Environmental Product Declaration for Precast Concrete Products

Product: Structural Precast Columns
(per ISO 14025 and ISO 21930)

About Legacy Precast LLC

A management team with more than 150 years of experience. The experts at Legacy Precast can save you time and money; from precast parking structures, to office buildings, industrial/institutional projects, schools and much more, we have you covered. At our precast/prestress concrete manufacturing plant, our main focus is providing our customers with the most cost-effective solutions to meet their precast concrete needs, and to make sure that we respect our professional relationship by delivering quality products and services on time, on schedule, and within budget. Maintaining our reputation as cost-competitive and efficient is important to us. We work to keep our staff team-oriented and willing to go above and beyond to provide the service and precast systems you need. After successfully completing our PCI Plant audits, we were granted PCI Plant Certification in 2014 and our PCI Architectural Certification in 2018.

Proudly serving the Great State of Texas, including Houston, Dallas, Austin, & San Antonio Metro Markets.

Author of the Life Cycle Assessment: D. Green - Master Builders Solutions US LLC
# EPD Information

<table>
<thead>
<tr>
<th>Program Operator</th>
<th>NSF Certification, LLC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Declaration Holder</td>
<td>Legacy Precast LLC</td>
</tr>
<tr>
<td><strong>Product:</strong></td>
<td></td>
</tr>
<tr>
<td>Column</td>
<td></td>
</tr>
<tr>
<td><strong>Date of Issue</strong></td>
<td>June 3, 2022</td>
</tr>
<tr>
<td><strong>Period of Validity</strong></td>
<td>5 Years</td>
</tr>
<tr>
<td><strong>Declaration Number</strong></td>
<td>EPD10689</td>
</tr>
</tbody>
</table>

Independently verification of the declaration and data, according to ISO 21930:2017 and ISO 14025:2006 by NSF Certification, LLC.

Internal  X  External

Tony Favilla
afavilla@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

<table>
<thead>
<tr>
<th>Basis LCA</th>
<th>Life Cycle Assessment Manager for Concrete Environmental Product Declaration June 2019</th>
</tr>
</thead>
</table>
| LCA Preparer | David Green  
Master Builders Solutions US LLC  
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

<table>
<thead>
<tr>
<th>Program Operator</th>
<th>NSF International</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference PCR</td>
<td>ISO 21930:2017 Sustainability in Building Construction – Environmental Declaration of Building Products serves as the core PCR. NSF PCR for Precast Concrete v2 serves as the sub-category PCR.</td>
</tr>
<tr>
<td>Date of Issue</td>
<td>May 1, 2021</td>
</tr>
<tr>
<td>Sub-category PCR review was conducted by:</td>
<td>Thomas P. Gloria, Ph.D, Industrial Ecology Consultants, <a href="mailto:t.gloria@industrial-ecology.com">t.gloria@industrial-ecology.com</a></td>
</tr>
</tbody>
</table>

### EPD Software Tool

<table>
<thead>
<tr>
<th>LCA Software &amp; Version Number</th>
<th>One Click LCA 2021</th>
</tr>
</thead>
<tbody>
<tr>
<td>LCI Database &amp; Version Number</td>
<td>One Click LCA, Ecoinvent 3.6</td>
</tr>
</tbody>
</table>

For additional explanatory material:  
Jay Cariveau  
jcarniveau@LegacyPrecast.com

Additional environmental activities
ENVIRONMENTAL PRODUCT DECLARATION: DETAILED VERSION

Product Scope
This declaration and its LCA study are relevant to precast concrete products manufactured by Legacy Precast LLC for the state of Texas. As the owner of the declaration, Legacy Precast LLC may 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 evidence.

Product Description

This EPD includes representative products developed from the Legacy Precast portfolio of products manufactured at its facility located in Brookshire, Texas. This Environmental Product Declaration (EPD) covers structural precast columns for markets throughout Texas including Houston, Dallas, Austin, and the San Antonio metro areas. The UNCPC Class for this product is 37550 and CSI Division 03 40 00. The primary audiences for structural precast products are engineers, designers, architects, and project owners.

The results for this EPD are based on the full year 2020 of operational data and current raw materials and suppliers. All production is completed at the Brookshire, Texas facility.

Product Specification and Application
The products evaluated for the EPD meet the following technical specifications:
- ASTM C-150: Portland cement
- ASTM C-33/33M: Concrete aggregates
- ASTM C-94: Ready-Mix Concrete
- ASTM C618: Supplementary cementitious materials – fly ash
- ASTM C494 and ASTM C60: Admixtures
Application
Legacy Precast structural columns are used in various building systems including parking garages, industrial buildings, data centers, office buildings, schools, and other commercial/industrial structures. Guidance on the safe and correct installation, use and disposal of the product is available from Legacy Precast LLC.

Technical Data
The technical specifications for the product(s) represented by this EPD are shown here.

Table 1: Product Technical Details – Column

<table>
<thead>
<tr>
<th>Precast Concrete Parameter</th>
<th>Range and Additional details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compressive Strength, psi prior to release</td>
<td>3,500 to 4,000</td>
</tr>
<tr>
<td>Compressive Strength, psi after 7 days</td>
<td>4,000 to 5,500</td>
</tr>
<tr>
<td>Compressive Strength, psi after 28 days</td>
<td>6,000 to 7,600 plus</td>
</tr>
<tr>
<td>Reinforcement</td>
<td>Embeds, rebar and strand per plans and details</td>
</tr>
<tr>
<td>Misc. plates and embeds</td>
<td>As required per plans and details</td>
</tr>
</tbody>
</table>

Flow Diagram
The life cycle assessment (LCA) is a cradle-to-gate study. An overview of the system boundaries is shown in Figure 1.

Manufacturing
Legacy Precast, LLC manufacturers precast, prestressed concrete structural and architectural components for various building systems such as parking garages, industrial buildings, data centers, office buildings, schools, and other commercial/industrial structures. All products are manufactured using a variety of steel and/or wood molds and forming. Steel embeds and assemblies are fabricated on site and placed in the forms along with rebar and prestressing.
strand reinforcement per the contract drawings. Concrete mixture is comprised of cement, supplementary cementitious materials, sand, aggregate and water per the project concrete mix designs. Additional admixtures are utilized to improve performance, durability and to keep material in proper suspension prior to concrete placement. The concrete is batched, placed in the forms, and stripped from the forms after achieving appropriate release strengths. The concrete continues to cure and harden to design strength and beyond. The products are placed in storage and scheduled for transportation and installation. The product does not require any packaging material.

This EPD is based on a cradle-to-gate system boundary deemed appropriate based on the North American PCR. 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-B7 (Use Phase) and C1-C4 (End of Life Stage).

**Material Composition**

The precast columns and upstream materials covered by this Environmental Product Declaration conform to the appropriate ASTM standards as described in NSF International PCR for Precast Concrete, UNSPSC code 37550 and CSI Specification Section 03 40 00. The raw materials for the product are obtained from various suppliers in the United States. The general composition is represented in Table 2:

<table>
<thead>
<tr>
<th>Material</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sands</td>
<td>40 – 50 %</td>
</tr>
<tr>
<td>Aggregates</td>
<td>30 – 40 %</td>
</tr>
<tr>
<td>Binders</td>
<td>10 - 20 %</td>
</tr>
<tr>
<td>SCMs</td>
<td>1 – 10%</td>
</tr>
<tr>
<td>Water</td>
<td>1 - 10%</td>
</tr>
<tr>
<td>Reinforcement and hardware</td>
<td>1 - 8%</td>
</tr>
<tr>
<td>Admixtures</td>
<td>&lt;1%</td>
</tr>
</tbody>
</table>

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

This sub-category PCR recognizes fly ash, silica fume and granulated blast furnace 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 precast concrete material input.
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 1,000 kg of Legacy Precast concrete produced as a column for commercial applications with a specified compressive strength range of 6,000 to 7,600 psi (41 to 52 MPa) at 28 days.

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 are as follows:

I. Raw Material Supply (A1): Extraction and processing of raw materials, including fuels used in raw material production and transport within the manufacturing process (A3). Constituent materials in precast concrete may include, but are not limited to cement, supplementary cementitious materials, aggregates, reinforcement, insulation, admixtures, and hardware.

II. Transportation (A2): Average or specific transportation of raw materials (including recovered materials) from an extraction site, manufacturing source or distribution terminal to the manufacturing site including empty backhauls and transportation to interim distribution centers or terminals.

III. Manufacturing (A3): Including the product and all energy and materials required and all emissions and wastes produced. This includes but is not limited to energy use throughout the process, average or specific transportation, fresh water for batch and processes, packaging including transportation, transportation to manage pre-consumer wastes and unutilized products from manufacturing and energy recovery of pre-consumer wastes and by-products from production.
Table 3: Life Cycle Stages

<table>
<thead>
<tr>
<th>Product Stage</th>
<th>Construction Process Stage</th>
<th>Use Stage</th>
<th>End of Life Stage</th>
<th>Benefits and loads beyond the system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw material supply</td>
<td>Transport</td>
<td>Manufacturing</td>
<td>Transport from the gate to the site</td>
<td>Assembly</td>
</tr>
<tr>
<td>A1</td>
<td>A2</td>
<td>A3</td>
<td>A4</td>
<td>A5</td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

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

The processes excluded from the EPD are as follows:

I. Production, manufacture and construction of manufacturing capital goods and infrastructure.

II. Production and manufacture of production equipment, delivery vehicles, and laboratory equipment.

III. Formwork.

IV. Personnel-related activities (travel, furniture, office supplies).

V. Energy and water use related to company management and sales activities that may not be located either within the factory site or at another location.

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 90% of the impacts of the concrete mix(es) included in this EPD and thus manufacturer specific cement impacts could result in variation of as much as 45%.

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:
EPDs may enable comparison between products but do not themselves compare products, as stated in ISO 14025 Sections 4 and 6.7.2. Environmental declarations from different programs (ISO 14025) may not be comparable. EPDs are comparable only if they use the same PCR (or sub-category PCR where applicable), include all relevant information modules and are based on equivalent scenarios with respect to the context of construction works. This PCR allows EPD comparability only when the same functional requirements between products are ensured and the requirements of ISO 21930:2017 §5.5 are met. However, variations and deviations are possible. Example of variations: different LCA software and background LCI datasets may lead to different results for the life cycle stages declared.

This EPD covers only cradle-to-gate impacts of precast concrete products using a declared unit and the results cannot be used to compare between products.

Allocation:
During the production of precast concrete products, 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.

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%.

Scenarios:
Per the sub-category PCR, scenarios are not required to be reported for cradle-to-gate EPDs.
LCA: Interpretation and Results

The following tables provide the results of the LCA and the environmental parameters from the LCA for one (1) metric tonne of precast concrete product. The environmental impacts are based on the TRACI v2.1 characterization factors and NSF International PCR for Precast Concrete.

**Note:** Some LCA impact categories and inventory items are still under development and can have high levels of uncertainty. To promote uniform guidance on the data collection, calculation, and reporting of results, the ACLCA methodology (ACLCA 2019) was used. 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)
- Hazardous waste disposed
- Non-hazardous waste disposed
- 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.

Removals and emissions associated with biogenic carbon content for products or packaging and emissions from carbonation or removals from calcination are not included in this study based on a cradle-to-gate approach and the absence of biobased materials in the declared unit. Renewable and non-renewable sources are not used for energy generation in any precast concrete production processes and are therefore not included in the information modules.
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 85% of the total results for GWP, AP, EP and POCP and over 60% for ODP.

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 CO$_2$ as part of the reaction from converting limestone (CaCO$_3$) 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 Precast Concrete. The calculated data in this report is based on actual precast 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 years from the year for which the data is deemed representative.

The technology coverage reflects the physical reality for the declared precast 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.

To calculate the life cycle of the declared precast concrete products, the software One Click LCA with Ecoinvent 3.6. was used. The last revision of the Ecoinvent data is less than 3 years old. The data quality is considered high. This EPD was created using the default data when available or data as representative to the default data as possible noted in appendix A of the NSF International PCR for concrete.

A data quality assessment is provided in the Legacy Precast LLC Project Report.

References

Product Category Rules (PCR) for Precast Concrete UNCPC: 37550. Version 3.0 of the Product Category Rules (PCR) for ISO 14025:2006 Type III Environmental Product Declarations (EPDs) of precast concrete – Issued May 30, 2021


Ecoinvent database v3.6 (2019) and One Click LCA database.