1	54.8
Maximum	485 0	26 3	458 0	118	0.0021	8.86	221	0.0065 5	0.226	6.98e- 05	0.01 1	54.8
Mean	384 0	20 9	363 0	93.5	0.0016 7	7.21	187	0.0053 1	0.207	6.98e- 05	0.01 1	54.8
Median	366 0	20 0	346 0	89. 2	0.0015 9	7.49	181	0.0050 8	0.205	6.98e- 05	0.01 1	54.8
10010871	319 0	174	304 0	77.7	0.0014 1	8.86	165	0.0045 2	0.194	6.98e- 05	0.01 1	54.8
10011040	350 0	191	330 0	85.1	0.0014 9	7.72	175	0.0048 7	0.215	6.98e- 05	0.01 1	54.8
10073583	383 0	20 9	361 0	93.3	0.0016 9	7.27	187	0.0052 9	0.194	6.98e- 05	0.01 1	54.8
10010779	485 0	26 3	458 0	118	0.0021	4.98	221	0.0065 5	0.226	6.98e- 05	0.01 1	54.8



Mix Designs: 31 to 35 MPa

Table 15: 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 CO ₂ -Eq	kg CFC-11-Eq	kg NO _x -Eq	kg Sb-Eq	MJ, net calorific value
Minimum	65.7	0.191	447	4.24e-05	0.961	0.00191	2980
Maximum	103	0.251	734	6.95e-05	1.47	0.00321	4890
Mean	79.3	0.213	559	5.29e-05	1.15	0.00241	3720
Median	76.6	0.209	534	5.04e-05	1.1	0.0023	3540
10010968	65.7	0.191	447	4.24e-05	0.961	0.00191	2980
10064968	71.1	0.2	491	4.63e-05	1.03	0.00211	3260
10065426	76.9	0.209	536	5.06e-05	1.11	0.00231	3560
10062421	71.3	0.2	487	4.61e-05	1.04	0.00209	3240
10062634	76.7	0.209	531	5.02e-05	1.11	0.00229	3530
10064962	76.5	0.212	587	5.55e-05	1.1	0.0025	3890
10062539	93.3	0.235	660	6.24e-05	1.34	0.00288	4390
10058176	103	0.251	734	6.95e-05	1.47	0.00321	4890

b) Inventory Metrics:

Indicator/LCI Metric	TPE	RE	NRE	NRR	RR	WDP	LFW	LFH W	CBW C	CW WC	CHW	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	3360	181	3160	81.9	0.00148	5.85	170	0.00472	0.152	6.98e-05	0.011	54.8
Maximum	5500	300	5210	134	0.0024	14.6	243	0.00739	0.226	6.98e-05	0.011	54.8
Mean	4190	226	3950	102	0.00182	8.06	198	0.00574	0.195	6.98e-05	0.011	54.8
Median	4000	218	3770	97.4	0.00176	7.46	192	0.0055	0.194	6.98e-05	0.011	54.8
10010968	3360	181	3160	81.9	0.00148	8.9	170	0.00472	0.184	6.98e-05	0.011	54.8
10064968	3680	199	3470	89.1	0.00161	7.39	181	0.00509	0.194	6.98e-05	0.011	54.8
10065426	4010	218	3790	97.9	0.00172	7.54	193	0.00552	0.21	6.98e-05	0.011	54.8
10062421	3650	199	3440	89	0.00157	7.57	181	0.00509	0.194	6.98e-05	0.011	54.8
10062634	3980	217	3750	97	0.00179	6.76	192	0.00548	0.184	6.98e-05	0.011	54.8
10064962	4390	229	4140	107	0.0019	14.6	203	0.00594	0.226	6.98e-05	0.011	54.8



10062539	4950	268	4670	121	0.00207	5.9	225	0.00669	0.215	6.98e-05	0.011	54.8
10058176	5500	300	5210	134	0.0024	5.85	243	0.00739	0.152	6.98e-05	0.011	54.8

Mix Designs: 41 to 45 MPa

Table 16: 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 CO ₂ -Eq	kg CFC-11-Eq	kg NO _x -Eq	kg Sb-Eq	MJ, net calorific value
Minimum	80.6	0.215	561	5.32e-05	1.17	0.00242	3740
Maximum	106	0.257	764	7.23e-05	1.52	0.00334	5090
Mean	91	0.232	647	6.12e-05	1.31	0.00281	4310
Median	86.3	0.225	615	5.81e-05	1.24	0.00266	4090
10010925	80.6	0.215	561	5.32e-05	1.17	0.00242	3740
10071858	86.3	0.225	615	5.81e-05	1.24	0.00266	4090
10070074	106	0.257	764	7.23e-05	1.52	0.00334	5090

b) Inventory Metrics:

Indicator/LCI Metric	TPE	RE	NRE	NRR	RR	WDP	LFW	LFH W	CBW C	CW WC	CHW	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	4230	229	3980	102	0.00188	5.72	199	0.00578	0.152	6.98e-05	0.011	54.8
Maximum	5750	311	5390	139	0.00246	7.75	251	0.00766	0.205	6.98e-05	0.011	54.8
Mean	4860	263	4570	118	0.00211	7.06	221	0.00657	0.18	6.98e-05	0.011	54.8
Median	4610	248	4350	112	0.002	7.72	213	0.00626	0.184	6.98e-05	0.011	54.8
10010925	4230	229	3980	102	0.00188	7.72	199	0.00578	0.184	6.98e-05	0.011	54.8
10071858	4610	248	4350	112	0.002	7.75	213	0.00626	0.205	6.98e-05	0.011	54.8
10070074	5750	311	5390	139	0.00246	5.72	251	0.00766	0.152	6.98e-05	0.011	54.8



Mix Designs: 46 to 50 MPa

Table 17: 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 CO ₂ -Eq	kg CFC-11-Eq	kg NO _x -Eq	kg Sb-Eq	MJ, net calorific value
10045182	88.5	0.228	629	5.95e-05	1.27	0.00273	4180

b) Inventory Metrics:

Indicator/LCI Metric	TPE	RE	NRE	NRR	RR	WDP	LFW	LFH W	CBW C	CW WC	CHW	CNH W
Unit	MJ-Eq	MJ-Eq	MJ-Eq	kg	m ³	m ³	kg waste	kg waste	m ³	m ³	kg	kg
10045182	4730	255	4480	115	0.00204	6.75	216	0.00638	0.226	6.98e-05	0.011	54.8

Mix Designs: 56 to 60 MPa

Table 18: 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 CO ₂ -Eq	kg CFC-11-Eq	kg NO _x -Eq	kg Sb-Eq	MJ, net calorific value
10050520	91.2	0.232	649	6.14e-05	1.31	0.00282	4320

b) Inventory Metrics:

Indicator/LCI Metric	TPE	RE	NRE	NRR	RR	WDP	LFW	LFH W	CBW C	CW WC	CHW	CNH W
Unit	MJ-Eq	MJ-Eq	MJ-Eq	kg	m ³	m ³	kg waste	kg waste	m ³	m ³	kg	kg
10050520	4870	264	4600	119	0.00215	6.53	222	0.00657	0.226	6.98e-05	0.011	54.8



ADDITIONAL ENVIRONMENTAL INFO

No regulated substances of very high concern are utilized on site.

The PCR allows for the grouping of similar products. Examples of grouping for concrete products include performance categories of compressive strength and high early strength, material characteristics of lightweight concrete, and production categories of ready-mix and central mix. Alternately, if a single value is chosen for each impact category for all products, the value reported should be the highest impact within the range of variation; therefore, the EPD would report the highest single value for each impact category amongst all of the products or plants included in the average EPD analysis." (PCR for Concrete v2.1)

All the ready-mix concrete products manufactured at the plant are listed below. A complete LCA with resulting impacts for the study was performed on all highlighted mixes. The non-highlighted mixes listed below are grouped by characteristics and then the amount of cement. The highest value for the GWP for each mix that was not part of the LCA but is within the 10% range is taken from the LCA mix as part of the study. The table outlines the GWP for all mixes produced at this plant as allowed by the PCR.

Table 19: **Mix Designs 0 to 15 MPa**

Mix	GWP	MPa
10062910	231	3
10062185	271	3
10046643	360	3,5
10067104	360	3,5
10067800	360	3,5
10010936	369	3,6
10047474	369	3,6
10017091	483	3,8
10063985	483	3,8
10063986	483	3,8
10010937	389	3,8
10020425	389	3,8
10062694	389	3,8
10061660	468	3,8
10010939	399	3,8
10049091	399	3,8
10058640	399	3,8
10044700	508	4
10019751	409	4
10062693	409	4
10010938	419	4
10054155	419	4
10059213	419	4
10060267	419	4
10010941	429	4,2



10044313	429	4,2
10056691	429	4,2
10057503	429	4,2
10061225	429	4,2
10074061	429	4,2
10074604	429	4,2
10011183	513	4,2
10060332	513	4,2
10062105	513	4,2
10011176	513	4,2
10045017	513	4,2
10074092	513	4,2
10044884	538	4,5
10021060	538	4,5
10010944	459	4,5
10075465	459	4,5
10067103	274	10,5
10068394	274	10,5
10071859	274	10,5
10010704	274	10,5
10010705	274	10,5
10010706	274	10,5
10071893	274	10,5
10074490	274	10,5

Table 20: Mix Designs 16 to 20 MPa

Mix	GWP	MPa
10075121	385	14
10020592	385	14
10068491	385	14
10068492	385	14
10053402	385	14
10010709	385	14
10060409	385	14
10064969	405	15
10010860	343	17,5
10010715	343	17,5
10062987	343	17,5
10065280	415	17,5



Table 21: Mix Designs 21 to 25 MPa

Mix	GWP	MPa
10010727	378	21
10062631	378	21
10062632	378	21
10056414	378	21
10012656	378	21
10062863	378	21
10062912	378	21
10069650	378	21
10063783	378	21
10049027	378	21
10049181	378	21
10019065	378	21
10073561	378	21
10010762	378	21
10073679	378	21
10010764	378	21
10010767	378	21
10027310	378	21
10048503	378	21
10049022	378	21
10010768	378	21
10032855	378	21
10062757	378	21
10010769	378	21
10074746	378	21
10062538	378	21
10010726	378	21
10031531	378	21
10050625	378	21
10056297	378	21
10060690	378	21
10061392	378	21
10062537	378	21
10062636	378	21
10072369	378	21
10074160	378	21
10010691	378	21
10067710	378	21
10010692	378	21



10011482	378	21
10010790	378	21
10010701	378	21
10010857	378	21
10061282	426	24,5
10061283	426	24,5
10064086	426	24,5
10064185	426	24,5
10056101	426	24,5
10010772	426	24,5
10062753	426	24,5
10018570	426	24,5
10071405	482	24,5
10023233	482	24,5
10058072	482	24,5
10058420	482	24,5
10065524	426	24,5
10070320	426	24,5
10010739	426	24,5
10010922	426	24,5
10058537	426	24,5
10067515	426	24,5
10072373	426	24,5
10010730	426	24,5
10010731	426	24,5
10010732	426	24,5
10010733	426	24,5
10010734	426	24,5
10010736	426	24,5
10070036	426	24,5
10070064	426	24,5
10022314	426	24,5
10010702	426	24,5

Table 22: Mix Designs 26 to 30 MPa

Mix	GWP	MPa
10054017	511	28
10060781	511	28
10062420	511	28
10062985	511	28
10064410	511	28



10050357	511	28
10062110	511	28
10073583	511	28
10073907	511	28
10062466	511	28
10064084	511	28
10064085	511	28
10033911	511	28
10013119	511	28
10048354	511	28
10063782	511	28
10049028	511	28
10010778	511	28
10046541	511	28
10067708	511	28
10069933	511	28
10010779	645	28
10062779	645	28
10047134	645	28
10060291	645	28
10010783	645	28
10071271	645	28
10067516	645	28
10012149	645	28
10028245	645	28
10034541	645	28
10055818	645	28
10061849	645	28
10062638	645	28
10068073	645	28
10072374	645	28
10073162	645	28
10010871	427	28
10010959	427	28
10035768	427	28
10048562	427	28
10062045	427	28
10072375	427	28
10010747	427	28
10056610	427	28
10061501	427	28
10068074	427	28
10071891	427	28



10072323	427	28
10072376	427	28
10010741	427	28
10010742	427	28
10010870	427	28
10062540	427	28
10010743	427	28
10010744	427	28
10010740	427	28
10010745	427	28
10055852	427	28
10019800	427	28
10071852	427	28
10071857	427	28
10061190	427	28
10061497	427	28
10071380	427	28
10062553	427	28
10010698	427	28
10074131	427	28
10068240	427	28
10011040	466	28
10010703	466	28
10064493	466	28

Table 23: Mix Designs 31 to 35 MPa

Mix	GWP	MPa
10064968	491	31,5
10057779	491	31,5
10074161	491	31,5
10010968	491	31,5
10010748	491	31,5
10011173	491	31,5
10010749	491	31,5
10065388	491	31,5
10071490	491	31,5
10010788	491	31,5
10062243	491	31,5
10065426	536	31,5
10062421	483	35
10010989	483	35
10072379	483	35



10075461	483	35
10010752	483	35
10072380	483	35
10072381	483	35
10010754	483	35
10062634	531	35
10061756	531	35
10053780	531	35
10046914	531	35
10064962	587	35
10049029	587	35
10035359	587	35
10061393	587	35
10033645	587	35
10028436	587	35
10071853	587	35
10071855	587	35
10047299	587	35
10066824	587	35
10011026	587	35
10062580	587	35
10062539	660	35
10058176	734	35
10069950	734	35
10010789	734	35

Table 24: Mix Designs 41 to 45 MPa

Mix	GWP	MPa
10061737	561	42
10071894	561	42
10072572	561	42
10010925	561	42
10064495	561	42
10071892	561	42
10024262	561	42
10065425	561	42
10047946	561	42
10049030	561	42
10071858	615	42
10065527	615	42
10071854	615	42
10065528	615	42



10071856	615	42
10065525	615	42
10065526	615	42
10070074	764	42

Table 25: **Mix Designs 46 to 50 MPa**

Mix	GWP	MPa
10045182	629	49
10064490	629	49
10051093	629	49
10072470	629	49
10067504	629	49
10067505	629	49

Table 26: **Mix Designs 56 to 60 MPa**

Mix	GWP	MPa
10050520	649	49
10068703	649	49

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>.

