

Environmental Product Declaration (EPD) for Concrete



Holliday Rock

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Environmental Product Declaration Ready-Mix Concrete

(per ISO 14025 and ISO 21930)

Holliday Rock has been a constant presence in the Southern California construction market for over eighty years and is one of the largest independent producers of aggregate, ready mix concrete and hot mix asphalt in the United States. Started by Otha and Ethel Holliday in 1937 during the Great Depression, Holliday Rock has allowed three successive generations of the Holliday family to thrive and expand in an ever more challenging and competitive industry.

Holliday Rock holds the beliefs that long-term success requires common goals, adaptability shared values, and most importantly safety.

Author of the Life Cycle Assessment:

D. Green Master Builders Solutions



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Product Declaration**

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| EPD Information | | | |
|---|---------------|--|-----------------------------------|
| Program Operator | | NSF Certification, LLC | |
| Declaration Holder | | Holliday Rock | |
| Product: | Date of Issue | Period of Validity | Declaration Number |
| 3C40C054 | July 23, 2020 | 5 Years | EPD10393 |
| This EPD was independently verified by NSF Certification, LLC in accordance with ISO 14025 and ISO 21930: | |  | |
| Internal | X | External | Jenny Oorbeck joorbeck@nsf.org |
| This life cycle assessment was independently verified in accordance with ISO 14044 and the reference PCR. | |  | |
| | | Jack Geibig jgeibig@ecoform.com | |
| LCA Information | | | |
| Basis LCA | | Life Cycle Assessment Manager for Concrete Environmental Product Declaration June 2019 | |
| LCA Preparers | | David Green BASF Corporation/BASF SE_ david.green@mbcc-group.com | |
| This life cycle assessment was critically reviewed in accordance with ISO 14044 by: | | Jack Geibig - Ecoform jgeibig@ecoform.com | |

| North America PCR Information | |
|--------------------------------------|---|
| Program Operator | NSF International |
| Reference PCR | Product Category Rules (PCR) for ISO 14025:2006 Type III Environmental Product Declarations (EPDs) of Concrete, Version 2.0. |
| Date of Issue | February 22, 2019 |
| PCR review was conducted by: | Thomas P. Gloria, Ph.D, Industrial Ecology Consultants; Bill Stough, Sustainable Research Group; Dr. Michael Overcash, Environmental Clarity. |
| EPD Software Tool | |
| LCA Software & Version Number | GaBi ts 8.5.079 |
| LCI Database & Version Number | GaBi ts 8.5.0.79 |

ENVIRONMENTAL PRODUCT DECLARATION: DETAILED VERSION

Product Scope



This declaration and its LCA study are relevant to concrete and concrete products manufactured by Holliday Rock in the Southern California area. As the owner of the declaration, Holliday Rock shall be liable for the underlying information and evidence; the program operator shall not be liable with respect to manufacturer information, life cycle assessment data and evidences.

Product Description

The product 3C40C054 covered by this Environmental Product Declaration (EPD) is for concrete applications for commercial and/or residential construction developed and produced by Holliday Rock for markets in Southern California. The design compressive strength is 4,000 psi (27.6 MPa) at 28 days.

Concrete is batched and delivered in accordance with local standards. The producer provides product that meets or exceeds the standards based on standard operating procedures. Warranties and additional information are determined by the producer's terms and conditions.

During normal use, hardened concrete is stable and inert and does not pose a significant health or environmental hazard.

Fresh, plastic concrete must be managed in accordance with local regulations. Hardened concrete is an inert product and can be recycled subject to local regulations.

This EPD reports the impacts for the concrete components made of in-situ or ready-mixed concrete. The life cycle phases covered are A1 (Raw Material Supply: Upstream Processes), A2 (Transportation from Supplier to Gate of Producer) and A3 (Concrete Production – Core Process). This EPD is based on a cradle-to-gate system boundary deemed appropriate as concrete mixtures are supplied to a variety of products and the function of the final product is not specifically determined. Reference service life is not relevant due to the cradle-to-gate boundary conditions.

Life cycle stages that are not included in this EPD are A4 (Transportation to the Construction Site), A5 (Construction and Installation Process), B1-7 (Use Phase) and C1-4 (End of Life Stage).

Technical Data (* These characteristics are not relevant for ready-mix concrete)

| Name | Value | Unit |
|---|---------------|-------------------|
| Density | 1,750 – 2,400 | kg/m ³ |
| Thermal conductivity | * | W/(mK) |
| Water vapor diffusion resistance factor | * | - |
| Sound absorption coefficient | * | % |
| Compressive strength | 17 - 110 | N/mm ² |
| Tensile strength | * | N/mm ² |
| Flexural strength | * | N/mm ² |
| Modulus of elasticity | * | N/mm ² |
| Equilibrium moisture content | * | % |

Product Components



The ready-mix concrete and its upstream materials covered by this Environmental Product Declaration conform to the appropriate ASTM standards as described in NSF International PCR for Concrete, UNSPSC code 30111500, CSI Specification Section 03 30 00 or the requirements of European standard EN 206:2013, BS 8500-1:2015 and BS 8500-2:2015 based on the IBU PCR. Ready-mix concrete is generally batched at a plant, centrally mixed and then discharged into a truck mixer for delivery (central mixed) or dry-batched into the truck for mixing in the production yard, in transit or at the job site (truck mixed). Ready-mix concrete does not require packaging. The base material ranges for the defined ready-mix concrete are:

| <i>Material</i> | <i>Amount</i> |
|-----------------|---------------|
| Binders | 10 – 20 % |
| Sands | 30 – 45 % |
| Aggregates | 35 - 50 % |
| Admixtures | < 1 % |
| Water | 1 - 12 % |

The product does not contain materials that are listed in the REACH “Candidate List of Substances of Very High Concern for Authorization”.

Production

Health and safety measures with potential impact to human health during manufacturing are to be consistently adhered to per regional regulatory requirements. Initiatives must be undertaken to minimize or eliminate potential impacts to the environment based on the use of best practices including engineered controls. Fresh, plastic concrete must be managed in accordance with local regulations. Hardened concrete is an inert product and can be recycled subject to local regulations. If disposed under the European waste catalogue, the waste code 17-01-01 for non-hazardous concrete and 17-01-06 for concrete containing hazardous substances is applicable. Any substances with hazardous and toxic properties that may be of concern to human health and/or the environment are provided in corresponding SDS documents based on regulatory requirements.



Declared Unit

The declared unit is 1 m³ of Holliday Rock concrete produced for commercial applications with a specified compressive strength of 4,000 psi (27.6 MPa) at 28 days.



Cut-off Criteria

All material and energy flows known or suspected to release substances into the air, water or soil in quantities that contribute significantly to any of the indicators in ISO 21930 are included. In cases where there is insufficient input data for a unit process or data gaps, the cut-off criteria used is 1% of renewable primary resources (energy), 1% of non-renewable primary resource (energy) usage, 1% of the total mass input of that unit process and 1% of environmental impacts. The total of neglected input flows per module does not exceed 5%.



Life Cycle Assessment (LCA)

The LCIA results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks.

A summary of the life cycle stages **included** in the EPD is as follows:

I. Raw Material Supply (upstream processes): Extraction, handling and processing of the raw materials used in production of concrete: cement, supplementary cementitious materials, aggregate (coarse and fine), water, admixtures and other materials or chemicals used in concrete mixtures.

II. Transportation: Transportation of these materials from supplier to the 'gate' of the concrete producer.

III. Manufacturing (core processes): The core processes result from the energy used to store, batch, mix and distribute the concrete and operate the facility (concrete plant).

IV. Water use in mixing and distributing concrete.

The processes **excluded** from the EPD are as follows:

- I. Production, manufacture and construction of buildings, capital goods and infrastructure with an expected lifespan of over 5 years.
- II. Production and manufacture of concrete production equipment, concrete delivery vehicles, earth-moving equipment and laboratory equipment with an expected lifespan of over 5 years.
- III. Personnel-related activities (travel, furniture, office supplies) as well as energy and water use related to company management and sales activities.

A summary of the limitations of this EPD include:

This EPD does not report all the environmental impacts due to manufacturing of the product, but rather reports the environmental impacts for those categories with established life cycle assessment-based methods to track and report. Unreported environmental impacts include (but are not limited to) factors attributable to human health, land use change and habitat destruction.

This EPD was calculated using industry average cement data. Cement LCA impacts can vary depending upon manufacturing processes, efficiency and fuel sources by as much as 50% for some environmental impact categories. Cement accounts for as much as 96% of the impacts of the concrete mixes included in this EPD and thus manufacturer specific cement impacts could result in variation of as much as 48%.

This EPD reports the results of an LCA for 'cradle to gate' analysis and is intended for business-to-business communications. Thus, declarations themselves are not comparative assertions, defined as an environmental claim regarding the superiority or equivalence of one product versus a competing product that performs the same function. An EPD does not make any statements that the product covered by the EPD is better or worse than any other product.

To assess the local impacts of product manufacturing, additional analysis is required. Life cycle impact assessment results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks.

Comparability:

EPD of concrete mixtures may not be comparable if they do not comply with this standard and data from this EPD. While an EPD can be used to compare concrete mixtures, the data cannot be used to compare between construction products or concrete mixtures used in different concrete products unless the data is integrated into a comprehensive LCA. For example, precast concrete, concrete masonry units and site cast concrete all have different manufacturing processes whose impacts are attributed to different LCA stages. This precludes direct comparison between mixtures used in these different products unless all life cycle phases are included and a functional unit is used.

Allocation:

During the production of ready-mix concrete, co-products are not introduced into the mixture designs. The product category rules for this EPD recognize fly ash, silica fume and slag as recovered materials and thus the environmental impacts allocated to these materials are limited to the treatment and transportation required to use as a concrete material input.

DESCRIPTION OF THE SYSTEM BOUNDARY (X = INCLUDED IN LCA; MND = MODULE NOT DECLARED)

| PRODUCT STAGE | | | CONSTRUCTION PROCESS STAGE | | USE STAGE | | | | | | | | END OF LIFE STAGE | | | | BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARIES |
|---------------------|-----------|---------------|-------------------------------------|----------|-----------|-------------|--------|-------------|---------------|------------------------|-----------------------|---------------------------|-------------------|------------------|----------|------------------------------------|---|
| Raw material supply | Transport | Manufacturing | Transport from the gate to the site | Assembly | Use | Maintenance | Repair | Replacement | Refurbishment | Operational energy use | Operational water use | Deconstruction demolition | Transport | Waste processing | Disposal | Reuse-Recovery-Recycling potential | |
| A1 | A2 | A3 | A4 | A% | B1 | B2 | B3 | B4 | B5 | B6 | B7 | C1 | C2 | C3 | C4 | D | |
| X | X | X | MND | MND | MND | MND | MND | MND | MND | MND | MND | MND | MND | MND | MND | MND | |



LCA: Interpretation and Results

The following tables provide the results of the LCA and the environmental parameters from the LCA for one (1) cubic meter of ready-mix concrete. The environmental impacts are based on the TRACI v2.1 characterization factors and NSF International PCR for Concrete.

Note: 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 these categories.

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

Additional note: not all LCA datasets for upstream materials include these impact categories and thus results may be incomplete. Use caution when interpreting data in these categories.

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 LCA Results for one m³ of ready-mix concrete

| Note: 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 these categories. | | | | |
|---|----------|----------|-----------|----------|
| Results of the LCA - environmental impact:1 m3 Ready Mix Concrete - TRACI v 2.1 | | | | |
| | A1 | A2 | A3 | Total |
| Global warming potential (GWP 100) [kg CO2 eq.] | 4.82E+02 | 7.04E+00 | 3.88E+00 | 4.93E+02 |
| Ozone depletion potential (ODP) [kg CFC 11 eq.] | 1.77E-06 | 1.75E-15 | -6.01E-14 | 1.77E-06 |
| Acidification potential (AP) [kg SO2 eq.] | 2.43E+00 | 2.13E-02 | 1.13E-02 | 2.46E+00 |
| Eutrophication potential (EP) [kg N eq.] | 6.06E-02 | 1.77E-03 | 8.33E-04 | 6.32E-02 |
| Photochemical smog creation potential (POCP) [kg O3 eq.] | 3.10E+01 | 4.57E-01 | 1.40E-01 | 3.16E+01 |
| Abiotic depletion potential for non fossil resources (ADPelements) [kg Sb eq.] | 2.90E-06 | 5.81E-07 | 1.14E-06 | 4.62E-06 |
| Abiotic depletion potential for fossil resources (ADPfossil) [MJ] | 2.08E+03 | 9.56E+01 | 5.53E+01 | 2.23E+03 |
| Results of the LCA - resource use:1 m3 Ready Mix Concrete | | | | |
| | A1 | A2 | A3 | Total |
| Renewable primary energy as energy carrier (PERE) [MJ] | 1.97E+01 | 5.53E+00 | 2.73E+01 | 5.25E+01 |
| Primary energy resources used as raw materials (PERM) [MJ] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Total use of renewable primary energy resources (PERT) [MJ] | 1.97E+01 | 5.53E+00 | 2.73E+01 | 5.25E+01 |
| Non-renewable primary energy as energy carrier (PENRE) [MJ] | 2.21E+03 | 9.61E+01 | 8.75E+01 | 2.39E+03 |
| Non-renewable primary energy resources used as raw materials (PENRM) [MJ] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Total use of non-renewable primary energy resources (PENRT) [MJ] | 2.21E+03 | 9.61E+01 | 8.75E+01 | 2.39E+03 |
| Use of secondary material (SM) [kg] | x | x | x | x |
| Use of renewable secondary fuels (RSF) [MJ] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Use of non-renewable secondary fuels (NRSF) [MJ] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Recovered energy (RE) [MJ] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Use of net fresh water (FW) [m3] | 5.11E-01 | 6.45E-03 | 3.22E-02 | 5.50E-01 |
| Results of the LCA - output flows and waste categories:1 m3 Ready Mix Concrete | | | | |
| | A1 | A2 | A3 | Total |
| Hazardous waste disposed (HWD) [kg] | 6.91E+02 | 4.44E-06 | 3.40E-08 | 6.91E+02 |
| Non-hazardous waste disposed (NHWD) [kg] | 5.58E+00 | 1.52E-02 | 4.94E-02 | 5.64E+00 |
| High level radioactive waste [kg] | 2.09E-05 | 4.04E-06 | 1.65E-07 | 2.51E-05 |
| Intermediate and low-level radioactive waste [kg] | 3.73E-04 | 7.54E-05 | 4.86E-06 | 4.53E-04 |
| Components for reuse (CRU) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Materials for recycling (MFR) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Materials for energy recovery (MER) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Exported electrical energy (EEE) [MJ] | x | x | x | x |
| Exported thermal energy (EET) [MJ] | x | x | x | x |

x-data not available for this inventory item. Not all LCA datasets for upstream materials include these impact categories and thus results may be incomplete. Use caution when interpreting data in these categories.

For the specific system boundaries identified for this EPD, the raw material supply (phase A1) is the primary driver for all environmental impact categories with this phase accounting for over 80% of the total results for GWP, ODP, AP, EP and POCP.

This is generally the result of the cement content in the concrete mixture as cement production requires high levels of energy for the calcining process while at the same time emitting CO₂ as part of the reaction from converting limestone (CaCO₃) to lime (CaO). Transportation may have a larger percentage of the total impact when raw materials are transported from long distances such as trans-oceanic locations.



Data Quality and Variability

The requirements for data quality and background data correspond with the requirements of the NSF International PCR for Concrete. The calculated data in this report is based on actual ready-mix concrete compositions. Manufacturer specific data is based on average data from the past 12 months.

The period over which inputs to and outputs from the system are accounted for is 100 year from the year for which the data is deemed representative.

The technology coverage reflects the physical reality for the declared ready-mix concrete product. Used datasets are complete according to the system boundary within the limits set by the criteria for the exclusion of inputs and outputs.

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To calculate the life cycle of the declared ready-mix concrete products, the software solution GaBi ts 8.5.0.79 from thinkstep AG was used. Background datasets were extracted from the GaBi database. The last revision of the GaBi data is less than 3 years ago according to thinkstep AG. Altogether, the data quality is considered high.

This EPD was created using the default data noted in appendix A of the NSF International PCR for concrete.

The following table summarizes the overall quality assessments for the main inputs for ready-mix concrete.

| Inputs | Data Quality | | | | | |
|-------------------------------------|--------------|------|-----------------|----------|-------------|--------------------|
| | Technology | Time | Geography | Complete | Reliability | Source |
| Binders | | | | | | |
| Cement (CEM I) | good | 2018 | Europe | good | good | Gabi 8.5 |
| Portland cement | good | 2016 | US | good | good | Gabi 8.5/PCA |
| Fly ash | good | 2018 | Regional | good | good | Gabi 8.5 |
| Blast furnace slag | good | 2018 | Germany | fair | good | Gabi 8.5/ASTM |
| Limestone | good | 2017 | Europe | good | good | Gabi 8.5 |
| Silica fume | good | 2017 | US | fair | good | Gabi 8.5 |
| Sands | | | | | | |
| Natural sand | good | 2016 | Europe | good | good | Gabi 8.5/Ecoinvent |
| Natural sand, washed | good | 2016 | Europe | good | good | Gabi 8.5 |
| Limestone powder | good | 2017 | Europe | good | good | Gabi 8.5 |
| River dredge sand | fair | 2016 | Global | fair | good | Gabi 8.5 |
| Aggregates | | | | | | |
| Natural aggregate | good | 2016 | China | good | good | Gabi 8.5/Ecoinvent |
| Recycled aggregate | good | 2016 | US | good | good | Gabi 8.5 |
| Lightweight aggregate/expanded clay | good | 2016 | Europe | good | good | Gabi 8.5/Ecoinvent |
| Recycled concrete | good | 2016 | US | good | good | Gabi 8.5 |
| Admixtures | | | | | | |
| MasterPozzolith (WR) | good | 2018 | US/Europe | good | good | GaBi 8.5/BASF |
| MasterPozzolith (MWR) | good | 2018 | US/Europe | good | good | GaBi 8.5/BASF |
| MasterPolyheed | good | 2018 | US/Europe | good | good | GaBi 8.5/BASF |
| MasterPolyheed (non-chloride) | good | 2018 | US/Europe | good | good | GaBi 8.5/BASF |
| MasterGlenium | good | 2018 | US/Europe | good | good | GaBi 8.5/BASF |
| MasterSet AC | good | 2018 | US/Europe | good | good | GaBi 8.5/BASF |
| Master X-Seed | good | 2018 | US/Europe | good | good | GaBi 8.5/BASF |
| MasterSet (Retarder) | good | 2018 | US/Europe | good | good | GaBi 8.5/BASF |
| MasterSet DELVO | good | 2018 | US/Europe | good | good | GaBi 8.5/BASF |
| MasterLife SRA | good | 2018 | US/Europe | good | good | GaBi 8.5/BASF |
| MasterAir | good | 2018 | US/Europe | good | good | GaBi 8.5/BASF |
| MasterSure Z 60 | good | 2018 | US/Europe | good | good | GaBi 8.5/BASF |
| Water | | | | | | |
| Water | good | 2018 | US/Germany | good | good | Gabi 8.5/Ecoinvent |
| Desalinated water | fair | 2018 | Middle East | fair | good | Gabi 8.5 |
| Energy | | | | | | |
| US Electricity grid mix | good | 2016 | US | good | good | Gabi 8.5/US LCI |
| US Natural gas | good | 2016 | US | good | good | Gabi 8.5/US LCI |
| Transport | | | | | | |
| Truck | good | 2016 | Global/regional | good | good | Gabi 8.5/US LCI |
| Train | good | 2018 | Global/regional | good | good | Gabi 8.5/US LCI |
| Ship - river | good | 2016 | Global/regional | good | good | Gabi 8.5/US LCI |
| Ship - oceanic | good | 2016 | Global/regional | good | good | Gabi 8.5/US LCI |

Ratings: good, fair, poor



References

North American Product Category Rules (PCR) for ISO 14025 Type III Environmental Product Declarations (EPD) Concrete version 1.1 December 4, 2013.

Product Category Rule for Environmental Product Declarations, PCR for Concrete version 2.0 February 22, 2019.

ISO 21930 Sustainability in buildings and civil engineering works - Core rules for environmental product declarations of construction products and services, second edition 2017-07.

ISO, International Organization for Standardization, Environmental Management-Life Cycle Assessment-Principles and Framework; ISO 14040:2006; ISO 14044:2006. ISO, Geneva, Switzerland, www.iso.org (2006).

ISO, International Organization for Standardization. Environmental Management - Eco-efficiency assessment of product systems - Principles, requirements and guidelines; ISO 14045. ISO, Geneva, Switzerland, www.iso.org (2012)

ASTM C94, C94 M Standard Specification for Ready-mixed Concrete

BS 8500-1:2015, Concrete - Complementary British Standards to BS EN 206. Method of specifying and guidance for the specifier.

BS 8500-2:2015, Concrete - Complementary British Standards to BS EN 206. Specification for constituent materials and concrete.

CSI Specification Section 03 30 00 Cast-in-Place Concrete

DIN EN ISO 14025:2011: Environmental labels and declarations - Type III environmental declarations - Principles and procedures.

EN 15804:2012, Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products.

EN 206:2013, Beton - Festlegung, Eigenschaften, Herstellung und Konformität

GaBi ts 8.5: Software and GaBi database, LBP, University of Stuttgart and thinkstep AG, 2018

Product Category Rules for Building-Related Products and Services Part A - IBU calculation rules for the life cycle assessment and requirements on the project report.

PCR Guidance - Texts for Building-Related Products and Services Part B - IBU requirements on the EPD for Concrete components made of in-situ or ready-mixed concrete, version 1.5, 10.04.2017.

REACH Directive (EG) No. 1907/2006 of the European Parliament and of the Council dated 18 December 2006 on the registration, evaluation, approval and restriction of chemical substances (REACH), for establishing a European Agency for chemical substances, for amending Directive 1999/45/EC and for annulment of Directive (EEC) No. 793/93 of the Council, Directive (EC) No. 1488/94 of the Commission, Guideline 76/769/EEC of the Council and Guidelines 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC of the Commission.

UNSPSC Code 30111500 Concrete and Mortars