

Environmental Product Declaration (EPD) for Concrete



Life Cycle Impact Results (per m³)

Declared Unit: 1 m³ of 4,000 psi concrete

OPERATIONAL IMPACTS *SSD09631*

| | |
|--|----------|
| Plant Operating Energy (MJ) | 14.7 |
| On-Site Plant Fuel Consumption (MJ) | 165.5 |
| Concrete Batch Water (m ³) | 1.63E-01 |
| Vehicle and Equipment Wash Water (m ³) | 5.59E-01 |
| On-Site Waste Disposal (kg) | 0.19 |

ENVIRONMENTAL IMPACTS

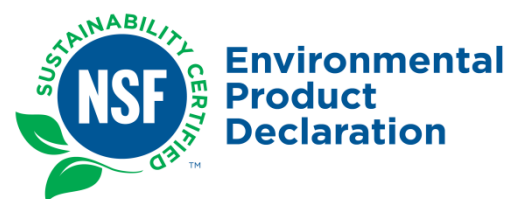
| | |
|---|----------|
| Total Primary Energy (MJ) | 3,282 |
| Climate Change (kg CO ₂ eq) | 377 |
| Ozone Depletion (kg CFC 11 eq) | 1.01E-08 |
| Acidification Air (kg SO ₂ eq) | 2.50 |
| Eutrophication (kg N eq) | 0.08 |
| Photochemical Ozone Creation (kg O ₃ eq) | 1.161 |

About Titan Concrete

Our products protect human life and personal property, improve the quality of life, generate economic prosperity and connect society. Our values guide how we conduct ourselves and our business affairs, particularly with regard to our customers, our employees, our communities and the environment.

We, at Titan Concrete, know that customer satisfaction begins with rigid adherence to quality control and that quality-minded people create quality products. Our ready-mixed concrete is manufactured with the most technically advanced equipment available, ensuring that our facilities are among the most efficient and environmentally-friendly in the world.

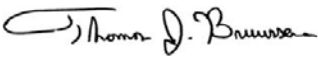

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Titan Concrete SSD09631

ENVIRONMENTAL PRODUCT DECLARATION VERIFICATION

| EPD Information | | | |
|--|--|--|--------------------------------|
| Program Operator | | NSF International | |
| Declaration Holder | | Titan Concrete | |
| Product SSD09631 | Date of Issue December 5, 2013 | Period of Validity 5 Years | Declaration Number EPD10015 |
| This EPD was independently verified by NSF International in accordance with ISO 14025: | |  Tom Bruursema Bruursema@nsf.org | |
| <input type="checkbox"/> Internal | <input checked="" type="checkbox"/> External | | |
| This life cycle assessment was independently verified by 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 2013 | |
| LCA Preparer | | David Green BASF Corporation david.r.green@basf.com | |
| This life cycle assessment was critically reviewed in accordance with ISO 14044 by: | | Bill Stough Sustainable Reasearch Group bstough@sustainableresearchgroup.com | |
| PCR Information | | | |
| Program Operator | | Carbon Leadership Forum | |
| Reference PCR | | North American Product Category Rules (PCR) for ISO 14025 Type III Environmental Product Declarations (EPDs) and/or GHG Protocol Conformant Product 'Carbon Footprint' of Concrete | |
| Date of Issue | | November 30, 2012 | |
| PCR review was conducted by: | | Nick Santero PE International | |

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Date of Issue: December 5, 2013
Period of Validity: 5 years
Declaration#: EPD10015



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Titan Concrete SSD09631

ENVIRONMENTAL PRODUCT DECLARATION: DETAILED VERSION



Product Description

Products covered by this Environmental Product Declaration (EPD) are for pumpable concrete for residential construction developed and produced by Titan Concrete for the Florida market. The specified compressive strength is 4,000 psi at 28 days.

This EPD reports the impacts for the product concrete further defined by ASTM C94, UNSPSC code 30111500 and CSI Specification Section 03 30 00. 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 different products and the function of the final product is not specifically determined. 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).



Product Components

The product components for the mixes identified for this EPD meet the following ASTM Standards:

| <i>Component</i> | <i>Standard</i> | <i>Specification for:</i> |
|--------------------------------|-----------------|---|
| Portland Cement | ASTM C150 | Portland Cement |
| Fly Ash | ASTM C618 | Coal fly ash and raw or calcined Natural pozzolan for use in concrete |
| Slag Cement | ASTM C989 | Slag cement for use in concrete and mortars |
| Natural and Crushed Aggregates | ASTM C33 | Concrete aggregates |
| Admixtures | ASTM C494 | Chemical Admixtures for Concrete |
| Batch Water | ASTM C1602 | Mixing water used in the production of hydraulic cement concrete |



Declared Unit

The declared unit is 1 m³ of Titan America brand concrete for commercial construction with a specified compressive strength of 4,000 psi (28 MPa) at 28 days.



Cut-off Criteria

The cut-off criteria for raw material/energy consumption and environmental impacts for inclusion is less than 1% however for the Carbon Leadership Forum PCR all inputs and outputs for which data is available shall be included. The total of the estimated neglected input flows does not exceed 5% for the total impacts from energy, mass or climate change.

Environmental Product Declaration (EPD) for Concrete

Titan Concrete SSD09631



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:

1. Raw Material Supply (upstream processes): Extraction, handling and processing of the raw materials used in production of concrete: cement, supplementary cementitious materials, aggregate (course and fine), water, admixtures and other materials or chemicals used in concrete mixtures.
2. Transportation: Transportation of these materials from supplier to the 'gate' of the concrete producer.
3. 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).
4. Water use in mixing and distributing concrete.

A summary of life cycle stages **excluded** from the EPD is as follows:

1. Production, manufacture and construction of buildings capital goods and infrastructure with an expected lifespan of over 5 years.
2. Production and manufacture of concrete production equipment, concrete delivery vehicles, earthmoving equipment and laboratory equipment with an expected lifespan of over 5 years.
3. Personnel-related activities (travel, furniture, office supplies)
4. Energy and water use related to company management and sales activities.
5. Water use in upstream manufacturing processes and in placement and curing of concrete. Better data and methodology is required to track and report these numbers.

A summary of the limitations of this EPD include:

1. This EPD does not report all of 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, water use in the upstream manufacturing process and habitat destruction.
2. This EPD reports the results of an LCA for 'cradle-to-gate' analysis. Thus, declarations 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.
3. In order to assess the local impacts of product manufacturing, additional analysis is required.
4. The product manufacturer has the option of declaring additional information about their product including conformance with any other sustainability certification programs that often have performance and prescriptive requirements that aim to illustrate environmental best practices that cannot be captured by LCA.
5. Life Cycle Impact Assessment results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks.

EPDs of concrete mixtures may not be comparable if they do not comply with this standard and data from this EPD.

Environmental Product Declaration (EPD) for Concrete

Titan Concrete SSD09631

While EPDs 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.



Data Quality and Variability

This EPD was created using industry average data for upstream materials. Variation can result from differences in supplier locations, manufacturing processes, manufacturing efficiency and fuel type used. A range of climate change impacts is not available at this time due a lack of industry average data. The EPD will be updated as industry average data becomes available for any/all inputs. The data sources used in the life-cycle assessment are included in Table 1. An assessment of the data quality selected for this EPD was conducted using the five data quality indicators per the “Greenhouse Gas Protocol Product Life Cycle Accounting and Reporting Standard”. A summary of the assessment is shown in Table 2 with data quality rated from low to high in the categories of “Technological Representativeness”, “Geographical Representativeness”, “Temporal Representativeness”, “Completeness” and “Reliability”.

| <i>Eco-Profile</i> | <i>Year</i> | <i>Source/Region</i> |
|--------------------------------------|-------------|--------------------------------------|
| Cement | 2010 | Boustead database ⁵ /U.S. |
| Fly Ash | 2009 | Boustead database ⁵ /U.S. |
| Ground Granulated Blast Furnace Slag | 2012 | Boustead database ⁵ /U.S. |
| Granite Powder | 2012 | Boustead database ⁵ /U.S. |
| Limestone Powder | 2013 | Boustead database ⁵ /U.S. |
| Silica Fume | 2013 | Boustead database ⁵ /U.S. |
| Rice Husk Ash | 2009 | Boustead database ⁵ /U.S. |
| Metakaolin | 2008 | Boustead database ⁵ /U.S. |
| Fine Aggregate | 2012 | Boustead database ⁵ /U.S. |
| Course Aggregate | 2012 | Boustead database ⁵ /U.S. |
| Recycled Aggregate | 2011 | Boustead database ⁵ /U.S. |
| Crushed Recycled Concrete | 2012 | Boustead database ⁵ /U.S. |
| Water | 2012 | Boustead database ⁵ /U.S. |
| Water Reducer | 2012 | Boustead database ⁵ /U.S. |
| Mid-range Water Reducer | 2012 | Boustead database ⁵ /U.S. |
| High Range Water Reducer | 2012 | Boustead database ⁵ /U.S. |
| Accelerator | 2012 | Boustead database ⁵ /U.S. |
| Retarder | 2008 | Boustead database ⁵ /U.S. |
| Stabilizer | 2012 | Boustead database ⁵ /U.S. |
| Corrosion Inhibitor | 2012 | Boustead database ⁵ /U.S. |
| Air Entrainment | 2012 | Boustead database ⁵ /U.S. |
| Color | 2010 | Boustead database ⁵ /U.S. |
| Transportation - Truck | 2010 | Boustead database ⁵ /U.S. |
| Transportation - Rail | 2010 | Boustead database ⁵ /U.S. |
| Transportation - Ocean | 2012 | Boustead database ⁵ /U.S. |
| Electricity – U.S | 2013 | Boustead database ⁵ /U.S. |

Table 1: Data Sources

Environmental Product Declaration (EPD) for Concrete

Titan Concrete SSD09631

| <i>Profile</i> | <i>Technology</i> | <i>Temporal</i> | <i>Geography</i> | <i>Completeness</i> | <i>Reliability</i> |
|--------------------------------------|-------------------|-----------------|------------------|---------------------|--------------------|
| Cement | High | Medium-High | Medium-High | Medium-High | Medium-High |
| Fly Ash | Medium-High | Medium-High | Medium-High | Medium | Medium |
| Ground Granulated Blast Furnace Slag | Medium-High | High | Medium-High | Medium | Medium |
| Granite Powder | Medium-High | High | Medium-High | Medium | Medium |
| Limestone Powder | Medium-High | High | Medium-High | Medium | Medium |
| Silica Fume | Medium | High | Medium-High | Medium | Medium |
| Rice Husk Ash | Medium-High | Medium-High | Medium-High | Medium | Medium |
| Metakaolin | High | Medium-High | Medium-High | High | Medium-High |
| Fine Aggregate | Medium-High | High | Medium-High | Medium-High | Medium-High |
| Course Aggregate | Medium-High | High | Medium-High | Medium-High | Medium-High |
| Recycled Aggregate | Medium | Low | Medium-High | Medium | Low |
| Crushed Recycled Concrete | Medium | Low | Medium-High | Medium | Low |
| Water | Medium-High | High | Medium-High | High | Medium-High |
| Water Reducer | High | High | Medium-High | High | Medium-High |
| Mid-range Water Reducer | High | High | Medium-High | High | Medium-High |
| High Range Water Reducer | High | Medium-High | Medium-High | High | Medium-High |
| Accelerator | High | High | Medium-High | High | Medium-High |
| Retarder | High | High | Medium-High | High | Medium-High |
| Stabilizer | High | High | Medium-High | High | Medium-High |
| Corrosion Inhibitor | High | Medium-High | Medium-High | High | Medium-High |
| Air Entrainment | High | Medium-High | Medium-High | High | Medium-High |
| Color | High | Medium-High | Medium-High | High | Medium-High |
| Transportation - Truck | Medium-High | High | Medium-High | Medium-High | Medium-High |
| Transportation - Rail | Medium-High | Medium-High | Medium-High | Medium-High | Medium-High |
| Transportation - Ocean | Medium-High | Medium-High | Medium-High | Medium-High | Medium-High |
| Electricity – U.S | Medium-High | High | Medium-High | High | Medium-High |

Table 2: Data Quality Assessment

Environmental Product Declaration (EPD) for Concrete

Titan Concrete SSD09631



References

1. North American Product Category Rules (PCR) for ISO 14025 Type III Environmental Product Declarations (EPDs) and/or GHG Protocol Conformant Product 'Carbon Footprint' of Concrete.
2. Saling, P., A. Kicherer, B. Dittrich-Kraemer, R. Wittlinger, W. Zombik, I. Schmidt, W. Schrott, and S. Schmidt. 2002. Eco-efficiency Analysis by BASF: The Method. *Int. J. Life Cycle Assess.*, 7 (4): 203.
3. Shonnard, D.; Kicherer, A; and Saling, P. Industrial Applications Using BASF Eco-Efficiency Analysis: Perspectives on Green Engineering Principles. *Environ. Sci. Technol.* 2003, 37, 5340-5348.
4. 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)
5. 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)
6. Boustead Consulting Ltd UK, The Boustead Model 5.1.2600.2180 LCA database.