

Environmental Product Declaration



Environmental Product Declaration for ready mix concrete products produced by Holcim Colombia at their Chia facility in Bogotá, 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 Rul (PCR) for Environmental Product Declarations (EPD) PCR for Concrete, v2.1
	Sub PCR Program Operator: NSF International
	Sub-category PCR review was conducted by: Thomas P. Gloria, Ph. D. of Industrial Ecology Consultants: 35 Bracebridge, Rd., Newton, MA 02459-1728, t.gloria@industrial-ecology.com . Dr. Michael Overcash of Environmental Clarity: 2908 Chipmunk Lane, Raleigh, NC 27607-3117, mrovercash@earthlink.net . Mr. Bill Stough of Sustainable Research Group: PO Box 1684, Grand Rapids, MI 49501-1684, bstough@sustainableresearchgroup.com . Mr. Jack Geilbig, EcoForm: 2624 Abelia Way, Suite 611, Knoxville, TN 37931, jgeilbig@ecoform.com .
Independent LCA Reviewer and EPD Verifier:	This EPD was independently verified in accordance with ISO 14025 and ISO 21930. The life cycle assessment was independently reviewed in accordance ISO 14044 and the referenced PCR.
	Independent verification of the declaration, according to ISO 14025:2006
	Internal <input type="checkbox"/> ; External X
	Third Party Verifier
	Geoffrey Guest, Certified 3rd Party Verifier under the International EPD Program (www.environdec.com), CSA Group (www.csaregistry.ca)
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COMPANY DESCRIPTION

Holcim 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 104 concrete mixes manufactured at the Holcim Colombia, Chia concrete facility in Bogotá, 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	10034328	1 MPa 28d strength ready mix concrete.	Ready Mix	1.0	2.388889
2	10061473	3 MPa 28d strength ready mix concrete.	Ready Mix	3.0	1.050821
3	10072302	3 MPa 28d strength ready mix concrete.	Ready Mix	3.0	0.277778
4	10052045	3.5 MPa 28d strength ready mix concrete.	Ready Mix	3.5	0.484394
5	10011182	3.6 MPa 28d strength ready mix concrete.	Ready Mix	3.6	0.532867
6	10045943	3.6 MPa 28d strength ready mix concrete.	Ready Mix	3.6	0.456686
7	10011185	3.8 MPa 28d strength ready mix concrete.	Ready Mix	3.8	0.431973
8	10072840	3.8 MPa 28d strength ready mix concrete.	Ready Mix	3.8	0.390244
9	10011186	3.9 MPa 28d strength ready mix concrete.	Ready Mix	3.9	0.484394
10	10068671	3.9 MPa 28d strength ready mix concrete.	Ready Mix	3.9	0.437890
11	10023331	4 MPa 28d strength ready mix concrete.	Ready Mix	4.0	0.492685
12	10053730	4 MPa 28d strength ready mix concrete.	Ready Mix	4.0	0.399529
13	10069920	4 MPa 28d strength ready mix concrete.	Ready Mix	4.0	0.309091
14	10048251	4.1 MPa 28d strength ready mix concrete.	Ready Mix	4.1	0.470118
15	10034538	4.1 MPa 28d strength ready mix concrete.	Ready Mix	4.1	0.426213
16	10045388	4.1 MPa 28d strength ready mix concrete.	Ready Mix	4.1	0.350596



17	10011211	4.2 MPa 28d strength ready mix concrete.	Ready Mix	4.2	0.431973
18	10051184	4.2 MPa 28d strength ready mix concrete.	Ready Mix	4.2	0.340000
19	10011451	4.3 MPa 28d strength ready mix concrete.	Ready Mix	4.3	0.431973
20	10011456	4.3 MPa 28d strength ready mix concrete.	Ready Mix	4.3	0.358239
21	10011455	4.3 MPa 28d strength ready mix concrete.	Ready Mix	4.3	0.304305
22	10011458	4.4 MPa 28d strength ready mix concrete.	Ready Mix	4.4	0.420579
23	10069092	4.5 MPa 28d strength ready mix concrete.	Ready Mix	4.5	0.434211
24	10025220	4.5 MPa 28d strength ready mix concrete.	Ready Mix	4.5	0.428119
25	10011459	4.5 MPa 28d strength ready mix concrete.	Ready Mix	4.5	0.343292
26	10042828	4.5 MPa 28d strength ready mix concrete.	Ready Mix	4.5	0.307963
27	10011468	5 MPa 28d strength ready mix concrete.	Ready Mix	5.0	0.350596
28	10033497	5 MPa 28d strength ready mix concrete.	Ready Mix	5.0	0.254098
29	10027896	7 MPa 28d strength ready mix concrete.	Ready Mix	7.0	1.277372
30	10012771	7 MPa 28d strength ready mix concrete.	Ready Mix	7.0	1.203210
31	10010823	7 MPa 28d strength ready mix concrete.	Ready Mix	7.0	1.044444
32	10011166	9 MPa 28d strength ready mix concrete.	Ready Mix	9.0	0.875000
33	10055953	10 MPa 28d strength ready mix concrete.	Ready Mix	10.0	1.029412
34	10048429	10.5 MPa 28d strength ready mix concrete.	Ready Mix	10.5	0.999526
35	10062285	10.5 MPa 28d strength ready mix concrete.	Ready Mix	10.5	0.885909
36	10012471	10.5 MPa 28d strength ready mix concrete.	Ready Mix	10.5	0.959184
37	10045441	10.5 MPa 28d strength ready mix concrete.	Ready Mix	10.5	0.758815
38	10061119	10.5 MPa 28d strength ready mix concrete.	Ready Mix	10.5	0.655279
39	10049804	12.5 MPa 28d strength ready mix concrete.	Ready Mix	12.5	0.759259
40	10011891	12.5 MPa 28d strength ready mix concrete.	Ready Mix	12.5	0.618571
41	10053315	12.5 MPa 28d strength ready mix concrete.	Ready Mix	12.5	0.577014
42	10072083	12.5 MPa 28d strength ready mix concrete.	Ready Mix	12.5	0.260870



43	10048440	14 MPa 28d strength ready mix concrete.	Ready Mix	14.0	0.883256
44	10048425	14 MPa 28d strength ready mix concrete.	Ready Mix	14.0	0.754653
45	10012342	14 MPa 28d strength ready mix concrete.	Ready Mix	14.0	0.777778
46	10011980	14 MPa 28d strength ready mix concrete.	Ready Mix	14.0	0.683333
47	10052795	14 MPa 28d strength ready mix concrete.	Ready Mix	14.0	0.593739

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
48	10055954	15 MPa 28d strength ready mix concrete.	Ready Mix	15.0	0.729167
49	10048445	17.5 MPa 28d strength ready mix concrete.	Ready Mix	17.5	0.803870
50	10059549	17.5 MPa 28d strength ready mix concrete.	Ready Mix	17.5	0.705412
51	10011469	17.5 MPa 28d strength ready mix concrete.	Ready Mix	17.5	0.648667
52	10034324	17.5 MPa 28d strength ready mix concrete.	Ready Mix	17.5	0.640156
53	10012141	17.5 MPa 28d strength ready mix concrete.	Ready Mix	17.5	0.519547
54	10052351	17.5 MPa 28d strength ready mix concrete.	Ready Mix	17.5	0.287956
55	10068682	20 MPa 28d strength ready mix concrete.	Ready Mix	20.0	0.373528

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
56	10059631	21 MPa 28d strength ready mix concrete.	Ready Mix	21.0	0.678792
57	10070130	21 MPa 28d strength ready mix concrete.	Ready Mix	21.0	0.592746
58	10056086	21 MPa 28d strength ready mix concrete.	Ready Mix	21.0	0.491846
59	10053034	21 MPa 28d strength ready mix concrete.	Ready Mix	21.0	0.586145



60	10052350	21 MPa 28d strength ready mix concrete.	Ready Mix	21.0	0.531190
61	10064388	21 MPa 28d strength ready mix concrete.	Ready Mix	21.0	0.488182
62	10068398	21 MPa 28d strength ready mix concrete.	Ready Mix	21.0	0.208226
63	10060130	24 MPa 28d strength ready mix concrete.	Ready Mix	24.0	0.506494
64	10059633	24.5 MPa 28d strength ready mix concrete.	Ready Mix	24.5	0.654073
65	10048450	24.5 MPa 28d strength ready mix concrete.	Ready Mix	24.5	0.573311
66	10051947	24.5 MPa 28d strength ready mix concrete.	Ready Mix	24.5	0.578190
67	10011150	24.5 MPa 28d strength ready mix concrete.	Ready Mix	24.5	0.456449
68	10010829	24.5 MPa 28d strength ready mix concrete.	Ready Mix	24.5	0.453023
69	10060300	24.5 MPa 28d strength ready mix concrete.	Ready Mix	24.5	0.428102
70	10068629	25 MPa 28d strength ready mix concrete.	Ready Mix	25.0	0.493039

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
71	10061628	27 MPa 28d strength ready mix concrete.	Ready Mix	27	0.415258
72	10059635	28 MPa 28d strength ready mix concrete.	Ready Mix	28	0.637483
73	10064494	28 MPa 28d strength ready mix concrete.	Ready Mix	28	0.577656
74	10067829	28 MPa 28d strength ready mix concrete.	Ready Mix	28	0.506592
75	10053913	28 MPa 28d strength ready mix concrete.	Ready Mix	28	0.531190
76	10067133	28 MPa 28d strength ready mix concrete.	Ready Mix	28	0.413333
77	10054547	28 MPa 28d strength ready mix concrete.	Ready Mix	28	0.395375
78	10067149	28 MPa 28d strength ready mix concrete.	Ready Mix	28	0.347170



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
79	10059679	31 MPa 28d strength ready mix concrete.	Ready Mix	31.0	0.443975
80	10059820	31 MPa 28d strength ready mix concrete.	Ready Mix	31.0	0.423778
81	10011129	31.5 MPa 28d strength ready mix concrete.	Ready Mix	31.5	0.552050
82	10069603	31.5 MPa 28d strength ready mix concrete.	Ready Mix	31.5	0.499543
83	10041264	31.5 MPa 28d strength ready mix concrete.	Ready Mix	31.5	0.499538
84	10071750	31.5 MPa 28d strength ready mix concrete.	Ready Mix	31.5	0.400000
85	10054034	31.5 MPa 28d strength ready mix concrete.	Ready Mix	31.5	0.282883
86	10011145	35 MPa 28d strength ready mix concrete.	Ready Mix	35.0	0.504323
87	10011136	35 MPa 28d strength ready mix concrete.	Ready Mix	35.0	0.499590
88	10010886	35 MPa 28d strength ready mix concrete.	Ready Mix	35.0	0.429767
89	10055007	35 MPa 28d strength ready mix concrete.	Ready Mix	35.0	0.357432
90	10058226	35 MPa 28d strength ready mix concrete.	Ready Mix	35.0	0.301434
91	10069485	35 MPa 28d strength ready mix concrete.	Ready Mix	35.0	0.309244

Mix Designs: 36 to 40 MPa

Table 6: Declared products with Mix designs: 36 to 40 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
92	10068395	36 MPa 28d strength ready mix concrete.	Ready Mix	36.0	0.371221
93	10012424	38.5 MPa 28d strength ready mix concrete.	Ready Mix	38.5	0.437890
94	10067929	40 MPa 28d strength ready mix concrete.	Ready Mix	40.0	0.341008



Mix Designs: 41 to 45 MPa

Table 7: 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	H2O to cement ratio
95	10011154	42 MPa 28d strength ready mix concrete.	Ready Mix	42	0.440806
96	10050246	42 MPa 28d strength ready mix concrete.	Ready Mix	42	0.471438
97	10047946	42 MPa 28d strength ready mix concrete.	Ready Mix	42	0.403385
98	10069395	42 MPa 28d strength ready mix concrete.	Ready Mix	42	0.356070
99	10061691	43 MPa 28d strength ready mix concrete.	Ready Mix	43	0.326973

Mix Designs: 46 to 50 MPa

Table 8: 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
100	10052062	49 MPa 28d strength ready mix concrete.	Ready Mix	49	0.393258
101	10062734	49 MPa 28d strength ready mix concrete.	Ready Mix	49	0.378175

Mix Designs: 56 to 60 MPa

Table 9: 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
102	10035230	56 MPa 28d strength ready mix concrete.	Ready Mix	56	0.352504



Mix Designs: >60 MPa

Table 10: Declared products with Mix designs: >60 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
103	10054187	63 MPa 28d strength ready mix concrete.	Ready Mix	63	0.371221
104	10069793	70 MPa 28d strength ready mix concrete.	Ready Mix	70	0.237310

READY MIX CONCRETE DESIGN COMPOSITION

The following figures provide mass breakdown (kg per functional unit) of the material composition of each ready mix concrete design considered. Please note that the presented breakdown has been randomly altered by +/-10%, and is therefore only an approximation; this manipulation is to ensure confidentiality

Table 11: 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:

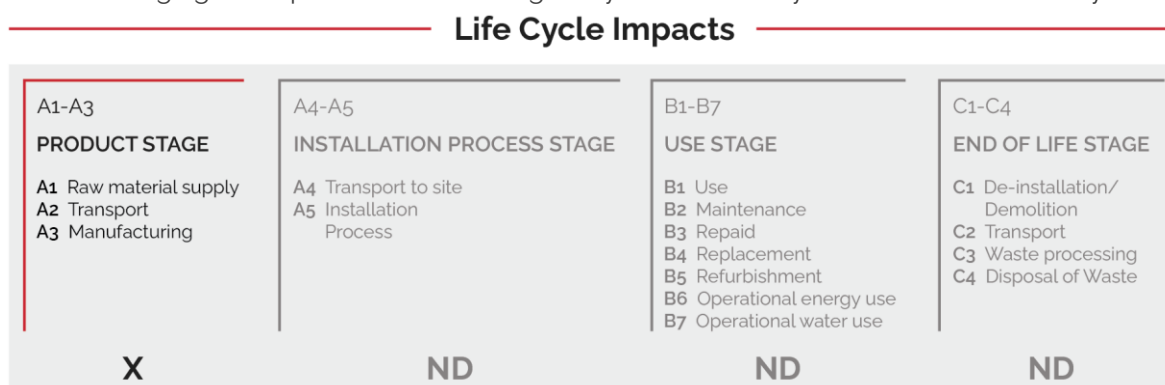


Figure 1: General life cycle phases for consideration in a construction works system

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 manufacture 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 Holcim Colombia, is located at their Planta Chia 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 whereasecoinvent 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.

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: (Ave. km



to site)* 2 for return L diesel/km /(ave. m3 of concrete in a load) total concrete volume in m3 *
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 12: 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	Cundinamarca	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
Additives	market for fibre, cotton, organic/fibre, cotton, 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	Cundinamarca	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	Cundinamarca	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 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	26.7	0.0505	150	2e-05	0.396	0.000703	1450
Maximum	126	4.26	589	5.09e-05	1.34	0.0025	3580
Mean	56.5	0.178	357	3.43e-05	0.824	0.00155	2430
Median	56.1	0.0913	362	3.43e-05	0.838	0.00157	2420
10034328	26.7	0.0505	150	2e-05	0.396	0.000703	1450
10061473	37.9	0.0668	239	2.69e-05	0.557	0.00108	1920
10072302	85.5	0.133	589	5.09e-05	1.25	0.0025	3580
10052045	55	0.0881	336	3.21e-05	0.82	0.00147	2270
10011182	51.9	0.0835	311	3.01e-05	0.776	0.00136	2130
10045943	57	0.0913	355	3.37e-05	0.847	0.00155	2380
10011185	59.2	0.0942	370	3.46e-05	0.879	0.00161	2440
10072840	63.2	0.101	407	3.78e-05	0.936	0.00176	2670
10011186	54.9	0.0883	338	3.24e-05	0.818	0.00148	2290
10068671	58.6	0.0931	364	3.4e-05	0.873	0.00158	2400
10023331	58.3	0.0924	362	3.36e-05	0.867	0.00157	2370
10053730	63.9	0.102	421	3.92e-05	0.941	0.00182	2760
10069920	126	4.26	552	4.63e-05	1.34	0.00224	3270
10048251	56.1	0.0895	343	3.24e-05	0.838	0.0015	2290
10034538	59.6	0.0947	373	3.47e-05	0.886	0.00162	2450
10045388	69.3	0.109	456	4.12e-05	1.02	0.00196	2910
10011211	59	0.0946	374	3.54e-05	0.874	0.00163	2500
10051184	72.4	0.114	480	4.28e-05	1.07	0.00206	3010
10011451	59.2	0.094	369	3.43e-05	0.882	0.0016	2420
10011456	68.5	0.108	445	4e-05	1.01	0.00191	2820
10011455	75.2	0.118	501	4.45e-05	1.11	0.00214	3130
10011458	60.3	0.0956	378	3.51e-05	0.896	0.00164	2480
10069092	60.9	0.0975	385	3.66e-05	0.903	0.00168	2580
10025220	63.9	0.101	410	3.72e-05	0.947	0.00177	2620
10011459	70.3	0.111	465	4.21e-05	1.04	0.002	2970
10042828	76.2	0.119	507	4.46e-05	1.12	0.00217	3140
10011468	69.5	0.109	453	4.05e-05	1.03	0.00194	2850
10033497	84.2	0.131	573	4.99e-05	1.24	0.00244	3510
10027896	34.4	0.0588	177	2.05e-05	0.523	0.000816	1470
10012771	36.5	0.0611	193	2.11e-05	0.554	0.000877	1500
10010823	37.4	0.067	261	2.84e-05	0.541	0.00116	2020
10011166	41.3	0.0738	286	3.17e-05	0.597	0.00127	2260
10055953	37.8	0.0638	206	2.28e-05	0.571	0.000934	1620
10048429	39.3	0.0661	221	2.38e-05	0.591	0.000996	1690
10062285	42.4	0.07	243	2.5e-05	0.638	0.00108	1770
10012471	39.5	0.07	278	2.96e-05	0.57	0.00123	2110



10045441	45.5	0.0784	304	3.22e-05	0.664	0.00135	2290
10061119	51	0.083	317	3.09e-05	0.759	0.00139	2180
10049804	44.5	0.0785	311	3.37e-05	0.642	0.00138	2390
10011891	50.4	0.0856	343	3.52e-05	0.734	0.00151	2490
10053315	54.3	0.0913	376	3.77e-05	0.789	0.00164	2660
10072083	65.7	0.101	424	3.56e-05	0.975	0.0018	2510
10048440	41.9	0.0699	243	2.55e-05	0.628	0.00108	1810
10048425	45.4	0.0748	268	2.73e-05	0.679	0.00119	1940
10012342	44.4	0.0783	311	3.36e-05	0.642	0.00138	2390
10011980	48.1	0.0839	339	3.61e-05	0.694	0.0015	2560
10052795	52.7	0.0907	377	3.9e-05	0.76	0.00165	2760

b) Inventory Metrics:

Indicator/LC I 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	m3	m3	kg waste	kg waste	m3	m3	kg	kg
Minimum	1590	66.7	1530	39.7	0.000693	0.429	59.2	0.00267	0.126	7.61e-06	0.0138	3.33
Maximum	5300	1800	3840	96.9	0.0018	14.8	131	0.00446	0.247	7.61e-06	0.0138	3.33
Mean	2780	197	2580	65.9	0.00123	7.93	92.6	0.00355	0.188	7.61e-06	0.0138	3.33
Median	2760	164	2580	65.7	0.00124	6.78	92.8	0.0035	0.178	7.61e-06	0.0138	3.33
10034328	1590	66.7	1530	39.7	0.000693	13.2	59.2	0.00314	0.226	7.61e-06	0.0138	3.33
10061473	2140	105	2030	52.3	0.000955	12.4	76.2	0.0035	0.215	7.61e-06	0.0138	3.33
10072302	4080	267	3840	96.9	0.0018	4.2	131	0.00425	0.184	7.61e-06	0.0138	3.33
10052045	2570	160	2420	61.6	0.00118	6.34	86.9	0.00328	0.168	7.61e-06	0.0138	3.33
10011182	2430	148	2260	58	0.00109	6.5	82.2	0.00317	0.168	7.61e-06	0.0138	3.33
10045943	2710	166	2540	64.6	0.00126	6.66	91	0.00342	0.168	7.61e-06	0.0138	3.33
10011185	2780	175	2610	66.2	0.00124	6.04	92.8	0.00341	0.168	7.61e-06	0.0138	3.33
10072840	3010	187	2840	72.5	0.00137	6.58	101	0.00367	0.168	7.61e-06	0.0138	3.33
10011186	2600	158	2440	62.2	0.00117	6.78	87.9	0.00335	0.168	7.61e-06	0.0138	3.33
10068671	2720	171	2540	65	0.0012	5.65	91	0.00333	0.168	7.61e-06	0.0138	3.33
10023331	2690	170	2530	64.5	0.00121	5.29	89.9	0.00325	0.189	7.61e-06	0.0138	3.33
10053730	3130	193	2940	74.7	0.0014	7.14	104	0.00379	0.178	7.61e-06	0.0138	3.33



10069920	5300	1800	3470	88.5	0.00164	4.27	123	0.00407	0.178	7.61e-06	0.0138	3.33
10048251	2600	163	2430	62.3	0.00118	5.86	87.5	0.00326	0.168	7.61e-06	0.0138	3.33
10034538	2790	175	2610	66.5	0.00126	5.74	92.9	0.00338	0.168	7.61e-06	0.0138	3.33
10045388	3320	209	3110	78.7	0.00145	5.75	109	0.0038	0.173	7.61e-06	0.0138	3.33
10011211	2850	173	2670	67.9	0.0013	7.07	95.3	0.00357	0.168	7.61e-06	0.0138	3.33
10051184	3440	222	3230	81.8	0.00154	5.11	112	0.00383	0.178	7.61e-06	0.0138	3.33
10011451	2760	173	2580	65.7	0.00126	5.64	91.9	0.00335	0.168	7.61e-06	0.0138	3.33
10011456	3220	206	3010	76.1	0.0015	5.02	105	0.00365	0.173	7.61e-06	0.0138	3.33
10011455	3570	231	3340	84.8	0.00159	4.99	116	0.00394	0.168	7.61e-06	0.0138	3.33
10011458	2820	178	2640	67.1	0.00126	5.74	93.8	0.00341	0.168	7.61e-06	0.0138	3.33
10069092	2930	178	2750	70.1	0.00133	7.42	98.3	0.0037	0.173	7.61e-06	0.0138	3.33
10025220	3000	190	2800	71.3	0.00133	5.14	98.6	0.00347	0.189	7.61e-06	0.0138	3.33
10011459	3390	214	3160	80.7	0.00152	5.93	111	0.00387	0.173	7.61e-06	0.0138	3.33
10042828	3610	233	3360	85.1	0.00164	4.33	116	0.00387	0.173	7.61e-06	0.0138	3.33
10011468	3270	210	3050	77.4	0.00149	4.8	106	0.00366	0.173	7.61e-06	0.0138	3.33
10033497	4040	262	3780	94.8	0.00178	4.42	129	0.00423	0.163	7.61e-06	0.0138	3.33
10027896	1640	86.9	1550	40.1	0.000752	8.86	59.7	0.00279	0.184	7.61e-06	0.0138	3.33
10012771	1690	95.4	1600	41.1	0.000797	7.49	60.5	0.00267	0.205	7.61e-06	0.0138	3.33
10010823	2250	113	2130	54.7	0.000984	12.4	79.1	0.00349	0.247	7.61e-06	0.0138	3.33
10011166	2500	121	2380	61.3	0.00109	14.6	88.2	0.004	0.22	7.61e-06	0.0138	3.33
10055953	1830	99.3	1720	44.1	0.000859	8.76	65.1	0.00292	0.184	7.61e-06	0.0138	3.33
10048429	1890	106	1800	46.1	0.000877	8.42	67.5	0.00294	0.199	7.61e-06	0.0138	3.33
10062285	2000	118	1880	48.2	0.00093	7.33	69.9	0.00289	0.205	7.61e-06	0.0138	3.33
10012471	2350	119	2240	57.4	0.00104	12.3	82.2	0.00356	0.247	7.61e-06	0.0138	3.33
10045441	2570	133	2420	62	0.00111	12.5	89.1	0.00384	0.215	7.61e-06	0.0138	3.33
10061119	2460	149	2320	59.3	0.00112	7.29	84.1	0.00326	0.21	7.61e-06	0.0138	3.33



10049804	2660	131	2540	64.9	0.001 17	14.5	93	0.00 412	0.215	7.61e -06	0.013 8	3.33
10011891	2800	150	2650	67.8	0.001 24	12.2	96.4	0.00 401	0.205	7.61e -06	0.013 8	3.33
10053315	2990	164	2830	72.2	0.001 32	11.9	102	0.00 412	0.215	7.61e -06	0.013 8	3.33
10072083	2900	204	2680	67.9	0.001 31	0.429	91.8	0.00 282	0.126	7.61e -06	0.013 8	3.33
10048440	2030	115	1910	49.2	0.00 0943	8.35	71.5	0.00 303	0.199	7.61e -06	0.013 8	3.33
10048425	2180	127	2050	52.7	0.00 099	7.91	75.8	0.00 311	0.194	7.61e -06	0.013 8	3.33
10012342	2660	131	2540	65.2	0.001 18	14.4	92.9	0.00 41	0.22	7.61e -06	0.013 8	3.33
10011980	2850	144	2710	69.4	0.001 22	14.8	99	0.00 431	0.215	7.61e -06	0.013 8	3.33
10052795	3090	159	2920	75.1	0.001 34	14.4	106	0.00 446	0.215	7.61e -06	0.013 8	3.33

Mix Designs: 15 to 20 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	43.8	0.0723	253	2.6e-05	0.658	0.00113	1850
Maximum	82.3	0.129	579	5.05e-05	1.2	0.00246	3550
Mean	55	0.0889	351	3.34e-05	0.815	0.00153	2360
Median	50	0.083	322	3.22e-05	0.737	0.00142	2280
10055954	45	0.0745	265	2.74e-05	0.673	0.00118	1940
10048445	43.8	0.0723	253	2.6e-05	0.658	0.00113	1850
10059549	46.5	0.0766	277	2.82e-05	0.694	0.00123	2000
10011469	49.5	0.0807	300	2.97e-05	0.738	0.00132	2100
10034324	50.5	0.0853	344	3.49e-05	0.736	0.00151	2470
10012141	58.4	0.0939	377	3.54e-05	0.864	0.00163	2500
10052351	64.3	0.0989	415	3.48e-05	0.954	0.00176	2450
10068682	82.3	0.129	579	5.05e-05	1.2	0.00246	3550



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	m3	m3	kg waste	kg waste	m3	m3	kg	kg
Minimum	2080	121	1960	50.5	0.000973	0.433	72.6	0.00275	0.136	7.61e-06	0.0138	3.33
Maximum	4060	259	3790	96.4	0.00182	11.5	130	0.00429	0.241	7.61e-06	0.0138	3.33
Mean	2680	163	2500	64	0.0012	6.98	89.8	0.00338	0.195	7.61e-06	0.0138	3.33
Median	2580	146	2420	61.8	0.00116	7.53	85.6	0.00321	0.194	7.61e-06	0.0138	3.33
10055954	2190	126	2050	53	0.000984	8.42	76.3	0.00318	0.184	7.61e-06	0.0138	3.33
10048445	2080	121	1960	50.5	0.000973	7.65	72.6	0.003	0.194	7.61e-06	0.0138	3.33
10059549	2250	131	2120	54.2	0.00103	8.12	78.1	0.0032	0.189	7.61e-06	0.0138	3.33
10011469	2370	141	2230	57	0.00109	7.41	81.3	0.00321	0.194	7.61e-06	0.0138	3.33
10034324	2780	150	2610	66.8	0.00122	11.5	95.1	0.00389	0.215	7.61e-06	0.0138	3.33
10012141	2840	175	2650	67.8	0.00124	6.94	95.1	0.00352	0.205	7.61e-06	0.0138	3.33
10052351	2840	199	2630	66.7	0.00128	0.433	89.8	0.00275	0.136	7.61e-06	0.0138	3.33
10068682	4060	259	3790	96.4	0.00182	5.38	130	0.00429	0.241	7.61e-06	0.0138	3.33

Mix Designs: 21 to 25 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 CO2-Eq	kg CFC-11-Eq	kg NOx-Eq	kg Sb-Eq	MJ, net calorific value
Minimum	47.5	0.078	285	2.88e-05	0.708	0.00126	2040
Maximum	77.4	0.119	524	4.45e-05	1.14	0.00221	3130
Mean	58	0.094	380	3.61e-05	0.855	0.00165	2550
Median	56.7	0.0945	380	3.56e-05	0.817	0.00165	2510
10059631	47.5	0.078	285	2.88e-05	0.708	0.00126	2040
10070130	50.1	0.0812	306	2.97e-05	0.747	0.00134	2100
10056086	53.6	0.0863	332	3.17e-05	0.798	0.00145	2240



10053034	55.6	0.0911	368	3.56e-05	0.817	0.0016	2510
10052350	59.6	0.0972	401	3.83e-05	0.874	0.00174	2700
10064388	62.9	0.104	446	4.28e-05	0.912	0.00193	3020
10068398	77.4	0.119	524	4.35e-05	1.14	0.00221	3060
10060130	56.7	0.0964	410	4.13e-05	0.816	0.00179	2920
10059633	48.5	0.0796	294	2.95e-05	0.723	0.0013	2090
10048450	51.8	0.0844	320	3.15e-05	0.77	0.00141	2230
10051947	54.6	0.0884	345	3.31e-05	0.81	0.0015	2340
10011150	59.1	0.0945	380	3.53e-05	0.875	0.00165	2490
10010829	64.1	0.102	423	3.89e-05	0.945	0.00182	2750
10060300	69.4	0.112	482	4.45e-05	1.01	0.00207	3130
10068629	59.5	0.0961	388	3.68e-05	0.878	0.00169	2600

b) Inventory Metrics:

Indicator/L CI Metric	TPE	RE	NRE	NR R	RR	WD P	LFW	LFHW	CBW C	CWW C	CHW	CNH W
Unit	MJ- Eq	MJ- Eq	MJ- Eq	kg	m3	m3	kg waste	kg waste	m3	m3	kg	kg
Minimum	230 0	134	217 0	55.4	0.0010 5	0.48 4	79.5	0.0031 2	0.126	7.61e- 06	0.013 8	3.33
Maximum	356 0	24 5	333 0	84. 9	0.0015 6	13.9	117	0.0045 5	0.226	7.61e- 06	0.013 8	3.33
Mean	288 0	173	271 0	69. 2	0.0012 9	7.76	96.8	0.0036 3	0.195	7.61e- 06	0.013 8	3.33
Median	283 0	173	267 0	68. 3	0.0012 7	7.95	96.1	0.0034 3	0.199	7.61e- 06	0.013 8	3.33
10059631	230 0	134	217 0	55.4	0.0010 5	8.05	79.5	0.0032 2	0.189	7.61e- 06	0.013 8	3.33
10070130	237 0	145	223 0	57	0.0010 8	6.68	81	0.0031 2	0.184	7.61e- 06	0.013 8	3.33
10056086	254 0	156	238 0	60. 9	0.0011 6	6.43	85.8	0.0032 4	0.168	7.61e- 06	0.013 8	3.33
10053034	283 0	16 6	267 0	68. 3	0.0012 5	8.81	96.1	0.0037	0.22	7.61e- 06	0.013 8	3.33
10052350	305 0	18 0	288 0	73.4	0.0013 2	8.93	103	0.0038 9	0.22	7.61e- 06	0.013 8	3.33
10064388	341 0	195	323 0	82.1	0.0014 7	11	114	0.0043 5	0.226	7.61e- 06	0.013 8	3.33
10068398	353 0	24 5	331 0	83	0.0015 3	0.48 4	111	0.0033 2	0.126	7.61e- 06	0.013 8	3.33
10060130	327 0	173	3110	79.2	0.0014 5	13.9	112	0.0045 5	0.205	7.61e- 06	0.013 8	3.33
10059633	236 0	138	221 0	56. 7	0.0010 8	7.99	81.1	0.0032 6	0.189	7.61e- 06	0.013 8	3.33
10048450	253 0	149	237 0	60. 5	0.0011 4	7.95	86.2	0.0033 9	0.184	7.61e- 06	0.013 8	3.33
10051947	264 0	159	248 0	63. 5	0.0012	7.28	89.6	0.0034 1	0.205	7.61e- 06	0.013 8	3.33



10011150	283 0	176	265 0	67. 8	0.0012 7	6.14	94.4	0.0034 3	0.184	7.61e- 06	0.013 8	3.33
10010829	3110	192	292 0	74.4	0.0014	6.58	103	0.0037 1	0.205	7.61e- 06	0.013 8	3.33
10060300	356 0	216	333 0	84. 9	0.0015 6	8.43	117	0.0042 3	0.22	7.61e- 06	0.013 8	3.33
10068629	294 0	178	276 0	70. 4	0.0013 2	7.69	98.7	0.0036 9	0.199	7.61e- 06	0.013 8	3.33

Mix Designs: 26 to 30 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 CO2-Eq	kg CFC-11-Eq	kg NOx-Eq	kg Sb-Eq	MJ, net calorific value
Minimum	49.8	0.0815	307	3.05e-05	0.74	0.00135	2160
Maximum	74.1	0.118	516	4.7e-05	1.08	0.00221	3310
Mean	61.6	0.0988	405	3.78e-05	0.907	0.00175	2670
Median	61.8	0.0984	406	3.71e-05	0.912	0.00175	2620
10061628	66.3	0.105	434	3.95e-05	0.979	0.00187	2790
10059635	49.8	0.0815	307	3.05e-05	0.74	0.00135	2160
10064494	53.1	0.0861	331	3.21e-05	0.789	0.00145	2270
10067829	56.8	0.0916	361	3.44e-05	0.842	0.00157	2430
10053913	59.3	0.0948	388	3.56e-05	0.876	0.00167	2510
10067133	64.3	0.102	425	3.87e-05	0.948	0.00183	2730
10054547	68.7	0.111	477	4.45e-05	1	0.00205	3140
10067149	74.1	0.118	516	4.7e-05	1.08	0.00221	3310

b) Inventory Metrics:

Indicator/LCI Metric	TPE	RE	NRE	NR R	RR	WD P	LFW	LFHW	CBW C	CWW C	CHW	CNH W
Unit	MJ-Eq	MJ-Eq	MJ-Eq	kg	m3	m3	kg waste	kg waste	m3	m3	kg	kg
Minimum	245 0	143	229 0	58. 6	0.0010 9	5.79	83.6	0.0033 2	0.189	7.61e- 06	0.013 8	3.33
Maximum	375 0	231	354 0	89. 9	0.0016 6	9.26	123	0.0043 7	0.22	7.61e- 06	0.013 8	3.33
Mean	302 0	18 6	284 0	72.4	0.0013 5	7.2	101	0.0037	0.196	7.61e- 06	0.013 8	3.33
Median	298 0	18 8	280 0	71.2	0.0013 4	7.33	98.4	0.0035 6	0.194	7.61e- 06	0.013 8	3.33
10061628	316 0	201	297 0	75. 8	0.0014	5.88	105	0.0036 9	0.194	7.61e- 06	0.013 8	3.33



10059635	245 0	143	229 0	58. 6	0.0010 9	8.06	83.6	0.0033 2	0.194	7.61e- 06	0.013 8	3.33
10064494	258 0	154	243 0	61.6	0.0011 5	7.39	87.2	0.0033 7	0.194	7.61e- 06	0.013 8	3.33
10067829	275 0	167	259 0	66	0.0012 2	7.27	92.8	0.0035	0.189	7.61e- 06	0.013 8	3.33
10053913	286 0	181	268 0	68. 2	0.0013	5.79	94.8	0.0033 8	0.22	7.61e- 06	0.013 8	3.33
10067133	309 0	19 6	291 0	74.2	0.0013 9	5.92	102	0.0036 1	0.189	7.61e- 06	0.013 8	3.33
10054547	354 0	211	334 0	85	0.0015 7	9.26	118	0.0043 3	0.199	7.61e- 06	0.013 8	3.33
10067149	375 0	231	354 0	89. 9	0.0016 6	7.99	123	0.0043 7	0.193	7.61e- 06	0.013 8	3.33

Mix Designs: 31 to 35 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
Minimum	52.9	0.0864	332	3.26e-05	0.785	0.00146	2310
Maximum	82.3	0.169	568	4.99e-05	1.21	0.00242	3510
Mean	66.1	0.114	438	4.03e-05	0.972	0.00189	2840
Median	64.6	0.109	423	3.89e-05	0.953	0.00182	2740
10059679	62.5	0.157	405	3.8e-05	0.915	0.00175	2680
10059820	70.8	0.169	478	4.3e-05	1.03	0.00205	3030
10011129	52.9	0.0864	332	3.26e-05	0.785	0.00146	2310
10069603	56.6	0.0912	357	3.42e-05	0.839	0.00156	2410
10041264	59.2	0.0949	387	3.58e-05	0.875	0.00167	2530
10071750	68.7	0.109	464	4.23e-05	1.01	0.00199	2980
10054034	82.3	0.129	568	4.99e-05	1.21	0.00242	3510
10011145	56	0.091	358	3.46e-05	0.829	0.00156	2450
10011136	59.9	0.0962	390	3.65e-05	0.884	0.00169	2580
10010886	64.6	0.103	423	3.89e-05	0.953	0.00182	2740
10055007	68.5	0.109	462	4.21e-05	1.01	0.00199	2960
10058226	75.6	0.119	509	4.56e-05	1.11	0.00218	3210
10069485	81.1	0.128	565	4.99e-05	1.19	0.00241	3510



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	m3	m3	kg waste	kg waste	m3	m3	kg	kg
Minimum	2600	155	2450	62.7	0.00117	5.47	88.9	0.00346	0.168	7.61e-06	0.0138	3.33
Maximum	4010	257	3760	95.3	0.00179	8.3	130	0.00436	0.22	7.61e-06	0.0138	3.33
Mean	3230	204	3030	77	0.00144	6.78	107	0.00382	0.191	7.61e-06	0.0138	3.33
Median	3130	208	2920	74.2	0.00139	6.64	103	0.00374	0.189	7.61e-06	0.0138	3.33
10059679	3060	208	2840	72.4	0.00136	7.4	101	0.00374	0.189	7.61e-06	0.0138	3.33
10059820	3470	240	3240	82.1	0.00156	6.27	113	0.00392	0.22	7.61e-06	0.0138	3.33
10011129	2600	155	2450	62.7	0.00117	8.3	88.9	0.0035	0.184	7.61e-06	0.0138	3.33
10069603	2740	166	2560	65.7	0.0012	7.29	92.2	0.0035	0.184	7.61e-06	0.0138	3.33
10041264	2860	179	2690	68.4	0.00132	6.34	95.7	0.00346	0.205	7.61e-06	0.0138	3.33
10071750	3400	210	3170	81.1	0.00153	6.91	112	0.00396	0.2	7.61e-06	0.0138	3.33
10054034	4010	257	3760	95.3	0.00179	5.47	129	0.00432	0.178	7.61e-06	0.0138	3.33
10011145	2760	164	2590	66	0.00125	8.17	93.7	0.00361	0.184	7.61e-06	0.0138	3.33
10011136	2930	179	2760	69.7	0.00133	7.02	97.7	0.00359	0.205	7.61e-06	0.0138	3.33
10010886	3130	195	2920	74.2	0.00139	6.36	103	0.00369	0.194	7.61e-06	0.0138	3.33
10055007	3370	210	3160	80.6	0.00147	6.64	111	0.00391	0.178	7.61e-06	0.0138	3.33
10058226	3660	232	3440	87.2	0.00157	5.93	119	0.0041	0.168	7.61e-06	0.0138	3.33
10069485	3990	255	3760	95.3	0.00174	6.1	130	0.00436	0.193	7.61e-06	0.0138	3.33



Mix Designs: 36 to 40 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
Minimum	57.9	0.0921	363	3.36e-05	0.862	0.00157	2370
Maximum	82.4	0.129	580	5.08e-05	1.2	0.00246	3580
Mean	72.6	0.114	494	4.4e-05	1.06	0.00211	3100
Median	77.5	0.122	538	4.77e-05	1.13	0.00229	3360
10068395	77.5	0.122	538	4.77e-05	1.13	0.00229	3360
10012424	57.9	0.0921	363	3.36e-05	0.862	0.00157	2370
10067929	82.4	0.129	580	5.08e-05	1.2	0.00246	3580

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	2690	171	2520	64.3	0.00121	5.44	90.1	0.00327	0.168	7.61e-06	0.0138	3.33
Maximum	4080	259	3820	97.1	0.00177	6.12	131	0.00435	0.22	7.61e-06	0.0138	3.33
Mean	3540	224	3310	84.1	0.00156	5.75	115	0.00394	0.203	7.61e-06	0.0138	3.33
Median	3850	242	3590	90.8	0.00169	5.69	124	0.0042	0.22	7.61e-06	0.0138	3.33
10068395	3850	242	3590	90.8	0.00169	6.12	124	0.0042	0.22	7.61e-06	0.0138	3.33
10012424	2690	171	2520	64.3	0.00121	5.44	90.1	0.00327	0.168	7.61e-06	0.0138	3.33
10067929	4080	259	3820	97.1	0.00177	5.69	131	0.00435	0.22	7.61e-06	0.0138	3.33



Mix Designs: 41 to 45 MPa

Table 19: 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	61.1	0.0987	401	3.8e-05	0.901	0.00174	2680
Maximum	79	0.124	544	4.78e-05	1.16	0.00232	3360
Mean	70.9	0.112	482	4.32e-05	1.04	0.00206	3040
Median	72.9	0.115	499	4.46e-05	1.07	0.00213	3140
10011154	61.1	0.0987	401	3.8e-05	0.901	0.00174	2680
10050246	63	0.1	430	3.86e-05	0.923	0.00184	2720
10047946	72.9	0.115	499	4.46e-05	1.07	0.00213	3140
10069395	79	0.124	544	4.78e-05	1.16	0.00232	3360
10061691	78.7	0.123	536	4.71e-05	1.16	0.00228	3320

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	3040	181	2850	72.7	0.00137	5.07	102	0.00351	0.184	7.61e-06	0.0138	3.33
Maximum	3840	247	3600	90.7	0.0017	8.04	124	0.00413	0.22	7.61e-06	0.0138	3.33
Mean	3480	218	3240	82.5	0.00155	6.01	113	0.00391	0.207	7.61e-06	0.0138	3.33
Median	3590	225	3330	84.9	0.00161	5.62	117	0.00401	0.215	7.61e-06	0.0138	3.33
10011154	3040	181	2850	72.7	0.00137	8.04	102	0.00381	0.184	7.61e-06	0.0138	3.33
10050246	3110	196	2890	74	0.0014	5.62	102	0.00351	0.22	7.61e-06	0.0138	3.33
10047946	3590	225	3330	84.9	0.00161	6.08	117	0.00401	0.22	7.61e-06	0.0138	3.33
10069395	3840	247	3600	90.7	0.0017	5.24	124	0.00413	0.215	7.61e-06	0.0138	3.33
10061691	3810	243	3540	90	0.00168	5.07	122	0.00409	0.194	7.61e-06	0.0138	3.33



Mix Designs: 46 to 50 MPa

Table 20: **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	66.1	0.106	442	4.12e-05	0.971	0.00191	2900
Maximum	72.6	0.116	499	4.52e-05	1.06	0.00214	3190
Mean	69.4	0.111	470	4.32e-05	1.02	0.00202	3040
Median	69.4	0.111	470	4.32e-05	1.02	0.00202	3040
10052062	66.1	0.106	442	4.12e-05	0.971	0.00191	2900
10062734	72.6	0.116	499	4.52e-05	1.06	0.00214	3190

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	3320	200	3090	78.8	0.00147	7.14	109	0.004	0.184	7.61e-06	0.0138	3.33
Maximum	3640	225	3390	85.9	0.00165	7.89	119	0.00416	0.204	7.61e-06	0.0138	3.33
Mean	3480	212	3240	82.4	0.00156	7.52	114	0.00408	0.194	7.61e-06	0.0138	3.33
Median	3480	212	3240	82.4	0.00156	7.52	114	0.00408	0.194	7.61e-06	0.0138	3.33
10052062	3320	200	3090	78.8	0.00147	7.89	109	0.004	0.184	7.61e-06	0.0138	3.33
10062734	3640	225	3390	85.9	0.00165	7.14	119	0.00416	0.204	7.61e-06	0.0138	3.33

Mix Designs: 56 to 60 MPa

Table 21: **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
10035230	80.7	0.127	566	5.01e-05	1.18	0.00241	3530



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	m3	m3	kg waste	kg waste	m3	m3	kg	kg
10035230	4020	255	3760	95.7	0.00181	6.44	130	0.00439	0.22	7.61e-06	0.0138	3.33

Mix Designs: >60 MPa

Table 22: 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	77.3	0.122	538	4.77e-05	1.13	0.00229	3360
Maximum	95.9	0.15	688	5.96e-05	1.4	0.00291	4190
Mean	86.6	0.136	613	5.36e-05	1.26	0.0026	3780
Median	86.6	0.136	613	5.36e-05	1.26	0.0026	3780
10054187	77.3	0.122	538	4.77e-05	1.13	0.00229	3360
10069793	95.9	0.15	688	5.96e-05	1.4	0.00291	4190

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	m3	m3	kg waste	kg waste	m3	m3	kg	kg
Minimum	3830	241	3590	91	0.00167	5.97	124	0.00419	0.183	7.61e-06	0.0138	3.33
Maximum	4800	306	4470	114	0.00218	6.08	153	0.00498	0.22	7.61e-06	0.0138	3.33
Mean	4320	274	4030	102	0.00192	6.02	138	0.00459	0.202	7.61e-06	0.0138	3.33
Median	4320	274	4030	102	0.00192	6.02	138	0.00459	0.202	7.61e-06	0.0138	3.33
10054187	3830	241	3590	91	0.00167	6.08	124	0.00419	0.22	7.61e-06	0.0138	3.33
10069793	4800	306	4470	114	0.00218	5.97	153	0.00498	0.183	7.61e-06	0.0138	3.33



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 23: **Mix Designs 0 to 15 MPa**

Mix	GWP	MPa
10072302	589	3
10061473	239	3
10052045	336	3.5
10011182	311	3.6
10045943	311	3.6
10072840	407	3.8
10053526	407	3.8
10011185	407	3.8
10052047	407	3.8
10052048	407	3.8
10059284	407	3.8
10068671	364	3.9
10032416	364	3.9
10052798	364	3.9
10054275	364	3.9
10056810	364	3.9
10058082	364	3.9
10011186	338	3.9
10011196	338	3.9
10033422	338	3.9
10058640	338	3.9
10023331	362	4
10022990	362	4
10011464	362	4
10047801	362	4



10045011	362	4
10053730	421	4
10069920	552	4
10048251	343	4,1
10050673	343	4,1
10034538	373	4,1
10011197	373	4,1
10011201	373	4,1
10011202	373	4,1
10035635	373	4,1
10054258	373	4,1
10068234	373	4,1
10072898	373	4,1
10045388	453	4,1
10041257	453	4,1
10053314	453	4,1
10011208	453	4,1
10011211	374	4,2
10023330	374	4,2
10033965	374	4,2
10047024	374	4,2
10059285	374	4,2
10063129	374	4,2
10051184	480	4,2
10058968	480	4,2
10011450	480	4,2
10011451	369	4,3
10026990	369	4,3
10023332	369	4,3
10030612	369	4,3
10053079	369	4,3
10061828	369	4,3
10068081	369	4,3
10011456	445	4,3
10053288	445	4,3
10072301	445	4,3
10011455	501	4,3
10011458	378	4,4
10025220	410	4,5
10011461	410	4,5
10011462	410	4,5
10033698	410	4,5
10068622	410	4,5
10069092	410	4,5
10072029	410	4,5
10011459	465	4,5
10042828	507	4,5



10011463	507	4,5
10011468	453	5
10030613	453	5
10033497	573	5
10012771	193	7
10027896	193	7
10010823	261	7
10012713	261	7
10011166	286	9
10055953	206	10
10022460	206	10
10048429	221	10,5
10048424	221	10,5
10074596	221	10,5
10010904	221	10,5
10024091	221	10,5
10062285	221	10,5
10010907	221	10,5
10049996	221	10,5
10045441	304	10,5
10069591	304	10,5
10011831	304	10,5
10010796	304	10,5
10012471	304	10,5
10012642	304	10,5
10061119	317	10,5
10049192	317	10,5
10011891	343	12,5
10050616	343	12,5
10010815	343	12,5
10012710	343	12,5
10055923	343	12,5
10064413	343	12,5
10053914	343	12,5
10010803	343	12,5
10053315	376	12,5
10055972	376	12,5
10072083	424	12,5
10072084	424	12,5
10072085	424	12,5
10048440	243	14
10010911	243	14
10010916	243	14
10048425	268	14
10068084	268	14
10068628	268	14
10010908	268	14



10067954	268	14
10069475	268	14
10012342	268	14
10010819	268	14
10011980	339	14
10011892	339	14
10052795	339	14
10062273	339	14
10058322	339	14
10068871	339	14
10070230	339	14
10049195	339	14
10057738	339	14
10055954	265	15

Table 24: Mix Designs 16 to 20 MPa

Mix	GWP	MPa
10048445	253	17.5
10010958	253	17.5
10010961	253	17.5
10059549	277	17.5
10048441	277	17.5
10059548	277	17.5
10048426	277	17.5
10010950	277	17.5
10010954	277	17.5
10010957	277	17.5
10069476	277	17.5
10011469	277	17.5
10012383	277	17.5
10034324	344	17.5
10010771	344	17.5
10068673	344	17.5
10052875	344	17.5
10011070	344	17.5
10011982	344	17.5
10012044	344	17.5
10012141	377	17.5
10010765	377	17.5
10064387	377	17.5
10032165	377	17.5
10010765	377	17.5
10052351	415	17.5



10052353	415	17,5
10068682	579	20
10068828	579	20

Table 25: Mix Designs 21 to 25 MPa

Mix	GWP	MPa
10059631	285	21
10048464	285	21
10048464	285	21
10048465	285	21
10059630	285	21
10011472	285	21
10048446	285	21
10048447	285	21
10048448	285	21
10053324	285	21
10063988	285	21
10069600	285	21
10013433	285	21
10010987	285	21
10010993	285	21
10011003	285	21
10011007	285	21
10035116	285	21
10056086	332	21
10045014	332	21
10010821	332	21
10010824	332	21
10027310	332	21
10010825	332	21
10049276	332	21
10048462	332	21
10048463	332	21
10051245	332	21
10052848	332	21
10063987	332	21
10064700	332	21
10068627	332	21
10069478	332	21
10052006	332	21
10059524	332	21
10060958	332	21



10068085	332	21
10068626	332	21
10069479	332	21
10070130	332	21
10016094	332	21
10010970	332	21
10010971	332	21
10010972	332	21
10010973	332	21
10010974	332	21
10012862	332	21
10033444	332	21
10058739	332	21
10061318	332	21
10062369	332	21
10062372	332	21
10063351	332	21
10074597	332	21
10012718	332	21
10045184	332	21
10067955	332	21
10052876	332	21
10052877	332	21
10052915	332	21
10052878	332	21
10052891	332	21
10052916	332	21
10011158	332	21
10011159	332	21
10069652	332	21
10018393	332	21
10011168	332	21
10011169	332	21
10062196	332	21
10062197	332	21
10018317	332	21
10048839	332	21
10049797	332	21
10054062	332	21
10060245	332	21
10069656	332	21
10069902	332	21
10074013	332	21



10011470	332	21
10068230	332	21
10011471	332	21
10011473	332	21
10050605	332	21
10012298	332	21
10052305	332	21
10011713	332	21
10028247	332	21
10068956	332	21
10012270	332	21
10012271	332	21
10012413	332	21
10052000	332	21
10062781	332	21
10063195	332	21
10062783	332	21
10012271	332	21
10012413	332	21
10052000	332	21
10062781	332	21
10063195	332	21
10062783	332	21
10053034	368	21
10011108	368	21
10012716	368	21
10011133	368	21
10010672	368	21
10060631	368	21
10062751	368	21
10029084	368	21
10069655	368	21
10010816	368	21
10010817	368	21
10010826	368	21
10011135	368	21
10071656	368	21
10052879	368	21
10060243	368	21
10056057	368	21
10069110	368	21
10056655	368	21
10061062	368	21



10053589	368	21
10067922	368	21
10011481	368	21
10011482	368	21
10052350	368	21
10053413	368	21
10055574	368	21
10011712	368	21
10051944	368	21
10070123	368	21
10012146	368	21
10033170	368	21
10053317	368	21
10055934	368	21
10049814	368	21
10064388	446	21
10044572	446	21
10064663	446	21
10065555	446	21
10073494	446	21
10010777	446	21
10010787	446	21
10010812	446	21
10062699	446	21
10067959	446	21
10068091	446	21
10011593	446	21
10052890	446	21
10056453	446	21
10057131	446	21
10060298	446	21
10060299	446	21
10054117	446	21
10054124	446	21
10071647	446	21
10056656	446	21
10068398	524	21
10060130	410	24
10059633	294	24.5
10011050	294	24.5
10011067	294	24.5
10048451	294	24.5
10048450	320	24.5



10073531	320	24.5
10073532	320	24.5
10011116	320	24.5
10048466	320	24.5
10048467	320	24.5
10048468	320	24.5
10059632	320	24.5
10070756	320	24.5
10048449	320	24.5
10057973	320	24.5
10068086	320	24.5
10073370	320	24.5
10021892	320	24.5
10055712	320	24.5
10011009	320	24.5
10011027	320	24.5
10011030	320	24.5
10011041	320	24.5
10011043	320	24.5
10044029	320	24.5
10010738	320	24.5
10011044	320	24.5
10011068	320	24.5
10044044	320	24.5
10052883	320	24.5
10011175	320	24.5
10070086	320	24.5
10041255	320	24.5
10011474	320	24.5
10034861	320	24.5
10051947	320	24.5
10012276	320	24.5
10032882	320	24.5
10011150	380	24.5
10030531	380	24.5
10030939	380	24.5
10068070	380	24.5
10011124	380	24.5
10012936	380	24.5
10068071	380	24.5
10012657	380	24.5
10012764	380	24.5
10010831	380	24.5



10012482	380	24.5
10027110	380	24.5
10034877	380	24.5
10010832	380	24.5
10035619	380	24.5
10066851	380	24.5
10032967	380	24.5
10052882	380	24.5
10011161	380	24.5
10050427	380	24.5
10071732	380	24.5
10011830	380	24.5
10051049	380	24.5
10011486	380	24.5
10034872	380	24.5
10041261	380	24.5
10051946	380	24.5
10060242	380	24.5
10056964	380	24.5
10010829	423	24.5
10059768	423	24.5
10010773	423	24.5
10010830	423	24.5
10060300	423	24.5
10053365	423	24.5
10064540	423	24.5
10068629	388	25
10057790	388	25

Table 26: Mix Designs 26 to 30 MPa

Mix	GWP	MPa
10061628	434	27
10059635	307	28
10011487	307	28
10062745	307	28
10048469	307	28
10048470	307	28
10048471	307	28
10059634	307	28
10059635	307	28
10062833	307	28



10048452	307	28
10048453	307	28
10048454	307	28
10053325	307	28
10055758	307	28
10057975	307	28
10059636	307	28
10059637	307	28
10060959	307	28
10062834	307	28
10064494	307	28
10064712	307	28
10064765	307	28
10068088	307	28
10068624	307	28
10069601	307	28
10069602	307	28
10074598	307	28
10013252	307	28
10019087	307	28
10013251	307	28
10069980	307	28
10010995	307	28
10011069	307	28
10011073	307	28
10011074	307	28
10011076	307	28
10041260	307	28
10048784	307	28
10011078	307	28
10011079	307	28
10011082	307	28
10011093	307	28
10012719	307	28
10035306	307	28
10044417	307	28
10049802	307	28
10049979	307	28
10064110	307	28
10064350	307	28
10067924	307	28
10067956	307	28
10067957	307	28



10074599	307	28
10051940	307	28
10052272	307	28
10012293	307	28
10012426	307	28
10062706	307	28
10063196	307	28
10032181	307	28
10067829	361	28
10011452	361	28
10018990	361	28
10031111	361	28
10057692	361	28
10062744	361	28
10062746	361	28
10067514	361	28
10073394	361	28
10011143	361	28
10018504	361	28
10049243	361	28
10057678	361	28
10057679	361	28
10061542	361	28
10061544	361	28
10065398	361	28
10010699	361	28
10048790	361	28
10048794	361	28
10050243	361	28
10052020	361	28
10053913	361	28
10069654	361	28
10010841	361	28
10010842	361	28
10057307	361	28
10010843	361	28
10010844	361	28
10010846	361	28
10056283	361	28
10058867	361	28
10065541	361	28
10068625	361	28
10072406	361	28



10045101	361	28
10033427	361	28
10050242	361	28
10052885	361	28
10052886	361	28
10052888	361	28
10052917	361	28
10071657	361	28
10052887	361	28
10052918	361	28
10017778	361	28
10046864	361	28
10060244	361	28
10069653	361	28
10074012	361	28
10049815	361	28
10011178	361	28
10046863	361	28
10027860	361	28
10060249	361	28
10074562	361	28
10011475	361	28
10062737	361	28
10011477	361	28
10053885	361	28
10063174	361	28
10067923	361	28
10033740	361	28
10011719	361	28
10051948	361	28
10053821	361	28
10062799	361	28
10011772	361	28
10051949	361	28
10068082	361	28
10069477	361	28
10069607	361	28
10057652	361	28
10062705	361	28
10067133	425	28
10057595	425	28
10067673	425	28
10011146	425	28



10049203	425	28
10051851	425	28
10061543	425	28
10061601	425	28
10067045	425	28
10067134	425	28
10067135	425	28
10068227	425	28
10068462	425	28
10068487	425	28
10068642	425	28
10057808	425	28
10010759	425	28
10065279	425	28
10067535	425	28
10029081	425	28
10059252	425	28
10010835	425	28
10010837	425	28
10010975	425	28
10013430	425	28
10071897	425	28
10010839	425	28
10010840	425	28
10043926	425	28
10050078	425	28
10059470	425	28
10061629	425	28
10068080	425	28
10068090	425	28
10061714	425	28
10052910	425	28
10059251	425	28
10032391	425	28
10054547	425	28
10068650	425	28
10071356	425	28
10062798	425	28
10062076	425	28
10072730	425	28
10072460	425	28
10071899	425	28
10067149	516	28



10068486	516	28
10068497	516	28
10066841	516	28
10035686	516	28
10052889	516	28
10063075	516	28
10068486	516	28

Table 27: Mix Designs 31 to 35 MPa

Mix	GWP	MPa
10059679	405	31
10059820	478	31
10059825	478	31
10011129	332	31,5
10048473	332	31,5
10048455	332	31,5
10048456	332	31,5
10069603	332	31,5
10030712	332	31,5
10011127	332	31,5
10041259	332	31,5
10075120	332	31,5
10047430	332	31,5
10051240	332	31,5
10063564	332	31,5
10041264	387	31,5
10012962	387	31,5
10068477	387	31,5
10073533	387	31,5
10073534	387	31,5
10010863	387	31,5
10048472	387	31,5
10011125	387	31,5
10011126	387	31,5
10012850	387	31,5
10012855	387	31,5
10052911	387	31,5
10021898	387	31,5
10024162	387	31,5
10058166	387	31,5
10071622	387	31,5
10050589	387	31,5



10064971	387	31,5
10060318	387	31,5
10035117	387	31,5
10072425	387	31,5
10071750	464	31,5
10032252	464	31,5
10054034	568	31,5
10011145	358	35
10011136	390	35
10049916	390	35
10049917	390	35
10055955	390	35
10060000	390	35
10034867	390	35
10048474	390	35
10048475	390	35
10048476	390	35
10048457	390	35
10048458	390	35
10048459	390	35
10052035	390	35
10069604	390	35
10074630	390	35
10019611	390	35
10032357	390	35
10032356	390	35
10010874	390	35
10011134	390	35
10012884	390	35
10025176	390	35
10070280	390	35
10011147	390	35
10018040	390	35
10031234	390	35
10041258	390	35
10052913	390	35
10011180	390	35
10050073	390	35
10074014	390	35
10011480	390	35
10011778	390	35
10062780	390	35
10063197	390	35



10053707	390	35
10053708	390	35
10062782	390	35
10010886	423	35
10055007	423	35
10055793	423	35
10057471	423	35
10059823	423	35
10073605	423	35
10055006	423	35
10055792	423	35
10056368	423	35
10056369	423	35
10057470	423	35
10058098	423	35
10060183	423	35
10028491	423	35
10017971	423	35
10010789	423	35
10059062	423	35
10068089	423	35
10010891	423	35
10011026	423	35
10052087	423	35
10052088	423	35
10052091	423	35
10068623	423	35
10052912	423	35
10071658	423	35
10060281	423	35
10017770	423	35
10056056	423	35
10060247	423	35
10070085	423	35
10070272	423	35
10071731	423	35
10060282	423	35
10060283	423	35
10058150	423	35
10052402	423	35
10058226	509	35
10053780	509	35
10063149	509	35



10069485	509	35
10072303	509	35
10050998	509	35
10055647	509	35

Table 28: Mix Designs 36 to 40 MPa

Mix	GWP	MPa
10068395	538	36
10012424	363	38,5
10067929	580	40

Table 29: Mix Designs 41 to 45 MPa

Mix	GWP	MPa
10011154	401	42
10048460	401	42
10035113	401	42
10050246	430	42
10050424	430	42
10052794	430	42
10067430	430	42
10042671	430	42
10059392	430	42
10048443	430	42
10051137	430	42
10059471	430	42
10069605	430	42
10070132	430	42
10041240	430	42
10011152	430	42
10035114	430	42
10050245	430	42
10074632	430	42
10045443	430	42
10052914	430	42
10027316	430	42
10068108	430	42
10062823	430	42
10062609	430	42
10063198	430	42
10047946	499	42



10069395	499	42
10048322	499	42
10061690	499	42
10069841	499	42
10071621	499	42
10069395	544	42
10061691	536	42

Table 30: **Mix Designs 46 to 50 MPa**

Mix	GWP	MPa
10052062	442	49
10049786	442	49
10069647	442	49
10070133	442	49
10049785	442	49
10050183	442	49
10035230	566	56
10054187	538	63
10069793	688	70

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/>
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- USGBC LEED v4 for Building Design and Construction, 11 Jan 2019 available at <https://www.usgbc.org/resources/pcr-committee-process-resources-part-b>
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