

Environmental Product Declaration

TAKTL®

Architectural Ultra High Performance Concrete



ENVIRONMENTAL PRODUCT DECLARATION

General Information

This Environmental Product Declaration (EPD) is for three Ultra High Performance Concrete (UHPC) Fiber Reinforced Panels manufactured by TAKTL, LLC at its Pittsburgh, PA plant for use as exterior and interior wall cladding. This declaration has been prepared in accordance with ISO 14025, ISO 14040, ISO 14044, ISO 21930, and ASTM International's EPD program operator rules.

EPD Scope: Cradle to Gate

EPD Type: Product Specific

Product Category Rule: ISO 21930 (2017), no US PCR has been developed for Concrete Fiber Reinforced Panels meeting the ASTM C1186 standard specification.

Verification Type: Independent external verification of the declaration and data, according to ISO 14025.

Declared Unit: 1 m² of 15.9 mm (5/8") thickness Concrete Reinforced Panel.

Date of Issue: September 15, 2021
(valid for 5 years until September 15, 2026)

ASTM Declaration Number: EPD - 248

EPD Owner:

TAKTL LLC
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Turtle Creek, PA 15145
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Program Operator:

ASTM International
100 Barr Harbor Drive
West Conshohocken, PA 19428
<http://www.astm.org/EPDs.htm>



Third-party verifier:

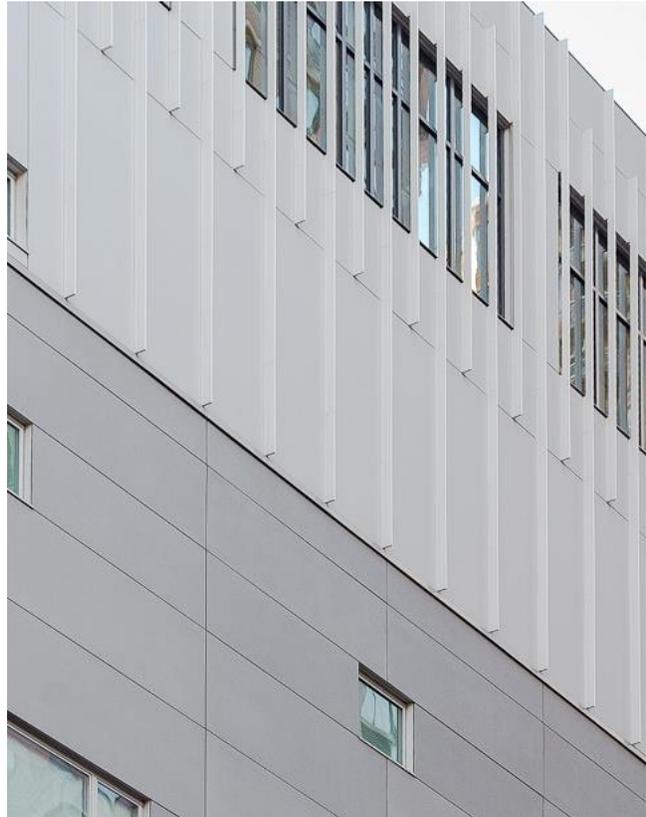
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Producer



About TAKTL

TAKTL® LLC is a Pittsburgh-based manufacturer of architectural facade panels and three-dimensional cast forms utilizing advanced Ultra High Performance Concrete (UHPC) technology. It is the first company to integrate the formulation, mold design, and automated manufacturing of UHPC to produce architectural elements of exceptional quality and performance. TAKTL's manufacturing process is designed as an automated, resource-efficient, scalable model that sources nearly all of its raw materials from within a 500-mile radius of the Pennsylvania factory.

TAKTL has completed hundreds of projects in North America across a wide variety of building types, applications, and regions and has steadily built a reputation for quality, on-time delivery, proactive project management, and collaborative problem-solving within the industry. Over the last two years, 60% of TAKTL's projects represent repeat business relationships with architects, owners, general contractors and installation contractors.

Features and Advantages

- Compatible with all wall assemblies and substrates
- Highest strength-to-weight ratio in its class
- Impermeable, chloride and carbonation resistant
- Excellent freeze-thaw resistance
- Non-combustible, Class A smoke and flame spread
- Impact resistance exceeds highest rating under ASTM 1629
- Graffiti-resistant sealer standard
- 9 textures and 9 colors standard
- Custom colors, surface textures, mineral face aggregates, and design profiles available
- Opaque stain option at no added cost
- Standard Panel Sizes up to 48" x 120" x 5/8" (1220mm x 3050mm x 15.9mm)
- Custom Panel Sizes up to 60" x 144" x 5/8" (1520mm x 3660mm x 15.9mm)
- Delivered precut and pre-drilled for visible or concealed attachment
- Easy to field cut and drill as needed
- 20-year standard warranty

Product

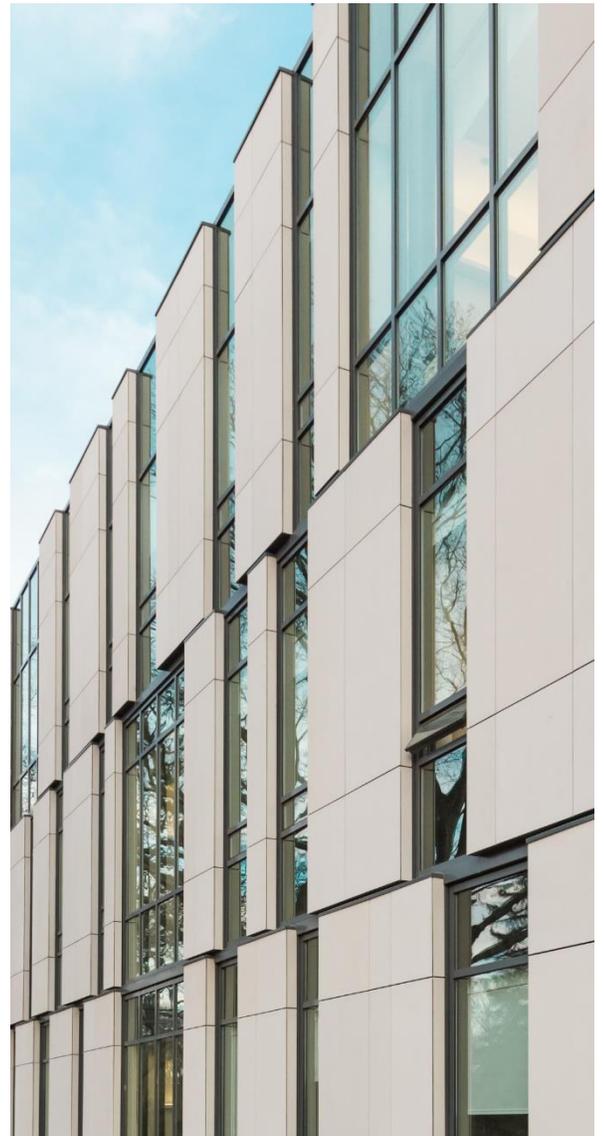
Description

The TAKTL A | UHPC® panels are textile reinforced composite panels manufactured with Ultra High Performance Concrete, alkali-resistant glass fibers, and two layers of alkali-resistant glass fiber reinforcement mesh. Panels are available in standard sizes up to 48" x 120" x 5/8" (1220mm x 3050mm x 15.9mm) and custom sizes up to 60" x 144" x 5/8" (1520mm x 3660mm x 15.9mm) and are designed to comply with a range of facade assemblies for all building construction types (Type I through V) and are also suitable for interior applications as part of a Class A interior wall.

Application

The TAKTL Standard and Select A | UHPC® Panel System is used as an exterior and interior wall cladding in the following applications:

- ALL types of construction under the 2012 & 2015 IBC and IRC
- New construction and renovation, retrofit and re-clad building enclosures
- Open Joint Cladding for Back Ventilated and Drained Cavity Walls (Rainscreen)
- Unitized Curtain Wall and Large Format Prefabricated Wall Systems (Barrier, Sealed or Rainscreen)
- Mechanically attached with concealed or visible hardware or adhered to engineered frames.
- Interior cladding, partitions, and feature wall finishes



ENVIRONMENTAL PRODUCT DECLARATION

LCA Study

Products

This study reports the average performance of 3 Ultra High Performance Concrete (UHPC) products (W10, W15 and B01) made in 9 standard colors (Figure 2) with through body integral pigment and 9 standard surface textures (Figure 3) meeting the ASTM C1186 Type A, Grade IV standard. This study reports the impacts of a standard cast sheet (Figure 1) before job specific custom cutting and finishing.

W10 – white cement base

W15 – white cement base with a contrasting integral pozzolanic micro-aggregate

B01 – grey cement base with TAKTL's highest level of post-industrial (recycled) pozzolanic aggregate

Each product meets equivalent strength, durability, and safety standards (see Tables 1 and 2 on following page), but each differs in water content, recycled content, and the percentage of cement. Some products are more appropriate for specific aesthetic effects such as darker colors (B01), or integral aggregate contrast or additional introduction of surface aggregates (W15).



Figure 1: Standard 4' x 10' cast sheet

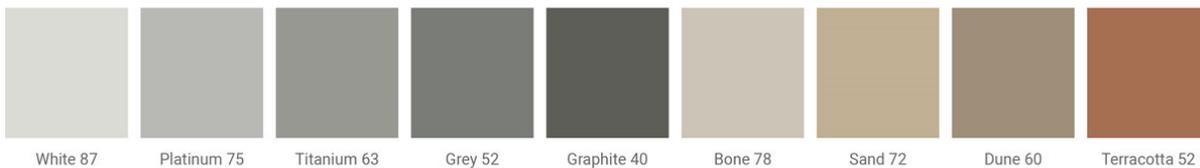


Figure 2: Standard colors included in study

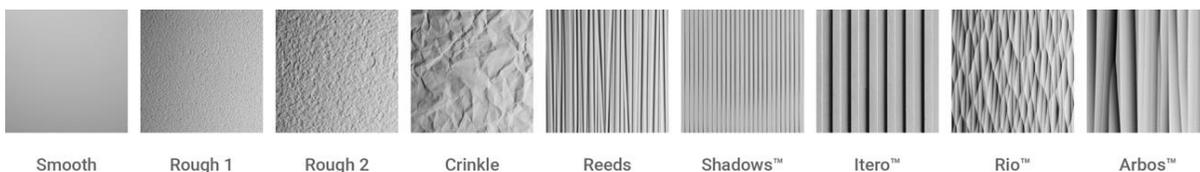


Figure 3: Standard textures included in study

ENVIRONMENTAL PRODUCT DECLARATION

LCA Study

Material Properties

Table 1: Material Properties

Reference Classification: ASTM C1186 TYPE A, GRADE IV		
Density	137 lb/ft ³	2,195 Kg/m ³
Compressive Strength	12,000 - 18,000 psi	95 MPa – 124 MPa
Flexural Strength (panel)	3916 - 4786 psi	27MPa – 33MPa
Modulus of Elasticity	3,683,000 psi	25.4 GPa
Coefficient of Thermal Expansion	6.41E-06 in/(in °F)	1.15E-05 m/(m °C)
Bulk Density / % Voids (permeable)	--	2,290-2,320 kg/m ³ / 2-4%
Specific Heat	241 Btu/lb ft	1010 J/Kg K
Thermal Conductivity	0.98 Btu/h-ft-°F	< 1.7 W/m K

Product Durability and Life Safety Testing

Table 2: Product Durability and Life Safety Testing

Watertightness	Zero water penetration, Zero droplet formation	ASTM C1185 (Section 11)
Water Absorption	No measurable absorption	RILEM Test No. 11.4
Freeze-Thaw Strength Retention (flexural)	≤ 97%	ASTM C1185 (Section 12)
Hard Body Impact	< Level 3 (247 ft-lb _f)	ASTM 1629
Soft Body Impact	< Level 3 (1500 ft-lb _f)	ASTM 1629
Large Missile Impact/HVWZ	PASS	TAS 201
High Temp Combustion (panel)	Noncombustible	ASTM E136 & UL/CAN S114
Smoke & Flame (panel)	Class A Finish	ASTM E84
Fire Propagation Test (wall assembly)	PASS	NFPA 285

LCA Study

System Boundary

This study is cradle-to-gate covering A1-A3 stages of the life cycle as illustrated in Figure 4

- A1 – Raw Material Supply (upstream processes): Extraction, handling, and processing of the materials (including fuels) used in the production of Ultra High Performance Concrete.
- A2 – Transportation: Transportation of these materials from the supplier to the 'gate' of the Turtle Creek, PA Plant.
- A3 – Manufacturing (core processes): The energy used to operate the Turtle Creek Plant.

PRODUCTION Stage (Mandatory)			CONSTRUCTION Stage		USE Stage					END-OF-LIFE Stage			
Extraction and upstream production	Transport to factory	Manufacturing	Transport to site	Installation	Use	Maintenance	Repair	Replacement	Refurbishment	De-construction/ Demolition	Transport to waste processing or disposal	Waste processing	Disposal of waste
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	C1	C2	C3	C4
X	X	X	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND

Figure 4: Life-cycle stages and modules

Note: MND = module not declared; X = module included.

Except as noted above, all other life cycle stages as described in Figure 4 are excluded from the LCA study. The following processes are also excluded from the study:

- Production, manufacture, and construction of manufacturing capital goods and infrastructure.
- Production and manufacture of production equipment and material, delivery vehicles.
- Personnel-related activities (travel, furniture, office supplies).
- Energy and water use related to company management and sales activities that may be located either within the factory site or at another location.

LCA Study

The main processes included in the system boundary are illustrated in Figure 5.

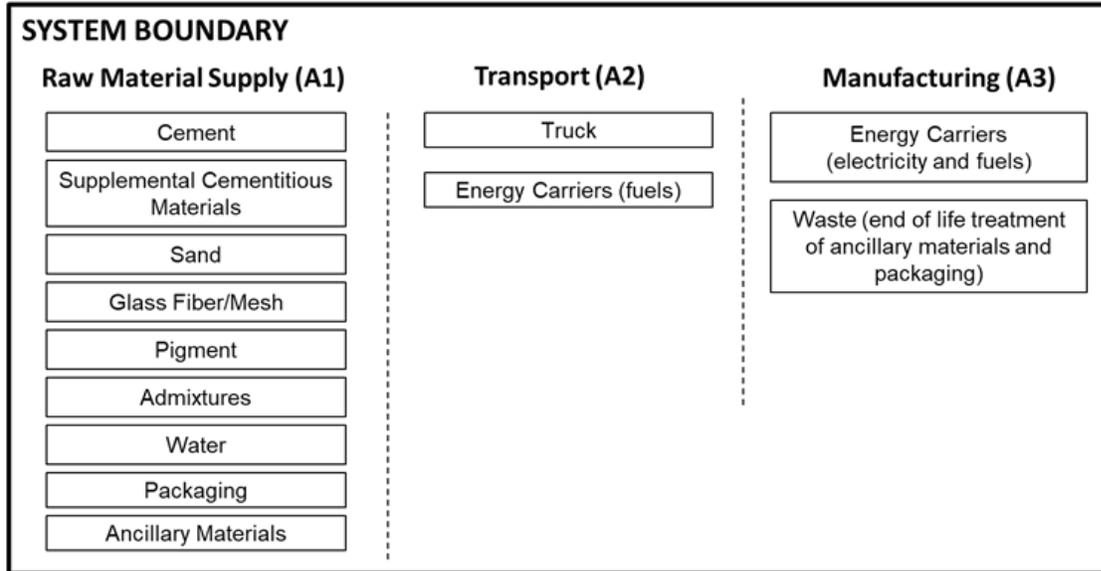


Figure 5: System Boundary for study

Electricity impacts are calculated based on electricity provided at the grid of the state of Pennsylvania provided by US EI database (Long Trail Sustainability, 2020). The resource mix for the state of Pennsylvania is: 36.3% nuclear, 16.6% coal, 42.8% natural gas, 1.3% hydro, 1.4%wind, 1.2% biomass, <0.3% other fossil fuels, and <0.1% solar.

Allocation Procedure

This study follows the rules of ISO 14044, 2006 section 4.3.4, avoiding allocation wherever possible, and when allocation cannot be avoided, partitioning impacts based on physical causality. Recycling procedures follow the rules of the ISO 21930:2017 Section 7.2.6 (ISO 21930, 2017). Supplemental cementitious materials are treated as recovered material and thus the environmental impacts allocated are limited to the treatment and transportation required to use as a material input.

LCA Study

Cutoff Criteria

All inputs and outputs to a unit process for which data are available have been included in the calculation. Data gaps have been filled by conservative assumptions with average or generic data. Any assumptions for such choices have been documented. When data was not reasonably available, the following cutoff criteria were used:

- Mass: If a flow is less than 1% of the cumulative mass of the model flows, it may be excluded, provided its environmental relevance is minor.
- Energy: If a flow is less than 1% of the cumulative energy of the system model, it may be excluded, provided its environmental relevance is minor.
- Environmental relevance: Material and energy flows known or expected to have the potential to cause environmentally relevant emissions into air, water, or soil related to the environmental indicators of the PCR shall be included unless justification for exclusion is documented.

The total of neglected input flows is less than 1% of energy usage and mass.

References

ACLCA (2019): ACLCA Guidance to Calculating Non-LCIA Inventory Metrics in Accordance with ISO 21930:2017.

Climate Earth (2021): TAKTL LCA Project Report.

EPA (2014): Tool for the Reduction of Assessment of Chemical and Other Environmental Impacts (TRACI).

ISO 14020 (2000): Environmental labels and declarations – General principles

ISO 14025 (2006): Environmental labels and declarations, Type III environmental declarations, Principles and procedures.

ISO 14040. (2006/Amd 1:2020). ISO 14040; Environmental Management - Life Cycle Assessment - Principles and Framework.

ISO 14044 (2006/Amd 1:2017/Amd 2:2020): Environmental management - Life cycle assessment - Requirements and guidelines.

ISO 21930 (2017): Sustainability in buildings and civil engineering works - Core rules for environmental product declarations of construction products and services.

Life Cycle Impact Assessment Results

Average W10 Cradle to Gate (A1-A3) Impacts

Table 3: Average W10 Cradle to Gate (A1-A3) impact results per m² and per ft² of 15.9 mm (5/8”) thickness

Impact Assessment	Unit	(A1-A3) m ²			(A1-A3) ft ²
		Average	Min	Max	Average
Global warming potential (GWP) ¹	kg CO ₂ e	34.4	33.3	37.3	3.20
Depletion potential of the stratospheric ozone layer (ODP)	kg CFC-11 e	6.56E-06	3.68E-06	1.96E-05	6.10E-07
Eutrophication potential (EP)	kg N e	4.74E-02	4.60E-02	4.51E-02	4.40E-03
Acidification potential of soil and water sources (AP)	kg SO ₂ e	1.45E-01	1.41E-01	1.44E-01	1.35E-02
Formation potential of tropospheric ozone (POCP)	kg O ₃ e	2.00	1.96	2.03	0.19
Resource Use					
Abiotic depletion potential for non-fossil mineral resources (ADPelements)*	Kg Sb e	6.00E-06			5.57E-07
Abiotic depletion potential for fossil resources (ADPfossil)	MJ, NCV	360			33.4
Renewable primary energy resources as energy (fuel), (RPRE) **	MJ, NCV	8.61			0.80
Renewable primary resources as material, (RPRM) **	MJ, NCV	0			0
Non-renewable primary resources as energy (fuel), (NRPRE) **	MJ, NCV	462			42.9
Non-renewable primary resources as material, (NRPRM) **	MJ, NCV	2.34			0.22
Consumption of fresh water, (FW)*	m ³	7.27			0.68
Secondary Material, Fuel and Recovered Energy					
Secondary Materials, (SM) **	kg	0			0
Renewable secondary fuels, (RSF) **	MJ, NCV	0			0
Non-renewable secondary fuels (NRSF) **	MJ, NCV	0			0
Recovered energy, (RE) **	MJ, NCV	0			0
Waste & Output Flows					
Hazardous waste disposed, (HW) **	kg	1.27E-04			1.18E-05
Non-hazardous waste disposed, (NHWD) **	kg	2.97			0.28
High-level radioactive waste, (HLRW) **	m ³	4.37E-04			4.06E-05
Intermediate and low-level radioactive waste, (ILLRW) **	m ³	1.93E-07			1.79E-08
Components for reuse, (CRU) **	kg	0			0
Materials for recycling, (MR) **	kg	1.03E-02			9.61E-04
Materials for energy recovery, (MER) **	kg	0			0
Recovered energy exported from the product system, (EE) **	MJ, NCV	0			0
Additional Inventory Parameters for Transparency					
CO ₂ emissions from calcination and uptake from carbonation	kg CO ₂ e	4.59			0.43

* 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.

+ Calculated per ACLCA ISO 21930 Guidance.

¹ GWP 100; 100-year time horizon GWP factors are provided by the IPCC 2013 Fifth Assessment Report (AR5).

Life Cycle Impact Assessment Results

Average W15 Cradle to Gate (A1-A3) Impacts

Table 4: Average W15 Cradle to Gate (A1-A3) impact results per m² and per ft² of 15.9 mm (5/8") thickness

Impact Assessment	Unit	(A1-A3) m ²			(A1-A3) ft ²
		Average	Min	Max	Average
Global warming potential (GWP) ²	kg CO ₂ e	32.8	32.2	35.4	3.05
Depletion potential of the stratospheric ozone layer (ODP)	kg CFC-11 e	5.84E-06	6.49E-06	1.27E-05	5.42E-07
Eutrophication potential (EP)	kg N e	4.49E-02	4.24E-02	4.37E-02	4.17E-03
Acidification potential of soil and water sources (AP)	kg SO ₂ e	1.38E-01	1.33E-01	1.39E-01	1.28E-02
Formation potential of tropospheric ozone (POCP)	kg O ₃ e	1.93	1.87	1.97	0.18
Resource Use					
Abiotic depletion potential for non-fossil mineral resources (ADPelements)*	Kg Sb e	5.40E-06			5.02E-07
Abiotic depletion potential for fossil resources (ADPfossil)	MJ, NCV	346			32.1
Renewable primary energy resources as energy (fuel), (RPRE) **	MJ, NCV	8.15			0.76
Renewable primary resources as material, (RPRM) **	MJ, NCV	0			0
Non-renewable primary resources as energy (fuel), (NRPRE) **	MJ, NCV	444			41.2
Non-renewable primary resources as material, (NRPRM) **	MJ, NCV	2.13			0.20
Consumption of fresh water, (FW)*	m ³	6.77			0.63
Secondary Material, Fuel and Recovered Energy					
Secondary Materials, (SM) **	kg	0			0
Renewable secondary fuels, (RSF) **	MJ, NCV	0			0
Non-renewable secondary fuels (NRSF) **	MJ, NCV	0			0
Recovered energy, (RE) **	MJ, NCV	0			0
Waste & Output Flows					
Hazardous waste disposed, (HW) **	kg	1.17E-04			1.09E-05
Non-hazardous waste disposed, (NHWD) **	kg	2.74			0.25
High-level radioactive waste, (HLRW) **	m ³	3.97E-04			3.69E-05
Intermediate and low-level radioactive waste, (ILLRW) **	m ³	1.90E-07			1.76E-08
Components for reuse, (CRU) **	kg	0			0
Materials for recycling, (MR) **	kg	1.03E-02			9.61E-04
Materials for energy recovery, (MER) **	kg	0			0
Recovered energy exported from the product system, (EE) **	MJ, NCV	0			0
Additional Inventory Parameters for Transparency					
CO ₂ emissions from calcination and uptake from carbonation	kg CO ₂ e	4.23			0.39

* 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.

+ Calculated per ACLCA ISO 21930 Guidance.

² GWP 100; 100-year time horizon GWP factors are provided by the IPCC 2013 Fifth Assessment Report (AR5).

Life Cycle Impact Assessment Results

Average B01 Cradle to Gate (A1-A3) Impacts

Table 5: Average B01 Cradle to Gate (A1-A3) impact results per m² and per ft² of 15.9 mm (5/8") thickness

Impact Assessment	Unit	(A1-A3) m ²			(A1-A3) ft ²
		Average	Min	Max	Average
Global warming potential (GWP) ³	kg CO ₂ e	31.7	30.3	33.4	2.95
Depletion potential of the stratospheric ozone layer (ODP)	kg CFC-11 e	8.66E-06	2.16E-06	1.27E-05	8.05E-07
Eutrophication potential (EP)	kg N e	4.22E-02	4.22E-02	4.29E-02	3.92E-03
Acidification potential of soil and water sources (AP)	kg SO ₂ e	1.46E-01	1.45E-01	1.51E-01	1.36E-02
Formation potential of tropospheric ozone (POCP)	kg O ₃ e	2.06	2.04	2.14	0.19
Resource Use					
Abiotic depletion potential for non-fossil mineral resources (ADPelements)*	Kg Sb e	3.57E-06			3.32E-07
Abiotic depletion potential for fossil resources (ADPfossil)	MJ, NCV	350			32.5
Renewable primary energy resources as energy (fuel), (RPRE) **	MJ, NCV	7.93			0.74
Renewable primary resources as material, (RPRM) **	MJ, NCV	0			0
Non-renewable primary resources as energy (fuel), (NRPRE) **	MJ, NCV	454			42.2
Non-renewable primary resources as material, (NRPRM) **	MJ, NCV	1.77			0.16
Consumption of fresh water, (FW)*	m ³	6.77			0.63
Secondary Material, Fuel and Recovered Energy					
Secondary Materials, (SM) **	kg	0			0
Renewable secondary fuels, (RSF) **	MJ, NCV	0			0
Non-renewable secondary fuels (NRSF) **	MJ, NCV	0			0
Recovered energy, (RE) **	MJ, NCV	0			0
Waste & Output Flows					
Hazardous waste disposed, (HW) **	kg	2.17E-04			2.02E-05
Non-hazardous waste disposed, (NHWD) **	kg	2.03			0.19
High-level radioactive waste, (HLRW) **	m ³	3.31E-04			3.07E-05
Intermediate and low-level radioactive waste, (ILLRW) **	m ³	1.83E-07			1.70E-08
Components for reuse, (CRU) **	kg	0			0
Materials for recycling, (MR) **	kg	1.03E-02			9.61E-04
Materials for energy recovery, (MER) **	kg	0			0
Recovered energy exported from the product system, (EE) **	MJ, NCV	0			0
Additional Inventory Parameters for Transparency					
CO ₂ emissions from calcination and uptake from carbonation	kg CO ₂ e	3.13			0.29

* 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.

+ Calculated per ACLCA ISO 21930 Guidance.

³ GWP 100; 100-year time horizon GWP factors are provided by the IPCC 2013 Fifth Assessment Report (AR5).

Life Cycle Impact Assessment Results

LCA Interpretation

Natural gas, electricity and cement are the major contributors to the Global Warming impacts of standard cast sheets. Pigments contribute most impacts to the Ozone Depletion impacts while truck transport and oriented strand board contribute significantly to the Acidification and Smog impact categories.

Life cycle impact assessment (LCIA) results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins, or risks.

EPDs are comparable only if they comply with this document, use the same sub-category PCR where applicable, include all relevant information modules and are based on equivalent scenarios with respect to the context of construction works.

Additional Environmental Information



Environment and Health During Product Manufacturing

TAKTL A | UHPC was founded with a focus on local raw materials sourcing, product lifecycle, the health and safety of plant personnel in the manufacture of TAKTL panels.

- TAKTL is manufactured with over 90% of raw materials sourced from within 500 miles of the Pittsburgh, PA factory
- No Red List Materials included in the manufacture
- No VOCs included in TAKTL panels or surface treatments
- TAKTL selects raw materials for health impact mitigation and has equipment and controls in place for workplace health and safety.
 - Air: Unlike other UHPCs and cementitious panels, TAKTL contains extremely low (trace) levels of crystalline silica, and operates below the limits established by OSHA, verified by inspection and third-party monitoring.
 - Water: Water utilized in manufacturing process is captured and treated mechanically and chemically prior to safe waste or reuse.
 - Noise: Noise emitted by the facility is below the permissible limits.
- Health Product Declaration (HPD) and Safety Data Sheet (SDS) are available upon request
- End-of-life and factory scrap is safe for landfill and suitable for clean sub-base material (recycled into roadbed fill) and other similar uses
- TAKTL identifies ways to reuse or repurpose the waste stream from the manufacture of A | UHPC panels. TAKTL has an ongoing relationship with a local nonprofit construction materials salvage enterprise that resells panel off-cuts and casting overruns.

Durability and Resilience

At only 5/8" (15mm) thickness and 7lbs/sf on average, the TAKTL panel does more with less. TAKTL is providing the AEC industry with flexibility in the design of high performance building enclosures while focusing on the environmental factors that commonly accompany the manufacture of concrete.

By Design, TAKTL panels have a long life, minimal maintenance requirements, and complete end-of-life recyclability. In addition to the durability testing data in the Product section, the other factors that contribute to the resilience and long-term durability of the product include:

- Resistance to carbonation: 10x that of conventional concrete
- Resistance to salts: 5x that of conventional concrete
- ASTM 6578 Graffiti Resistance: Cleanability Level 3 after 25 cycles
- ASTM 653 Accelerated Weathering: No change in graffiti resistance after 2,000 hours (with hydrophobic surface treatment)