Environmental Product Declaration (EPD) for Concrete

Concrete Just Got Greener™

CADMAN
HEIDELBERGCEMENT Group®

Life Cycle Impact Results (per m^3)

Declared Unit: 1 m^3 of 7,000 psi concrete at 28 days

OPERATIONAL IMPACTS	*2D35427*
Plant Operating Energy (MJ)	38.6
On-Site Plant Fuel Consumption (MJ)	11.1
Concrete Batch Water (m^3)	1.68E-01
Concrete Wash Water (m^3)	1.91E-02
On-Site Waste Disposal (kg)	0.0
ENVIRONMENTAL IMPACTS	
Total Primary Energy (MJ)	3,120
Climate Change (kg CO_2 eq)	464
Ozone Depletion (kg CFC 11 eq)	1.09E-08
Acidification Air (kg SO_2 eq)	3.08
Eutrophication (kg N eq)	0.09
Photochemical Ozone Creation (kg O_3 eq)	0.63

About Cadman Inc.

Cadman, Inc., part of the Heidelberg Cement Group, has been serving the greater Puget Sound for more than 75 years. Cadman is committed to being the industry leader in providing outstanding value to our customers, a safe and stimulating work environment for our employees, and also offering the latest in concrete technology.

As a business that depends on natural resources, we are committed to operating in a socially and environmentally responsible manner.

Mission

To supply our customers with sustainable and resilient ready mixed concrete – today, tomorrow and beyond.

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SUSTAINABILITY CERTIFIED NSF Environmental Product Declaration

ENVIRONMENTAL PRODUCT DECLARATION VERIFICATION

<table>
<tr><th colspan="4">EPD Information</th></tr>
<tr><td colspan="2">Program Operator</td><td colspan="2">NSF International</td></tr>
<tr><td colspan="2">Declaration Holder</td><td colspan="2">Cadman Inc</td></tr>
<tr><td>Product:
2D35427</td><td>Date of Issue/Date of Revision
May 16, 2014/June 1, 2016</td><td>Period of Validity
5 Years from Issue Date</td><td>Declaration Number
EPD10029</td></tr>
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<tr><td colspan="2">Reference PCR</td><td colspan="2">North American Product Category Rules (PCR) for ISO 14025 Type III Environmental Product Declarations (EPDs) version 1.0</td></tr>
<tr><td colspan="2">Date of Issue</td><td colspan="2">November 30, 2012</td></tr>
<tr><td colspan="2">PCR review was conducted by:</td><td colspan="2">Nick Santero
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ENVIRONMENTAL PRODUCT DECLARATION: DETAILED VERSION

Product Description

Products covered by this Environmental Product Declaration (EPD) are for post- tension mix designs for commercial and high rise residential applications developed and produced by Cadman Inc for the Seattle, Washington market. The specified compressive strength is 7,000 psi at 28 days or 8,000 psi at 56 days with a 7" +/- 1" slump.

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:

Component	*Standard*	*Specification for:*
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 m^3 of Cadman Inc ready mix post tension concrete produced for commercial and high rise residential applications with a specified compressive strength of 7,000 psi (48 MPa) at 28 days and 8,000 psi (55 MPa) at 56 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.

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 report 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. 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”.

Eco-Profile	*Year*	*Source/Region*
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 Entrainer	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

Profile	Technology	Temporal	Geography	Completeness	Reliability
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 Entrainer	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

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.