# Environmental Product Declaration

**Environmental Product Declaration for various ready mix concrete products produced by Holcim México Operaciones S.A. de C.V. at their Vallejo facility in Azcapotzalco, Ciudad de México**

# ADMINISTRATIVE INFORMATION

## International Certified Environmental Product Declaration

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|---|---|
| **Declared Product:** | This Environmental Product Declaration (EPD) covers concrete products produced by Holcim México Operaciones S.A. de C.V.. Declared unit: 1 m3 of concrete |
| **Declaration Owner:** | Holcim México Operaciones S.A. de C.V.<br>Av. Prolongación Vasco de Quiroga #4800 Torre II Ofic. 101 Piso 1, Santa Fe Cuajimalpa de Morelos<br>Ciudad de México, México<br>www.holcim.com.mx |
| **Program Operator:** | Labeling Sustainability<br>11670 W Sunset Blvd.<br>Los Angeles, CA<br>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<br>Sub PCR Program Operator: NSF International<br>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.<br>Independent verification of the declaration, according to ISO 14025:2006<br>Internal ☐ ; External X<br>Third Party Verifier<br>Geoffrey Guest, Certified 3rd Party Verifier under the International EPD Program (www.environdec.com), CSA Group (www.csaregistries.ca) |
| **Date of Issue:** | 29 July 2023 |
| **Period of Validity:** | 5 years; valid until 29 July 2028 |
| **EPD Number:** | 6bba49bf-03c5-4c3e-9a16—a9a95627aa31 |

## TABLE OF CONTENTS

## COMPANY DESCRIPTION

Holcim Mexico produces and markets cement, ready-mix concrete, and other products and services for construction. The company has a nationwide presence through 7 cement plants with a current installed capacity to produce 12.6 million tons per year, 23 cement distribution centers, two maritime terminals, 1 Corporate Office, plus 35 ready-mix concrete plants, seven platforms, and a Geocycle transfer center, 26 commercial partners with more than 90 ready-mix concrete plants, more than 500 mixing pots, one aggregates plant and a Technological Innovation Center for Construction (CITEC).

Sustainable Development is an integral part of Lafarge Holcim's strategy around the world. Holcim Mexico has a clear vision of the future it wants for our country, which contributes to its development. Holcim Mexico's main objective is to create value. Creating value ensures long-term business success in covering the triple bottom line (i.e., social, economic, environmental values). Finally, good operating performance and a solid return on invested capital go hand in hand with sustainable development.

Holcim continues to invest in research and development. They have the Innovation and Development Center, located in Lyon (France), with satellite locations in various regions developing a comprehensive portfolio of innovators and sustainable solutions. These include different categories: inclusive business models, water management solutions, urban mining solutions (recycled aggregates), waste treatment services, energy-efficient solutions (insulating building materials), resource-efficient solutions (high recycled content, bags soluble cement), and low CO2 building materials.

Holcim operates with the belief that they can gain an advantage by developing knowledge and brand equity in the green building segment.

## STUDY GOAL

The intended application of this life cycle assessment (LCA) is to comply with the procedures for creating a Type III environmental product declaration (EPD) and publish the EPD for public review on the website, http://labelingsustainability.com/ . This level of study is in accordance with EPD Product Category Rule (PCR) for Ready Mix Concrete published by NSF International (2019) and is a sub-PCR of International Standards Organization (ISO) 21930:2017 Sustainability in buildings and civil works - Core rules for EPDs of construction products and services; International Standards Organization (ISO) 14025:2006 Environmental labels and declarations, Type III environmental declarations-Principles and procedures; ISO 14044:2006 Environmental management, Life cycle assessment- Requirements and guidelines; and ISO 14040:2006 Environmental management, Life cycle assessment-Principles and framework. The performance of this study and its subsequent publishing is in alignment with the business-to-business (B2B) communication requirements for the environmental assessment of building products. The study does not intend to support comparative assertions and is intended to be disclosed to the public.

This project report was commissioned to differentiate Holcim México Operaciones S.A. de C.V. from their competition for the following reasons: generate an advantage for the organization; offer customers information to help them make informed product decisions; improve the environmental performance of Holcim México Operaciones S.A. de C.V. by continuously measuring, controlling and reducing the environmental impacts of their products; help project facilitators working on Leadership

in Energy and Environmental Design (LEED) projects achieve their credit goal; and to strengthen Holcim México Operaciones S.A. de C.V.'s license to operate in the community. The intended audience for this LCA report is Holcim México Operaciones S.A. de C.V.'s employees, their suppliers, project specifiers of their products, architects, and engineers. The EPD report is also available for policy makers, government officials interested in sustainability, academic professors, and LCA professionals. This LCA report does not include product comparisons from other facilities.

## DESCRIPTION OF PRODUCT AND SCOPE

This EPD reports on 64 concrete mixes manufactured at the Holcim Mexico Operaciones S.A. de C.V. Vallejo concrete facility in Ciudad de Mexico, México.

This LCA assumes the impacts from products manufactured in accordance with the standards outlined in this report. This LCA is a cradle-to-gate study, and therefore, stages extending beyond the plant gate are not included in this LCA. Excluded stages include transportation of the manufactured material to the construction site; on-site construction processes and components; building (infrastructure) use and maintenance; and "end-of-life" effects.

## READY MIX CONCRETE DESIGN SUMMARY

The following tables provide a list of the ready mix concrete products considered in this EPD along with key performance parameters.

### Mix designs: 0 to 15 MPa

Table 1: **Declared products with Mix designs: 0 to 15MPa considered in this environmental product declaration**

| Mix# | Unique name/ID | Short description | Product type | 28 day strength, MPa | H2O to cement ratio |
|---|---|---|---|---|---|
| **1** | 37.40NB2012 | 0.039 MPa 28d strength Ready mix concrete | Ready mix concrete | 0.039 | 0.36 |
| **2** | 37.42NB2012 | 0.041 MPa 28d strength Ready mix concrete | Ready mix concrete | 0.041 | 0.39 |
| **3** | 37.45NB2012 | 0.044 MPa 28d strength Ready mix concrete | Ready mix concrete | 0.044 | 0.43 |
| **4** | 37.50NB2012 | 0.049 MPa 28d strength Ready mix concrete | Ready mix concrete | 0.049 | 0.48 |
| **5** | 37.55NB2012 | 0.054 MPa 28d strength Ready mix concrete | Ready mix concrete | 0.054 | 0.53 |
| **6** | 24005NB0518 | 0.491 MPa 28d strength mortars and fillers | Mortars and fillers | 0.491 | 4.45 |
| **7** | 60007NB1218 | 0.687 MPa 28d strength special concrete | Special concrete | 0.687 | 3.02 |
| **8** | 24007NB0520 | 0.687 MPa 28d strength mortars and fillers | Mortars and fillers | 0.687 | 4.40 |
| **9** | 24010NB0518 | 0.981 MPa 28d strength mortars and fillers | Mortars and fillers | 0.981 | 3.89 |
| **10** | 24015NB0518 | 1.472 MPa 28d strength mortars and fillers | Mortars and fillers | 1.472 | 3.21 |

| | | | | | |
|---|---|---|---|---|---|
| **11** | 24020NB0518 | 1.963 MPa 28d strength mortars and fillers | Mortars and fillers | 1.963 | 2.88 |
| **12** | 60025NB1218 | 2.453 MPa 28d strength special concrete | Special concrete | 2.453 | 2.04 |
| **13** | 24025NB0524 | 2.453 MPa 28d strength mortars and fillers | Mortars and fillers | 2.453 | 2.61 |
| **14** | 24030NB0520 | 2.944 MPa 28d strength mortars and fillers | Mortars and fillers | 2.944 | 2.39 |
| **15** | 77035NB4014 | 3.435 MPa 28d strength Ready mix concrete | Ready mix concrete | 3.435 | 0.82 |
| **16** | 68035ND4010 | 3.435 MPa 28d strength special concrete | Special concrete | 3.435 | 0.93 |
| **17** | 24035NB0518 | 3.435 MPa 28d strength mortars and fillers | Mortars and fillers | 3.435 | 2.20 |
| **18** | 39036NB4012 | 3.533 MPa 28d strength Ready mix concrete | Ready mix concrete | 3.533 | 0.71 |
| **19** | 39038NB4012 | 3.729 MPa 28d strength Ready mix concrete | Ready mix concrete | 3.729 | 0.67 |
| **20** | 39040NB4012 | 3.925 MPa 28d strength Ready mix concrete | Ready mix concrete | 3.925 | 0.63 |
| **21** | 24040NB0518 | 3.925 MPa 28d strength mortars and fillers | Mortars and fillers | 3.925 | 2.11 |
| **22** | 39042ND4012 | 4.122 MPa 28d strength Ready mix concrete | Ready mix concrete | 4.122 | 0.59 |
| **23** | 68042ND4010 | 4.122 MPa 28d strength special concrete | Special concrete | 4.122 | 0.67 |
| **24** | 77045ND4010 | 4.416 MPa 28d strength Ready mix concrete | Ready mix concrete | 4.416 | 0.61 |
| **25** | 68045ND4010 | 4.416 MPa 28d strength special concrete | Special concrete | 4.416 | 0.70 |
| **26** | 77048ND4010 | 4.711 MPa 28d strength Ready mix concrete | Ready mix concrete | 4.711 | 0.58 |
| **27** | 39050ND4010 | 4.907 MPa 28d strength Ready mix concrete | Ready mix concrete | 4.907 | 0.51 |
| **28** | 76050ND1218 | 4.907 MPa 28d strength special concrete | Special concrete | 4.907 | 1.06 |
| **29** | 24050NB0518 | 4.907 MPa 28d strength mortars and fillers | Mortars and fillers | 4.907 | 1.94 |
| **30** | 24060NB0514 | 5.888 MPa 28d strength mortars and fillers | Mortars and fillers | 5.888 | 1.93 |
| **31** | 70100ND2014 | 9.814 MPa 28d strength Ready mix concrete | Ready mix concrete | 9.814 | 1.45 |
| **32** | 76100ND1218 | 9.814 MPa 28d strength special concrete | Special concrete | 9.814 | 0.95 |
| **33** | 73100NB0514 | 9.814 MPa 28d strength mortars and fillers | Mortars and fillers | 9.814 | 1.50 |
| **34** | 01150NB2018 | 14.72 MPa 28d strength Ready mix concrete | Ready mix concrete | 14.720 | 1.18 |
| **35** | 27150NB1200 | 14.72 MPa 28d strength special concrete ,dry mix only | Special concrete | 14.720 | 0.00 |

| | | | | | |
|---|---|---|---|---|---|
| **36** | 73150NB0514 | 14.72 MPa 28d strength mortars and fillers | Mortars and fillers | 14.720 | 1.18 |

### Mix designs: 15 to 20 MPa

Table 2: **Declared products with Mix designs: 15 to 20MPa considered in this environmental product declaration**

| Mix# | Unique name/ID | Short description | Product type | 28 day strength, MPa | H2O to cement ratio |
|---|---|---|---|---|---|
| **37** | 70175NB2018 | 17.174 MPa 28d strength Ready mix concrete | Ready mix concrete | 17.174 | 1.12 |
| **38** | 70200ND2014 | 19.627 MPa 28d strength Ready mix concrete | Ready mix concrete | 19.627 | 1.03 |
| **39** | 27200NB1200 | 19.627 MPa 28d strength special concrete ,dry mix only | Special concrete | 19.627 | 0.00 |
| **40** | 73200NB0518 | 19.627 MPa 28d strength mortars and fillers | Mortars and fillers | 19.627 | 0.98 |

### Mix designs: 21 to 25 MPa

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

| Mix# | Unique name/ID | Short description | Product type | 28 day strength, MPa | H2O to cement ratio |
|---|---|---|---|---|---|
| **41** | 70210NB2014 | 20.608 MPa 28d strength Ready mix concrete | Ready mix concrete | 20.608 | 1.01 |
| **42** | 71250ND1210 | 24.534 MPa 28d strength Ready mix concrete | Ready mix concrete | 24.534 | 0.93 |
| **43** | 27250NB1200 | 24.534 MPa 28d strength special concrete ,dry mix only | Special concrete | 24.534 | 0.00 |
| **44** | 73250NB0518 | 24.534 MPa 28d strength mortars and fillers | Mortars and fillers | 24.534 | 0.85 |

### Mix designs: 26 to 30 MPa

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

| Mix# | Unique name/ID | Short description | Product type | 28 day strength, MPa | H2O to cement ratio |
|---|---|---|---|---|---|
| **45** | 70280ND2014 | 27.478 MPa 28d strength Ready mix concrete | Ready mix concrete | 27.478 | 0.85 |
| **46** | 70300NB2014 | 29.441 MPa 28d strength Ready mix concrete | Ready mix concrete | 29.441 | 0.80 |
| **47** | 56300NB1224 | 29.441 MPa 28d strength special concrete | Special concrete | 29.441 | 0.48 |

| | | | | | |
|---|---|---|---|---|---|
| **48** | 73300NB0518 | 29.441 MPa 28d strength mortars and fillers | Mortars and fillers | 29.441 | 0.76 |

### Mix designs: 31 to 35 MPa

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

| Mix# | Unique name/ID | Short description | Product type | 28 day strength, MPa | H2O to cement ratio |
|---|---|---|---|---|---|
| **49** | 70320ND2010 | 31.403 MPa 28d strength Ready mix concrete | Ready mix concrete | 31.403 | 0.74 |
| **50** | 70350NB2014 | 34.347 MPa 28d strength Ready mix concrete | Ready mix concrete | 34.347 | 0.70 |
| **51** | 40350NB1214 | 34.347 MPa 28d strength special concrete | Special concrete | 34.347 | 0.65 |
| **52** | 73350NB0518 | 34.347 MPa 28d strength mortars and fillers | Mortars and fillers | 34.347 | 0.69 |

### Mix designs: 36 to 40 MPa

Table 6: **Declared products with Mix designs: 36 to 40MPa considered in this environmental product declaration**

| Mix# | Unique name/ID | Short description | Product type | 28 day strength, MPa | H2O to cement ratio |
|---|---|---|---|---|---|
| **53** | 70360ND2010 | 35.329 MPa 28d strength Ready mix concrete | Ready mix concrete | 35.329 | 0.67 |
| **54** | 13400ND1210 | 39.254 MPa 28d strength Ready mix concrete | Ready mix concrete | 39.254 | 0.47 |
| **55** | 40400NB1218 | 39.254 MPa 28d strength special concrete | Special concrete | 39.254 | 0.46 |

### Mix designs: 41 to 45 MPa

Table 7: **Declared products with Mix designs: 41 to 45MPa considered in this environmental product declaration**

| Mix# | Unique name/ID | Short description | Product type | 28 day strength, MPa | H2O to cement ratio |
|---|---|---|---|---|---|
| **56** | 13450ND1212 | 44.161 MPa 28d strength Ready mix concrete | Ready mix concrete | 44.161 | 0.42 |
| **57** | 56450NB1265 | 44.161 MPa 28d strength special concrete | Special concrete | 44.161 | 0.37 |

### Mix designs: 46 to 50 MPa

Table 8: **Declared products with Mix designs: 46 to 50MPa considered in this environmental product declaration**

| Mix# | Unique name/ID | Short description | Product type | 28 day strength, MPa | H2O to cement ratio |
|---|---|---|---|---|---|
| **58** | 13500ND1212 | 49.068 MPa 28d strength Ready mix concrete | Ready mix concrete | 49.068 | 0.37 |
| **59** | 56500NB1265 | 49.068 MPa 28d strength special concrete | Special concrete | 49.068 | 0.35 |

### Mix designs: 51 to 55 MPa

Table 9: **Declared products with Mix designs: 51 to 55MPa considered in this environmental product declaration**

| Mix# | Unique name/ID | Short description | Product type | 28 day strength, MPa | H2O to cement ratio |
|---|---|---|---|---|---|
| **60** | 13550ND1212 | 53.974 MPa 28d strength Ready mix concrete | Ready mix concrete | 53.974 | 0.34 |

### Mix designs: 56 to 60 MPa

Table 10: **Declared products with Mix designs: 56 to 60MPa considered in this environmental product declaration**

| Mix# | Unique name/ID | Short description | Product type | 28 day strength, MPa | H2O to cement ratio |
|---|---|---|---|---|---|
| **61** | 13600NB2012 | 58.881 MPa 28d strength Ready mix concrete | Ready mix concrete | 58.881 | 0.34 |

### Mix designs: >60 MPa

Table 11: **Declared products with Mix designs: 56 to 60MPa considered in this environmental product declaration**

| Mix# | Unique name/ID | Short description | Product type | 28 day strength, MPa | H2O to cement ratio |
|---|---|---|---|---|---|
| **62** | 14650NB2024 | 63.788 MPa 28d strength Ready mix concrete | Ready mix concrete | 63.788 | 0.30 |
| **63** | 14700NB2024 | 68.695 MPa 28d strength Ready mix concrete | Ready mix concrete | 68.695 | 0.31 |
| **64** | 14750NB2024 | 73.602 MPa 28d strength Ready mix concrete | Ready mix concrete | 73.602 | 0.30 |

## READY MIX CONCRETE DESIGN COMPOSITION

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

Table 12: **Design composition**

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

## SYSTEM BOUNDARIES

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

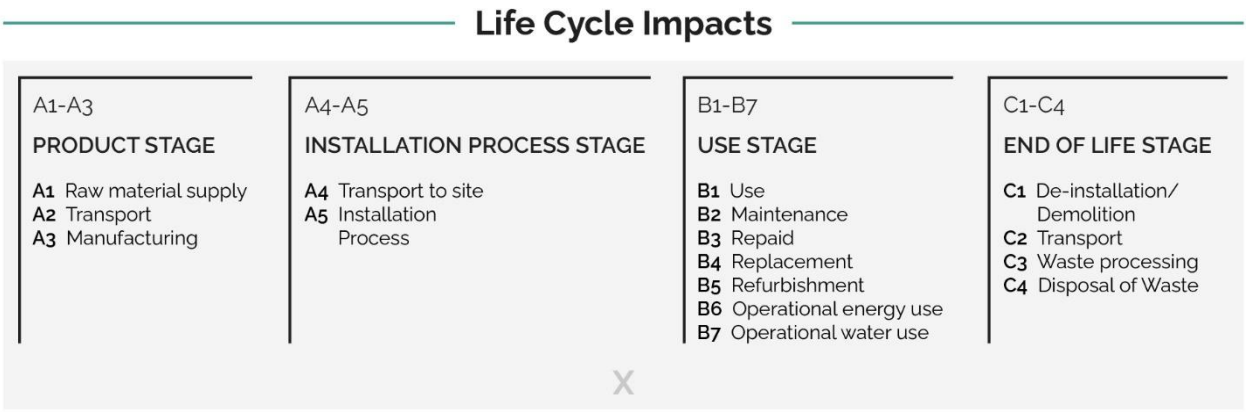


Figure 1: **General life cycle phases for consideration in a construction works system**

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

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

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

## System Boundary

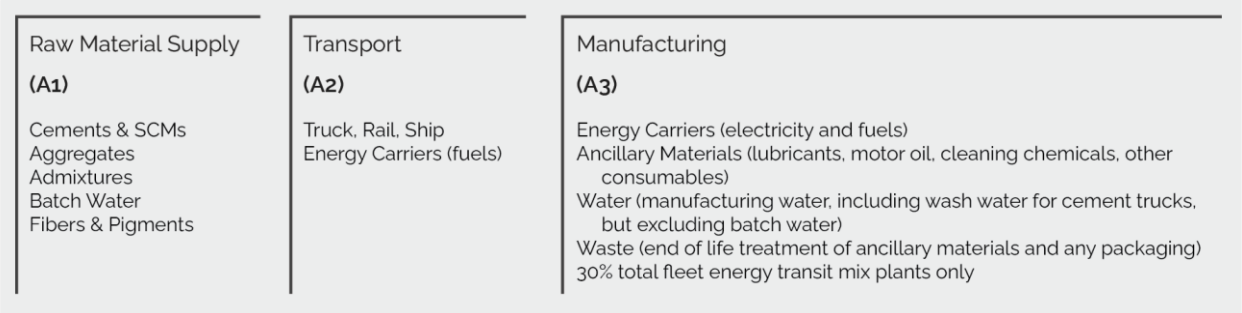


Figure 2: **General system inputs considered in the product system and categorized by modules in scope**

In addition, as according to the relevant PCR, the following requirements are excluded from this study:

- Production, manufacture and construction of A3 building/capital goods and infrastructure;
- Production and manufacture of steel production equipment, steel delivery vehicles, earth-moving equipment, and laboratory equipment;
- Personnel-related activities (travel, furniture, office supplies);
- Energy use related to company management and sales activities.

For this LCA the manufacturing plant, owned and operated by Holcim México Operaciones S.A. de C.V., is located at their Planta Vallejo facility in México. All operating data is formulated using the actual data from Holcim México Operaciones S.A. de C.V.'s plant at the above location, including water, energy consumption and waste generation. All inputs for this system boundary are calculated for the plant.

This life cycle inventory was organized in a spreadsheet and was then input into an RStudio environment where pre-calculated LCIA results for relevant products/activities stemming from the ecoinvent v3.8 database and a local EPD database in combination with primary data from Holcim México Operaciones S.A. de C.V. were utilized. Explanations of the contribution of each data source to this study are outlined in the section 'Data Sources and Quality'. Further LCI details for each declared product are provided in the sections 'Detailed LCI tables' and 'Transport tables' of the detailed LCA report. A parameter uncertainty analysis was also performed where key statistical results (e.g. min/mean/max etc.) are provided in the detailed LCA report.

## CUT-OFF CRITERIA

ISO 14044:2006 and the focus PCR requires the LCA model to contain a minimum of 95% of the total inflows (mass and energy) to the upstream and core modules be included in this study. The cut-off criteria were applied to all other processes unless otherwise noted above as follows. A 1% cut-off is considered for all renewable and non-renewable primary energy consumption and the total mass of inputs within a unit process where the total of the neglected inputs does not exceed 5%.

## DATA SOURCES AND DATA QUALITY ASSESSMENT

**Raw material transport**: A combination of actual mode/distance combinations were assumed for key bulk materials whereas ecoinvent default multi-modal market mix distances were assumed for other inputs where no original data could be provided.

**Electricity**: Electricity consumption values are for Holcim Mexico in calendar year 2022. These values were direct reported from Holcim records. The unit process "market for electricity, medium voltage/electricity, medium voltage/MX/kWh" was used to represent the Mexico grid electricity used by the concrete plant.

**Process/space heating**: No fuel is used for space heating at this plant.

**Fuel required for machinery**: Machinery-related fuel requirements were determined from direct Holcim information. The types of machinery used include generators, pumps to pump concrete to higher elevations, and transportation equipment used for moving materials.

**Waste generation**: Waste generation values are directly reported from Holcim operations for both bulk waste and hazardous waste. No High-level radioactive waste is generated on-site at this facility. Wash water values are direct reported water use from Holcim México for 2022.

**Recovered energy:** Not applicable.

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

**Module A1 material losses**: Due to lack of data, default loss factors of 5% were assumed. The PCR states" A3 shall include an assumption of 5% material loss unless product specific data is available and transparently reported in the project LCA report underlying the EPD;"

**Direct A3 emissions accounting**: Direct emissions are modeled using fuel and technology appropriate ecoinvent activities. See LCI input tables for details.

**Waste transport requirements**: Transportation distances are using estimated values. The waste hauler cannot guarantee the exact distances traveled due to the variation of route and actual location of disposal. Most waste disposal sites are near the plant therefore the 25 km distance is a representative estimate. Returned concrete and wash water, measured in kilograms, is based on direct Holcim reporting for the reference year 2022.

**Product transport requirements:** The diesel fuel used by the mixing trucks is direct primary information reported from Holcim México records for the year 2022. The concrete PCR allots 30% of the overall mixing truck total for stage A3 (manufacturing) for mixing the materials.

The following tables depict a list of assumed life cycle inventory utilized in the LCA modeling to generate the impact results across the life cycle modules in scope. An assessment of the quality of each LCI activities utilized from various sources is also provided.

Table 13: **LCI inputs assumed for module A1 (i.e. raw material supply)** ***Data Quality Assessment Key Fair=1, Good=2, Very Good =3.***

| Input | LCI.activity | Data.source | Geo | Year | Technology | Time | Geography | Reliability | Completeness |
|---|---|---|---|---|---|---|---|---|---|
| **Andesite sand** | basalt quarry operation/basalt/RoW/kg; Note: modifications made (see ecoinvent activity changes table) | ecoinvent v3.8 | Estado de México | v3.8 in 2021 | 2 | 3 | 1 | 3 | 3 |
| **Water** | tap water production, conventional with biological treatment/tap water/RoW/kg | ecoinvent v3.8 | Estado de Mexico | v3.8 in 2021 | 2 | 3 | 1 | 3 | 3 |
| **Limestone Gravel** | limestone quarry operation/limestone, unprocessed/RoW/kg ; Note: modifications made (see ecoinvent activity changes table) | ecoinvent v3.8 | Estado de Mexico | v3.8 in 2021 | 2 | 3 | 1 | 3 | 3 |
| **Additives** | market for chemical, organic/chemical, organic/GLO/kg | ecoinvent v3.8 | Estado de Mexico | v3.8 in 2021 | 2 | 3 | 1 | 3 | 3 |
| **Cement (CPC 40) Apaxco** | CPC 40 | Progam Operator: Labeling Sustainability- EPD ID: e38f688d-1fa5-41b0-a9b1-e5b1422ea654 | Estado de México | very good, 3rd party verfied facility - specific EPD dataset | 3 | NA | 3 | 3 | 3 |
| **CPC 40R CEMENTO PORTLAND GRANEL: Apaxco** | CPC 40R | Progam Operator: Labeling Sustainability- EPD ID: e38f688d-1fa5-41b0-a9b1-e5b1422ea654 | Estado de México | very good, 3rd party verfied facility - specific EPD dataset | 3 | NA | 3 | 3 | 3 |
| **Cement (CPO 30R R) PROVEEDOR** | CPC 30R | Progam Operator: Labeling | Veracruz | 25 Februa | 3 | 3 | 3 | 3 | 3 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **: HOLCI Orizaba** | | Sustainability- EPD ID: 565b7deb-ebd6-4cb3-9aa6-a585381c41f3 | | ry 2023 | | | | | |
| **Natural River sand** | sand quarry operation, extraction from river bed/sand/BR/kg; Note: modifications made (see ecoinvent activity changes table) | ecoinvent v3.8 | Morelos | v3.8 in 2021 | 2 | 3 | 1 | 3 | 3 |
| **Silica fume** | Waste input produced off-site | See A3 inputs | Texcoco | See A3 inputs | 3 | A3 | 3 | A3 | A3 |

## DATA QUALITY ASSESSMENT

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

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

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

**Consistency**: To ensure consistency, the same modeling structure across the respective product systems was utilized for all inputs, which consisted of raw material inputs and ancillary material, energy flows, water resource inputs, product, and co-products outputs, returned and recovered Ready Mix Concrete materials, emissions to air, water and soil, and waste recycling and treatment. The same background LCI datasets from the ecoinvent v3.8 database were used across all product systems. Crosschecks concerning the plausibility of mass and energy flows were continuously conducted. The LCA team conducted mass and energy balances at the plant and selected process level to maintain a high level of consistency.

**Reproducibility**: Internal reproducibility is possible since the data and the models are stored and available in a machine readable project file for all foreground and background processes, and in Labeling Sustainability's proprietary Ready Mix Concrete LCA calculator* for all production facility and product-specific calculations. A considerable level of transparency is provided throughout the detailed LCA report as the specifications and material quantity make-up for the declared products

are presented and key primary and secondary LCI data sources are summarized. The provision of more detailed publicly accessible data to allow full external reproducibility was not possible due to reasons of confidentiality.

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

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

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

## ENVIRONMENTAL INDICATORS AND INVENTORY METRICS

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

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

## TOTAL IMPACT SUMMARY

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

## Mix designs: 0 to 15 MPa

Table 14: **Total life cycle (across modules in scope) impact results for Mix designs: 0 to 15MPa, assuming the geometric mean point values on a per 1 m3 of concrete basis1**

### 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 | 21 | 0.0387 | 108 | 6.97e-06 | 0.266 | 0.000422 | 644 |
| Maximum | 369 | 0.399 | 651 | 5.12e-05 | 8.72 | 0.00135 | 4020 |
| Mean | 165 | 0.189 | 293 | 1.78e-05 | 3.71 | 0.000809 | 1460 |
| Median | 148 | 0.163 | 284 | 1.04e-05 | 3.41 | 0.000709 | 926 |
| 37.40NB2012 | 52.8 | 0.0922 | 651 | 5.12e-05 | 0.562 | 0.000924 | 4020 |
| 37.42NB2012 | 48.9 | 0.0856 | 593 | 4.73e-05 | 0.526 | 0.00086 | 3700 |
| 37.45NB2012 | 45.5 | 0.0798 | 539 | 4.39e-05 | 0.495 | 0.000807 | 3420 |
| 37.50NB2012 | 42.1 | 0.0741 | 489 | 4.05e-05 | 0.465 | 0.000753 | 3150 |
| 37.55NB2012 | 39 | 0.0688 | 440 | 3.73e-05 | 0.437 | 0.000704 | 2900 |
| 24005NB0518 | 88.4 | 0.0998 | 108 | 7.02e-06 | 2 | 0.000422 | 647 |
| 60007NB1218 | 21 | 0.0387 | 177 | 2.01e-05 | 0.266 | 0.00043 | 1540 |
| 24007NB0520 | 90 | 0.102 | 109 | 6.97e-06 | 2.04 | 0.000426 | 644 |
| 24010NB0518 | 98.7 | 0.111 | 117 | 7.14e-06 | 2.25 | 0.000456 | 660 |
| 24015NB0518 | 116 | 0.129 | 132 | 7.33e-06 | 2.66 | 0.000511 | 680 |
| 24020NB0518 | 127 | 0.141 | 142 | 7.46e-06 | 2.92 | 0.000546 | 694 |
| 60025NB1218 | 23.4 | 0.0427 | 222 | 2.27e-05 | 0.284 | 0.00046 | 1740 |
| 24025NB0524 | 144 | 0.159 | 156 | 7.43e-06 | 3.33 | 0.000595 | 695 |
| 24030NB0520 | 151 | 0.167 | 163 | 7.66e-06 | 3.49 | 0.000621 | 716 |
| 77035NB4014 | 284 | 0.312 | 285 | 1.05e-05 | 6.66 | 0.00109 | 927 |
| 68035ND4010 | 276 | 0.303 | 267 | 1.06e-05 | 6.47 | 0.00104 | 926 |
| 24035NB0518 | 160 | 0.177 | 171 | 7.82e-06 | 3.71 | 0.000652 | 731 |
| 39036NB4012 | 32.3 | 0.0574 | 338 | 3.06e-05 | 0.377 | 0.000591 | 2330 |
| 39038NB4012 | 33.2 | 0.0589 | 352 | 3.15e-05 | 0.385 | 0.000604 | 2400 |
| 39040NB4012 | 34.1 | 0.0604 | 365 | 3.23e-05 | 0.392 | 0.000617 | 2470 |
| 24040NB0518 | 167 | 0.184 | 177 | 7.89e-06 | 3.87 | 0.000673 | 739 |
| 39042ND4012 | 34.7 | 0.0613 | 374 | 3.28e-05 | 0.398 | 0.000626 | 2520 |
| 68042ND4010 | 359 | 0.392 | 351 | 1.13e-05 | 8.46 | 0.00133 | 1000 |
| 77045ND4010 | 348 | 0.381 | 342 | 1.13e-05 | 8.2 | 0.0013 | 1000 |
| 68045ND4010 | 358 | 0.392 | 336 | 1.13e-05 | 8.44 | 0.00128 | 1010 |
| 77048ND4010 | 365 | 0.399 | 357 | 1.14e-05 | 8.6 | 0.00135 | 1020 |
| 39050ND4010 | 37.7 | 0.0665 | 421 | 3.59e-05 | 0.425 | 0.000673 | 2760 |
| 76050ND1218 | 334 | 0.361 | 318 | 8.01e-06 | 7.88 | 0.00116 | 788 |
| 24050NB0518 | 180 | 0.198 | 189 | 8.03e-06 | 4.19 | 0.000714 | 754 |
| 24060NB0514 | 176 | 0.193 | 186 | 8.1e-06 | 4.08 | 0.000701 | 753 |
| 70100ND2014 | 208 | 0.23 | 217 | 9.45e-06 | 4.86 | 0.000844 | 846 |
| 76100ND1218 | 369 | 0.399 | 350 | 8.34e-06 | 8.72 | 0.00127 | 826 |
| 73100NB0514 | 228 | 0.25 | 233 | 8.86e-06 | 5.33 | 0.000873 | 832 |
| 01150NB2018 | 252 | 0.276 | 255 | 9.74e-06 | 5.9 | 0.000975 | 878 |
| 27150NB1200 | 333 | 0.363 | 328 | 1.04e-05 | 7.83 | 0.0012 | 938 |
| 73150NB0514 | 283 | 0.309 | 283 | 9.5e-06 | 6.65 | 0.00105 | 913 |

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 | 709 | 29.7 | 678 | 19.2 | 0.000529 | 0.323 | 17.3 | 0.00135 | 0 | 2.56e-05 | 0.0954 | 0.349 |
| Maximum | 4390 | 82.2 | 4330 | 106 | 0.00473 | 13.8 | 64.4 | 0.00485 | 0.365 | 2.56e-05 | 0.0954 | 0.349 |
| Mean | 1610 | 52.4 | 1560 | 40.9 | 0.00227 | 2.99 | 32.8 | 0.00243 | 0.29 | 2.56e-05 | 0.0954 | 0.349 |
| Median | 1040 | 52 | 984 | 28.2 | 0.00202 | 0.593 | 27.8 | 0.00201 | 0.306 | 2.56e-05 | 0.0954 | 0.349 |
| **37.40NB2012** | 4390 | 82.2 | 4330 | 106 | 0.00101 | 5.63 | 64.4 | 0.00485 | 0.243 | 2.56e-05 | 0.0954 | 0.349 |
| **37.42NB2012** | 4060 | 75.1 | 3970 | 98.1 | 0.000952 | 6.01 | 61.3 | 0.0046 | 0.24 | 2.56e-05 | 0.0954 | 0.349 |
| **37.45NB2012** | 3740 | 69.1 | 3660 | 90.4 | 0.000895 | 6.41 | 58.8 | 0.0044 | 0.236 | 2.56e-05 | 0.0954 | 0.349 |
| **37.50NB2012** | 3440 | 63.9 | 3380 | 83.5 | 0.000833 | 6.81 | 56.1 | 0.00418 | 0.234 | 2.56e-05 | 0.0954 | 0.349 |
| **37.55NB2012** | 3170 | 58.3 | 3100 | 77 | 0.00079 | 7.22 | 53.7 | 0.00399 | 0.233 | 2.56e-05 | 0.0954 | 0.349 |
| **24005NB0518** | 715 | 31 | 683 | 19.3 | 0.00127 | 0.514 | 17.4 | 0.00136 | 0.359 | 2.56e-05 | 0.0954 | 0.349 |
| **60007NB1218** | 1680 | 29.7 | 1640 | 41.8 | 0.000529 | 13.8 | 41.3 | 0.003 | 0.364 | 2.56e-05 | 0.0954 | 0.349 |
| **24007NB0520** | 709 | 31.3 | 678 | 19.2 | 0.0013 | 0.519 | 17.3 | 0.00135 | 0.363 | 2.56e-05 | 0.0954 | 0.349 |
| **24010NB0518** | 731 | 32.3 | 696 | 19.7 | 0.00142 | 0.52 | 17.7 | 0.00138 | 0.357 | 2.56e-05 | 0.0954 | 0.349 |
| **24015NB0518** | 755 | 35.3 | 718 | 20.3 | 0.00166 | 0.529 | 18.2 | 0.00141 | 0.354 | 2.56e-05 | 0.0954 | 0.349 |
| **24020NB0518** | 770 | 36.9 | 732 | 20.8 | 0.00172 | 0.535 | 18.6 | 0.00143 | 0.352 | 2.56e-05 | 0.0954 | 0.349 |
| **60025NB1218** | 1890 | 34.1 | 1850 | 46.8 | 0.000552 | 12.8 | 42.1 | 0.00307 | 0.355 | 2.56e-05 | 0.0954 | 0.349 |
| **24025NB0524** | 772 | 38.9 | 734 | 21.1 | 0.00195 | 0.557 | 18.6 | 0.00142 | 0.364 | 2.56e-05 | 0.0954 | 0.349 |
| **24030NB0520** | 798 | 40.8 | 758 | 21.7 | 0.00208 | 0.552 | 19.1 | 0.00147 | 0.352 | 2.56e-05 | 0.0954 | 0.349 |
| **77035NB4014** | 1050 | 56.9 | 989 | 28 | 0.00357 | 0.521 | 28.9 | 0.00203 | 0.248 | 2.56e-05 | 0.0954 | 0.349 |
| **68035ND4010** | 1040 | 55.8 | 980 | 27.7 | 0.00355 | 0.631 | 29.3 | 0.00206 | 0.271 | 2.56e-05 | 0.0954 | 0.349 |
| **24035NB0518** | 819 | 42.5 | 776 | 22.3 | 0.00217 | 0.553 | 19.6 | 0.0015 | 0.346 | 2.56e-05 | 0.0954 | 0.349 |
| **39036NB4012** | 2550 | 46.5 | 2510 | 62.3 | 0.000673 | 7.67 | 48.6 | 0.00358 | 0.227 | 2.56e-05 | 0.0954 | 0.349 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **39038NB40 12** | 2620 | 47.8 | 2570 | 64.1 | 0.000683 | 7.49 | 49.2 | 0.00363 | 0.226 | 2.56e-05 | 0.0954 | 0.349 |
| **39040NB40 12** | 2700 | 49.3 | 2650 | 65.5 | 0.000695 | 7.31 | 49.8 | 0.00368 | 0.225 | 2.56e-05 | 0.0954 | 0.349 |
| **24040NB05 18** | 828 | 43.4 | 778 | 22.5 | 0.00233 | 0.558 | 19.7 | 0.00151 | 0.346 | 2.56e-05 | 0.0954 | 0.349 |
| **39042ND40 12** | 2750 | 50.3 | 2690 | 66.8 | 0.000704 | 6.76 | 50 | 0.00369 | 0.217 | 2.56e-05 | 0.0954 | 0.349 |
| **68042ND40 10** | 1140 | 67.9 | 1070 | 30.6 | 0.00473 | 0.583 | 30.9 | 0.00216 | 0.258 | 2.56e-05 | 0.0954 | 0.349 |
| **77045ND40 10** | 1140 | 66.1 | 1060 | 30.4 | 0.00445 | 0.55 | 31 | 0.00216 | 0.232 | 2.56e-05 | 0.0954 | 0.349 |
| **68045ND40 10** | 1150 | 67.7 | 1080 | 30.7 | 0.00467 | 0.715 | 31.5 | 0.0022 | 0.269 | 2.56e-05 | 0.0954 | 0.349 |
| **77048ND40 10** | 1150 | 68.2 | 1080 | 31 | 0.00469 | 0.562 | 31.4 | 0.00219 | 0.233 | 2.56e-05 | 0.0954 | 0.349 |
| **39050ND40 10** | 3020 | 55.4 | 2940 | 73.4 | 0.000749 | 6.16 | 52.2 | 0.00387 | 0.215 | 2.56e-05 | 0.0954 | 0.349 |
| **76050ND12 18** | 907 | 64.8 | 842 | 25.1 | 0.00447 | 0.677 | 20.3 | 0.00148 | 0.365 | 2.56e-05 | 0.0954 | 0.349 |
| **24050NB05 18** | 844 | 45.4 | 803 | 22.9 | 0.00243 | 0.567 | 20.1 | 0.00153 | 0.346 | 2.56e-05 | 0.0954 | 0.349 |
| **24060NB05 14** | 846 | 44.5 | 797 | 22.9 | 0.00239 | 0.555 | 20.3 | 0.00155 | 0.336 | 2.56e-05 | 0.0954 | 0.349 |
| **70100ND20 14** | 951 | 46.9 | 898 | 25.2 | 0.00284 | 0.538 | 25.1 | 0.00183 | 0.307 | 2.56e-05 | 0.0954 | 0.349 |
| **76100ND12 18** | 958 | 70.1 | 882 | 26.4 | 0.00463 | 0.698 | 21.2 | 0.00154 | 0.362 | 2.56e-05 | 0.0954 | 0.349 |
| **73100NB05 14** | 938 | 53.8 | 884 | 25.6 | 0.00303 | 0.603 | 22.3 | 0.00169 | 0.343 | 2.56e-05 | 0.0954 | 0.349 |
| **01150NB20 18** | 992 | 53.6 | 933 | 26.5 | 0.00336 | 0.566 | 25.9 | 0.00187 | 0.305 | 2.56e-05 | 0.0954 | 0.349 |
| **27150NB12 00** | 1070 | 68.5 | 993 | 29.6 | 0.00436 | 0.323 | 26.6 | 0.00199 | 0 | 2.56e-05 | 0.0954 | 0.349 |
| **73150NB05 14** | 1030 | 62.1 | 971 | 28.3 | 0.00366 | 0.64 | 23.8 | 0.00179 | 0.34 | 2.56e-05 | 0.0954 | 0.349 |

## Mix designs: 15 to 20 MPa

Table 15: **Total life cycle (across modules in scope) impact results for Mix designs: 15 to 20MPa, assuming the geometric mean point values on a per 1 m3 of concrete basis**

### 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** | 272 | 0.298 | 273 | 1e-05 | 6.37 | 0.00104 | 908 |
| **Maximum** | 365 | 0.397 | 356 | 1.07e-05 | 8.59 | 0.00129 | 972 |
| **Mean** | 316 | 0.345 | 312 | 1.02e-05 | 7.42 | 0.00116 | 943 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Median** | 314 | 0.342 | 310 | 1.01e-05 | 7.37 | 0.00116 | 946 |
| **70175NB2018** | 272 | 0.298 | 273 | 1e-05 | 6.37 | 0.00104 | 908 |
| **70200ND2014** | 280 | 0.307 | 281 | 1.02e-05 | 6.57 | 0.00107 | 924 |
| **27200NB1200** | 365 | 0.397 | 356 | 1.07e-05 | 8.59 | 0.00129 | 967 |
| **73200NB0518** | 347 | 0.377 | 339 | 1e-05 | 8.17 | 0.00125 | 972 |

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** | 1020 | 57.1 | 965 | 27.6 | 0.00348 | 0.345 | 25.3 | 0.00188 | 0 | 2.56e-05 | 0.0954 | 0.349 |
| **Maximum** | 1110 | 74.8 | 1030 | 30.6 | 0.00464 | 0.691 | 27.4 | 0.00204 | 0.348 | 2.56e-05 | 0.0954 | 0.349 |
| **Mean** | 1070 | 65.2 | 1000 | 29.2 | 0.00407 | 0.551 | 26.6 | 0.00195 | 0.24 | 2.56e-05 | 0.0954 | 0.349 |
| **Median** | 1080 | 64.5 | 1010 | 29.3 | 0.00408 | 0.584 | 27 | 0.00194 | 0.306 | 2.56e-05 | 0.0954 | 0.349 |
| **70175NB2018** | 1020 | 57.1 | 965 | 27.6 | 0.00348 | 0.588 | 26.6 | 0.00192 | 0.312 | 2.56e-05 | 0.0954 | 0.349 |
| **70200ND2014** | 1040 | 57.7 | 987 | 28.1 | 0.00365 | 0.58 | 27.3 | 0.00196 | 0.299 | 2.56e-05 | 0.0954 | 0.349 |
| **27200NB1200** | 1110 | 74.8 | 1030 | 30.6 | 0.00464 | 0.345 | 27.4 | 0.00204 | 0 | 2.56e-05 | 0.0954 | 0.349 |
| **73200NB0518** | 1110 | 71.3 | 1030 | 30.5 | 0.00451 | 0.691 | 25.3 | 0.00188 | 0.348 | 2.56e-05 | 0.0954 | 0.349 |

## Mix designs: 21 to 25 MPa

Table 16: **Total life cycle (across modules in scope) impact results for Mix designs: 21 to 25MPa, assuming the geometric mean point values on a per 1 m3 of concrete basis**

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** | 287 | 0.315 | 288 | 1.01e-05 | 6.74 | 0.00109 | 931 |
| **Maximum** | 398 | 0.432 | 385 | 1.1e-05 | 9.38 | 0.00141 | 1030 |
| **Mean** | 348 | 0.379 | 341 | 1.05e-05 | 8.2 | 0.00126 | 980 |
| **Median** | 354 | 0.385 | 346 | 1.04e-05 | 8.33 | 0.00128 | 979 |
| **70210NB2014** | 287 | 0.315 | 288 | 1.03e-05 | 6.74 | 0.00109 | 931 |
| **71250ND1210** | 311 | 0.339 | 309 | 1.01e-05 | 7.31 | 0.00115 | 961 |
| **27250NB1200** | 398 | 0.432 | 385 | 1.1e-05 | 9.38 | 0.0014 | 997 |
| **73250NB0518** | 397 | 0.431 | 383 | 1.05e-05 | 9.35 | 0.00141 | 1030 |

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 | 1050 | 58 | 992 | 28.3 | 0.00374 | 0.367 | 25.3 | 0.0019 | 0 | 2.56e-05 | 0.0954 | 0.349 |
| Maximum | 1170 | 79.5 | 1090 | 32.3 | 0.0052 | 0.727 | 28.3 | 0.0021 | 0.349 | 2.56e-05 | 0.0954 | 0.349 |
| Mean | 1120 | 70.6 | 1040 | 30.6 | 0.00451 | 0.576 | 26.8 | 0.00198 | 0.238 | 2.56e-05 | 0.0954 | 0.349 |
| Median | 1120 | 72.4 | 1040 | 31 | 0.00454 | 0.605 | 26.9 | 0.0019 | 0.3 | 2.56e-05 | 0.0954 | 0.349 |
| 70210NB2014 | 1050 | 58 | 992 | 28.3 | 0.00374 | 0.589 | 27.3 | 0.0019 | 0.302 | 2.56e-05 | 0.0954 | 0.349 |
| 71250ND1210 | 1090 | 66.7 | 1020 | 30.1 | 0.00408 | 0.621 | 25.3 | 0.0019 | 0.299 | 2.56e-05 | 0.0954 | 0.349 |
| 27250NB1200 | 1150 | 79.5 | 1060 | 31.8 | 0.005 | 0.367 | 28.3 | 0.0021 | 0 | 2.56e-05 | 0.0954 | 0.349 |
| 73250NB0518 | 1170 | 78.1 | 1090 | 32.3 | 0.0052 | 0.727 | 26.5 | 0.0019 | 0.349 | 2.56e-05 | 0.0954 | 0.349 |

## Mix designs: 26 to 30 MPa

Table 17: **Total life cycle (across modules in scope) impact results for Mix designs: 26 to 30MPa, assuming the geometric mean point values on a per 1 m3 of concrete basis**

a) Midpoint Impact Categories:

| Indicator/LCI Metric | AP | EP | GWP | ODP | PCOP | ADPe | ADPf |
|---|---|---|---|---|---|---|---|
| Unit | moles of H+-Eq | kg N | kg CO2-Eq | kg CFC-11-Eq | kg NOx-Eq | kg Sb-Eq | MJ, net calorific value |
| Minimum | 335 | 0.366 | 330 | 1.08e-05 | 7.88 | 0.00124 | 980 |
| Maximum | 471 | 0.516 | 467 | 1.59e-05 | 11.1 | 0.00178 | 1440 |
| Mean | 403 | 0.44 | 394 | 1.22e-05 | 9.49 | 0.00148 | 1130 |
| Median | 403 | 0.438 | 390 | 1.1e-05 | 9.49 | 0.00144 | 1040 |
| 70280ND2014 | 335 | 0.366 | 330 | 1.08e-05 | 7.88 | 0.00124 | 980 |
| 70300NB2014 | 360 | 0.392 | 352 | 1.1e-05 | 8.48 | 0.00132 | 1010 |
| 56300NB1224 | 471 | 0.516 | 467 | 1.59e-05 | 11.1 | 0.00178 | 1440 |
| 73300NB0518 | 446 | 0.484 | 427 | 1.1e-05 | 10.5 | 0.00157 | 1080 |

b) Inventory Metrics:

| Indicator/LCI Metric | TPE | RE | NRE | NRR | RR | WDP | LFW | LFHW | CBWC | CWWC | CHW | CNHW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Unit | MJ-Eq | MJ-Eq | MJ-Eq | kg | m3 | m3 | kg waste | kg waste | m3 | m3 | kg | kg |
| Minimum | 1110 | 66.4 | 1050 | 30.1 | 0.00436 | 0.616 | 27.8 | 0.00204 | 0.246 | 2.56e-05 | 0.0954 | 0.349 |
| Maximum | 1620 | 87.9 | 1540 | 43.3 | 0.0062 | 8.75 | 44 | 0.00305 | 0.351 | 2.56e-05 | 0.0954 | 0.349 |
| Mean | 1280 | 77.7 | 1200 | 34.6 | 0.00526 | 2.69 | 32.4 | 0.00231 | 0.299 | 2.56e-05 | 0.0954 | 0.349 |
| Median | 1200 | 78.2 | 1120 | 32.6 | 0.00524 | 0.701 | 29 | 0.00206 | 0.3 | 2.56e-05 | 0.0954 | 0.349 |
| 70280ND2014 | 1110 | 66.4 | 1050 | 30.1 | 0.00436 | 0.616 | 28.8 | 0.00205 | 0.298 | 2.56e-05 | 0.0954 | 0.349 |
| 70300NB2014 | 1150 | 71 | 1070 | 31 | 0.00467 | 0.638 | 29.2 | 0.00208 | 0.301 | 2.56e-05 | 0.0954 | 0.349 |
| 56300NB1224 | 1620 | 87.9 | 1540 | 43.3 | 0.0062 | 8.75 | 44 | 0.00305 | 0.246 | 2.56e-05 | 0.0954 | 0.349 |
| 73300NB0518 | 1250 | 85.4 | 1160 | 34.1 | 0.00582 | 0.764 | 27.8 | 0.00204 | 0.351 | 2.56e-05 | 0.0954 | 0.349 |

## Mix designs: 31 to 35 MPa

Table 18: **Total life cycle (across modules in scope) impact results for Mix designs: 31 to 35MPa, assuming the geometric mean point values on a per 1 m3 of concrete basis**

a) Midpoint Impact Categories:

| Indicator/LCI Metric | AP | EP | GWP | ODP | PCOP | ADPe | ADPf |
|---|---|---|---|---|---|---|---|
| Unit | moles of H+-Eq | kg N | kg CO2-Eq | kg CFC-11-Eq | kg NOx-Eq | kg Sb-Eq | MJ, net calorific value |
| Minimum | 371 | 0.404 | 362 | 1.12e-05 | 8.73 | 0.00136 | 1020 |
| Maximum | 496 | 0.537 | 471 | 1.15e-05 | 11.7 | 0.00172 | 1130 |
| Mean | 438 | 0.475 | 420 | 1.14e-05 | 10.3 | 0.00155 | 1080 |
| Median | 442 | 0.479 | 423 | 1.14e-05 | 10.4 | 0.00156 | 1080 |
| 70320ND2010 | 371 | 0.404 | 362 | 1.12e-05 | 8.73 | 0.00136 | 1020 |
| 70350NB2014 | 415 | 0.451 | 400 | 1.15e-05 | 9.79 | 0.00149 | 1060 |
| 40350NB1214 | 468 | 0.507 | 446 | 1.14e-05 | 11 | 0.00163 | 1110 |
| 73350NB0518 | 496 | 0.537 | 471 | 1.15e-05 | 11.7 | 0.00172 | 1130 |

b) Inventory Metrics:

| Indicator/LCI Metric | TPE | RE | NRE | NRR | RR | WDP | LFW | LFHW | CBWC | CWWC | CHW | CNHW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Unit | MJ-Eq | MJ-Eq | MJ-Eq | kg | m3 | m3 | kg waste | kg waste | m3 | m3 | kg | kg |
| Minimum | 1160 | 71.2 | 1090 | 31.5 | 0.00485 | 0.634 | 28.7 | 0.00211 | 0.291 | 2.56e-05 | 0.0954 | 0.349 |
| Maximum | 1310 | 94.5 | 1210 | 36 | 0.00627 | 0.801 | 30.7 | 0.00217 | 0.353 | 2.56e-05 | 0.0954 | 0.349 |
| Mean | 1240 | 83 | 1150 | 33.9 | 0.00566 | 0.715 | 29.6 | 0.00213 | 0.316 | 2.56e-05 | 0.0954 | 0.349 |
| Median | 1240 | 83.1 | 1160 | 34.1 | 0.00575 | 0.712 | 29.4 | 0.00213 | 0.31 | 2.56e-05 | 0.0954 | 0.349 |
| 70320ND2010 | 1160 | 71.2 | 1090 | 31.5 | 0.00485 | 0.634 | 29.9 | 0.00213 | 0.291 | 2.56e-05 | 0.0954 | 0.349 |
| 70350NB2014 | 1210 | 77.1 | 1130 | 32.9 | 0.00539 | 0.678 | 30.7 | 0.00217 | 0.303 | 2.56e-05 | 0.0954 | 0.349 |
| 40350NB1214 | 1280 | 89.1 | 1180 | 35.3 | 0.00611 | 0.746 | 28.7 | 0.00211 | 0.317 | 2.56e-05 | 0.0954 | 0.349 |
| 73350NB0518 | 1310 | 94.5 | 1210 | 36 | 0.00627 | 0.801 | 29 | 0.00212 | 0.353 | 2.56e-05 | 0.0954 | 0.349 |

## Mix designs: 36 to 40 MPa

Table 19: **Total life cycle (across modules in scope) impact results for Mix designs: 36 to 40MPa, 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 | 414 | 0.45 | 399 | 1.16e-05 | 9.76 | 0.00149 | 1060 |
| Maximum | 569 | 0.616 | 537 | 1.51e-05 | 13.5 | 0.00196 | 1380 |
| Mean | 479 | 0.521 | 462 | 1.31e-05 | 11.3 | 0.00172 | 1220 |
| Median | 455 | 0.498 | 450 | 1.27e-05 | 10.7 | 0.00172 | 1220 |
| 70360ND2010 | 414 | 0.45 | 399 | 1.16e-05 | 9.76 | 0.00149 | 1060 |
| 13400ND1210 | 455 | 0.498 | 450 | 1.51e-05 | 10.7 | 0.00172 | 1380 |
| 40400NB1218 | 569 | 0.616 | 537 | 1.27e-05 | 13.5 | 0.00196 | 1220 |

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 | 1210 | 77.7 | 1130 | 33.1 | 0.00523 | 0.665 | 31 | 0.00219 | 0.233 | 2.56e-05 | 0.0954 | 0.349 |
| Maximum | 1560 | 105 | 1470 | 41.6 | 0.00728 | 6.75 | 41.6 | 0.00289 | 0.293 | 2.56e-05 | 0.0954 | 0.349 |
| Mean | 1390 | 89.3 | 1300 | 37.9 | 0.00613 | 2.73 | 35.2 | 0.00248 | 0.268 | 2.56e-05 | 0.0954 | 0.349 |
| Median | 1410 | 85.2 | 1300 | 39 | 0.00587 | 0.77 | 33.1 | 0.00237 | 0.279 | 2.56e-05 | 0.0954 | 0.349 |
| 70360ND2010 | 1210 | 77.7 | 1130 | 33.1 | 0.00523 | 0.665 | 31 | 0.00219 | 0.293 | 2.56e-05 | 0.0954 | 0.349 |
| 13400ND1210 | 1560 | 85.2 | 1470 | 41.6 | 0.00587 | 6.75 | 41.6 | 0.00289 | 0.233 | 2.56e-05 | 0.0954 | 0.349 |
| 40400NB1218 | 1410 | 105 | 1300 | 39 | 0.00728 | 0.77 | 33.1 | 0.00237 | 0.279 | 2.56e-05 | 0.0954 | 0.349 |

**Mix designs: 41 to 45 MPa**

Table 20: **Total life cycle (across modules in scope) impact results for Mix designs: 41 to 45MPa, assuming the geometric mean point values on a per 1 m3 of concrete basis**

a) Midpoint Impact Categories:

| 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 | 528 | 0.576 | 514 | 1.56e-05 | 12.5 | 0.00195 | 1450 |
| Maximum | 687 | 0.747 | 659 | 1.76e-05 | 16.3 | 0.0025 | 1770 |
| Mean | 608 | 0.662 | 586 | 1.66e-05 | 14.4 | 0.00222 | 1610 |
| Median | 608 | 0.662 | 586 | 1.66e-05 | 14.4 | 0.00222 | 1610 |
| 13450ND1212 | 528 | 0.576 | 514 | 1.56e-05 | 12.5 | 0.00195 | 1450 |
| 56450NB1265 | 687 | 0.747 | 659 | 1.76e-05 | 16.3 | 0.0025 | 1770 |

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 | 1650 | 94.5 | 1550 | 44.4 | 0.00696 | 6.35 | 42.8 | 0.00296 | 0.24 | 2.56e-05 | 0.0954 | 0.349 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Maximum** | 2030 | 124 | 1900 | 54.6 | 0.00873 | 6.78 | 46.8 | 0.00325 | 0.272 | 2.56e-05 | 0.0954 | 0.349 |
| **Mean** | 1840 | 109 | 1720 | 49.5 | 0.00784 | 6.56 | 44.8 | 0.0031 | 0.256 | 2.56e-05 | 0.0954 | 0.349 |
| **Median** | 1840 | 109 | 1720 | 49.5 | 0.00784 | 6.56 | 44.8 | 0.0031 | 0.256 | 2.56e-05 | 0.0954 | 0.349 |
| **13450ND1212** | 1650 | 94.5 | 1550 | 44.4 | 0.00696 | 6.35 | 42.8 | 0.00296 | 0.24 | 2.56e-05 | 0.0954 | 0.349 |
| **56450NB1265** | 2030 | 124 | 1900 | 54.6 | 0.00873 | 6.78 | 46.8 | 0.00325 | 0.272 | 2.56e-05 | 0.0954 | 0.349 |

## Mix designs: 46 to 50 MPa

Table 21: **Total life cycle (across modules in scope) impact results for Mix designs: 46 to 50MPa, assuming the geometric mean point values on a per 1 m3 of concrete basis**

### a) Midpoint Impact Categories:

| **Indicator/LCI Metric** | **AP** | **EP** | **GWP** | **ODP** | **PCOP** | **ADPe** | **ADPf** |
|---|---|---|---|---|---|---|---|
| **Unit** | **moles of H+-Eq** | **kg N** | **kg CO2-Eq** | **kg CFC-11-Eq** | **kg NOx-Eq** | **kg Sb-Eq** | **MJ, net calorific value** |
| **Minimum** | 588 | 0.64 | 567 | 1.61e-05 | 13.9 | 0.00214 | 1520 |
| **Maximum** | 737 | 0.8 | 703 | 1.8e-05 | 17.4 | 0.00266 | 1830 |
| **Mean** | 662 | 0.72 | 635 | 1.7e-05 | 15.6 | 0.0024 | 1680 |
| **Median** | 662 | 0.72 | 635 | 1.7e-05 | 15.6 | 0.0024 | 1680 |
| **13500ND1212** | 588 | 0.64 | 567 | 1.61e-05 | 13.9 | 0.00214 | 1520 |
| **56500NB1265** | 737 | 0.8 | 703 | 1.8e-05 | 17.4 | 0.00266 | 1830 |

### 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** | 1730 | 107 | 1620 | 46.8 | 0.00763 | 6.03 | 43.9 | 0.00303 | 0.242 | 2.56e-05 | 0.0954 | 0.349 |
| **Maximum** | 2110 | 132 | 1970 | 56.6 | 0.00965 | 6.4 | 47.6 | 0.00331 | 0.275 | 2.56e-05 | 0.0954 | 0.349 |
| **Mean** | 1920 | 120 | 1800 | 51.7 | 0.00864 | 6.22 | 45.8 | 0.00317 | 0.258 | 2.56e-05 | 0.0954 | 0.349 |
| **Median** | 1920 | 120 | 1800 | 51.7 | 0.00864 | 6.22 | 45.8 | 0.00317 | 0.258 | 2.56e-05 | 0.0954 | 0.349 |
| **13500ND1212** | 1730 | 107 | 1620 | 46.8 | 0.00763 | 6.03 | 43.9 | 0.00303 | 0.242 | 2.56e-05 | 0.0954 | 0.349 |
| **56500NB1265** | 2110 | 132 | 1970 | 56.6 | 0.00965 | 6.4 | 47.6 | 0.00331 | 0.275 | 2.56e-05 | 0.0954 | 0.349 |

## Mix designs: 51 to 55 MPa

Table 22: **Total life cycle (across modules in scope) impact results for Mix designs: 51 to 55MPa, assuming the geometric mean point values on a per 1 m3 of concrete basis**

a) Midpoint Impact Categories:

| Indicator/LCI Metric | AP | EP | GWP | ODP | PCOP | ADPe | ADPf |
|---|---|---|---|---|---|---|---|
| Unit | moles of H+-Eq | kg N | kg CO2-Eq | kg CFC-11-Eq | kg NOx-Eq | kg Sb-Eq | MJ, net calorific value |
| **13550ND1212** | 649 | 0.705 | 621 | 1.66e-05 | 15.4 | 0.00233 | 1580 |

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 |
| **13550ND1212** | 1810 | 115 | 1700 | 49 | 0.00858 | 5.72 | 44.9 | 0.0031 | 0.243 | 2.56e-05 | 0.0954 | 0.349 |

## Mix designs: 56 to 60 MPa

Table 23: **Total life cycle (across modules in scope) impact results for Mix designs: 56 to 60MPa, assuming the geometric mean point values on a per 1 m3 of concrete basis**

a) Midpoint Impact Categories:

| Indicator/LCI Metric | AP | EP | GWP | ODP | PCOP | ADPe | ADPf |
|---|---|---|---|---|---|---|---|
| Unit | moles of H+-Eq | kg N | kg CO2-Eq | kg CFC-11-Eq | kg NOx-Eq | kg Sb-Eq | MJ, net calorific value |
| **13600NB2012** | 671 | 0.729 | 642 | 1.7e-05 | 15.9 | 0.00241 | 1640 |

b) Inventory Metrics:

| Indicator/LCI Metric | TPE | RE | NRE | NRR | RR | WDP | LFW | LFHW | CBWC | CWWC | CHW | CNHW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Unit | MJ-Eq | MJ-Eq | MJ-Eq | kg | m3 | m3 | kg waste | kg waste | m3 | m3 | kg | kg |
| **13600NB2012** | 1880 | 118 | 1760 | 50.7 | 0.0085 | 6.09 | 46.1 | 0.00319 | 0.25 | 2.56e-05 | 0.0954 | 0.349 |

### Mix designs: >60 MPa

Table 24: **Total life cycle (across modules in scope) impact results for Mix designs: >60MPa, assuming the geometric mean point values on a per 1 m3 of concrete basis**

a) Midpoint Impact Categories:

| Indicator/LCI Metric | AP | EP | GWP | ODP | PCOP | ADPe | ADPf |
|---|---|---|---|---|---|---|---|
| Unit | moles of H+-Eq | kg N | kg CO2-Eq | kg CFC-11-Eq | kg NOx-Eq | kg Sb-Eq | MJ, net calorific value |
| Minimum | 724 | 0.785 | 686 | 1.67e-05 | 17.2 | 0.00258 | 1700 |
| Maximum | 733 | 0.795 | 695 | 1.69e-05 | 17.4 | 0.00263 | 1770 |
| Mean | 729 | 0.791 | 691 | 1.68e-05 | 17.3 | 0.00261 | 1740 |
| Median | 731 | 0.792 | 692 | 1.68e-05 | 17.3 | 0.00261 | 1740 |
| 14650NB2024 | 724 | 0.785 | 686 | 1.67e-05 | 17.2 | 0.00258 | 1700 |
| 14700NB2024 | 731 | 0.792 | 692 | 1.68e-05 | 17.3 | 0.00261 | 1740 |
| 14750NB2024 | 733 | 0.795 | 695 | 1.69e-05 | 17.4 | 0.00263 | 1770 |

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 | 1950 | 126 | 1820 | 52.7 | 0.0094 | 3.25 | 44.1 | 0.00306 | 0.24 | 2.56e-05 | 0.0954 | 0.349 |
| Maximum | 2030 | 129 | 1900 | 55 | 0.00951 | 3.54 | 44.3 | 0.00306 | 0.246 | 2.56e-05 | 0.0954 | 0.349 |
| Mean | 1990 | 128 | 1860 | 53.8 | 0.00945 | 3.4 | 44.2 | 0.00306 | 0.243 | 2.56e-05 | 0.0954 | 0.349 |
| Median | 2000 | 128 | 1860 | 53.8 | 0.00945 | 3.4 | 44.2 | 0.00306 | 0.244 | 2.56e-05 | 0.0954 | 0.349 |
| 14650NB2024 | 1950 | 126 | 1820 | 52.7 | 0.00951 | 3.54 | 44.1 | 0.00306 | 0.24 | 2.56e-05 | 0.0954 | 0.349 |
| 14700NB2024 | 2000 | 129 | 1860 | 53.8 | 0.00945 | 3.4 | 44.2 | 0.00306 | 0.246 | 2.56e-05 | 0.0954 | 0.349 |
| 14750NB2024 | 2030 | 128 | 1900 | 55 | 0.0094 | 3.25 | 44.3 | 0.00306 | 0.244 | 2.56e-05 | 0.0954 | 0.349 |

## ADDITIONAL ENVIRONMENTAL INFO

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

## REFERENCES

**ASTM Standards:**

- ASTM A36/A36M Standard Specification for Carbon Structural Steel

- ASTM A108 Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished
- ASTM A123/A123M Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
- ASTM A153/A153M Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
- ASTM A184 Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement
- ASTM A307 Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength
- ASTM A416/A416M Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete
- ASTM A555/A555M Standard Specification for General Requirements for Stainless Steel Wire and Wire Rods
- ASTM A615/A615M Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
- ASTM A666 Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar
- ASTM A706/A706M Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement
- ASTM A767/A767M Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement
- ASTM A775/A775M Standard Specification for Epoxy-Coated Steel Reinforcing Bars
- ASTM A820/A820M Standard Specification for Steel Fibers for Fiber-Reinforced Concrete
- ASTM A884/A884M Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement
- ASTM A934/A934M Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars
- ASTM A1064/A1064M Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
- ASTM C33/C33M Standard Specification for Concrete Aggregates
- ASTM C94 Standard Specification for Ready-Mixed Concrete
- ASTM C150/C150M Standard Specification for Portland Cement
- ASTM C260/C260M Standard Specification for Air-Entraining Admixtures for Concrete
- ASTM C595 Standard Specification for Blended Hydraulic Cements
- ASTM C618 Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
- ASTM C979/C979M Standard Specification for Pigments for Integrally Colored Concrete
- ASTM C989/C989M Standard Specification for Slag Cement for Use in Concrete and Mortars
- ASTM C1017/C1017M Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
- ASTM C1116/C1116M Standard Specification for Fiber-Reinforced Concrete
- ASTM C1157/C1157M Standard Performance Specification for Hydraulic Cement
- ASTM C1240 Standard Specification for Silica Fume Used in Cementitious Mixtures

- ASTM C1602/C1602M Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
- ASTM G109 Standard Test Method for Determining Effects of Chemical Admixtures on Corrosion of Embedded Steel Reinforcement in Concrete Exposed to Chloride Environments
- ASTM C330/C330M Standard Specification for Lightweight Aggregates for Structural Concrete
- ASTM C494/C494M Standard Specification for Chemical Admixtures for Concrete

**CSA Standards:**

- CAN/CGSB-1.40 Anticorrosive Structural Steel Alkyd Primer
- CAN/CSA G30.18 Carbon steel bars for concrete reinforcement
- CAN/CSA A3000 Cementitious Materials Compendium
- CAN/CSA G40.20/G40.21 General requirements for rolled or welded structural quality steel / Structural quality steel
- CAN/CSA A23.1/A23.2 Concrete Materials and Methods of Concrete Construction/Test methods and Standard Practices for Concrete
- CAN/CSA A23.4 Precast concrete - Materials and construction
- CSA S806 Design and construction of building structures with fiber-reinforced polymers

**ISO Standards:**

- ISO 6707-1: 2014 Buildings and Civil Engineering Works - Vocabulary - Part 1: General Terms
- ISO 14021:1999 Environmental Labels and Declarations - Self-declared Environmental Claims (Type II Environmental Labeling)
- ISO 14025:2006 Environmental Labels and Declarations - Type III Environmental Declarations - Principles and Procedures
- ISO 14040:2006 Environmental Management - Life Cycle Assessment - Principles and Framework
- ISO 14044:2006 Environmental Management - Life Cycle Assessment - Requirements and Guidelines
- ISO 14067:2018 Greenhouse Gases - Carbon Footprint of Products - Requirements and Guidelines for Quantification
- ISO 14050:2009 Environmental Management - Vocabulary
- ISO 21930:2017 Sustainability in Building Construction - Environmental Declaration of Building Products

**EN Standards:**

- EN 16757 Sustainability of construction works - Environmental product declarations - Product Category Rules for concrete and concrete elements
- EN 15804 Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products

## Other References:


- US EPA Waste Reduction Model (WARM), Fly Ash Chapter: http://epa.gov/climatechange/wycd/waste/downloads/fly-ash-chapter10-28-10.pdf
- American Concrete Institute (ACI) 211: Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
- ACI 318-14 Building Code Requirements for Structural Concrete and Commentary. American Concrete Institute. Farmington Hills, MI, USA available at https://www.concrete.org/store/
- Mather, B & Ozyildirim, C. (2002). SP-1(02) : Concrete Primer. American Concrete Institute: SP0102. American Concrete Institute. Farmington Hills, MI, USA available at https://www.concrete.org/store/
- NSF International (February 2019). Product Category Rules (PCR) for ISO 14025 Type III Environmental Product Declarations (EPDs) of Concrete v1.2.
- Product Category Rules for Preparing an Environmental Product Declaration for Precast Concrete (UN CPC 37550), ASTM International, March 2015. https://www.astm.org/CERTIFICATION/DOCS/266.PCR_for_Precast_Concrete.pdf
- USGBC LEED v4 for Building Design and Construction, 11 Jan 2019 available at https://www.usgbc.org/resources/pcr-committee-process-resources-part-b
- USGBC PCR Committee Process & Resources: Part B, USGBC, 7 July 2017 available at https://www.usgbc.org/resources/pcr-committee-process-resources-part-b.