SsangYong C&E

South Korean Donghae Cement Plant

(Inclusive of transportation to Anchorage, AK; Seattle, WA; Portland, OR; and Stockton, CA)

An Environmental Product Declaration

ASTM INTERNATIONAL
Helping our world work better

About this EPD

This is a Type III environmental product declaration (EPD) for Type I/II and Type III cements as produced by SsangYong C&E Co. Ltd. (SSY) at its plant located in South Korea, inclusive of transportation to four ports on the US pacific coast. The results of the underlying LCA are computed using the North American (N.A.) version of the Global Cement and Concrete Association (GCCA) Industry EPD Tool for cement and concrete [1]. This tool and the underlying LCA model and database [2] have been previously verified to conform to the prevailing sub-product category rule (PCR) [3], ISO 21930:2017 (the core PCR) [4] as well as ISO 14020:2000 [5] and ISO 14040/44:2006 LCA standards [7], [8].

This EPD is certified by ASTM to conform to the sub-Product Category Rule (PCR) referenced above [3], as well as to the requirements of ISO 14020, ISO 14025 [6], ISO 21930 and ASTM International's General Program Instructions [9]. This EPD is intended for business-to-business audiences.

General Summary

EPD Commissioner and Owner SsangYong C&E	**SsangYong C&E Co. Ltd.** City Center Tower, 34 Supyo-ro, Jung-gu, Seoul 04555, South Korea https://www.ssangyongcne.co.kr SSY company personnel provided LCI and meta data for the 2022 reference year in support of this EPD. *The owner of the declaration is liable for the underlying information and evidence*.
Product Group and Name	*Cement, UN CPC 3744.*
Product Definition	***Portland cement*** is defined as a hydraulic cement produced by pulverizing clinker, consisting essentially of crystalline hydraulic calcium silicates, and usually containing one or more of the following: water, calcium sulfate, up to 5% limestone, and processing additions (NSF PCR 2021, ASTM C150, ASTM C219) Portland Cement *Type I* – For use when the special properties specified for any other type are not required. Portland Cement *Type II* – For general use, especially when moderate sulfate resistance is desired. Portland Cement *Type III* – For use when high early strength is desired. Some cements are designated with a combined type classification, such as Type I/II, indicating that the cement meets the requirements of the indicated types and is being offered as suitable for use when either type is desired.
Product Category Rules (PCR)	NSF International, Product Category Rules for Preparing an Environmental Product Declaration for Portland, Blended Hydraulic, Masonry, Mortar, and Plastic (Stucco) Cements, V3.2, September 2021 [3].
Date of Issue & Validity Period	March 20, 2024 – 5 years
Declared Unit	1 metric ton of cement

SsangYong C&E

An Environmental Product Declaration

In accordance with ISO 14025 and 21930

EPD and Project Report Information

Program Operator	ASTM International
Declaration Number	EPD 641
Declaration Type	Cradle-to-gate (modules A1 to A3). Facility and product-specific.
Applicable Countries	United States
Product Applicability	Portland cement is the basic ingredient of concrete. Concrete, one of the most widely used construction materials in the world, is formed when Portland cement creates a paste with water that binds with sand and rock to harden.
Content of the Declaration	This declaration follows Section 9; Content of an EPD, NSF International, Product Category Rules for Preparing an Environmental Product Declaration for Portland, Blended Hydraulic, Masonry, Mortar, and Plastic (Stucco) Cements, V3.2, September 2021 [3].
This EPD was independently verified by ASTM in accordance with ISO 14025 and the reference PCR: Internal: External: X	Tim Brooke ASTM International 100 Barr Harbor Drive PO Box C700 West Conshohocken PA 19428-2959, USA cert@astm.org
Notes	The EPD results reported herein are computed using the N.A. GCCA Industry EPD tool for Cement and Concrete (https://concrete-epd-tool.org) [1].
EPD Prepared by: Athena Sustainable Materials Institute	Kevin Garrahan and Jamie Meil Athena Sustainable Materials Institute 280 Albert Street, Suite 404 Ottawa, Ontario, Canada K1P 5G8 info@athenasmi.org www.athenasmi.org

PCR Information

Program Operator	NSF International
Reference PCR	Product Category Rules for Preparing an Environmental Product Declaration for Portland, Blended Hydraulic, Masonry, Mortar, and Plastic (Stucco) Cements, V3.2, September 2021 [3].
PCR review was conducted by:	Thomas P. Gloria, PhD (Chair), Industrial Ecology Consultants, Mr. Jack Geibig, EcoForm Mr. Bill Stough, Sustainable Research Group

SSY Cement & Production Facilities

SSY operates one cement plant located in Donghae South Korea which exports Type I/II and Type III cement to various USA customers. The plant consists of seven kilns - five kilns operate using *dry with preheater and precalciner* kiln technology, and two kilns operate using *dry with preheater* kiln technology. SSY provides all logistics for cement delivery, with the customers responsible for off-loading of the bulk cement.

This particular EPD pertains to Type I/II and Type III cement produced at the Donghae plant and delivered to four port locations – port of Anchorage, AK; Port of Seattle, WA; Port of Portland, Oregon; and Port of Stockton, CA.

Product Description

This EPD reports environmental transparency information for Type I/II and Type III cements. Cements are hydraulic binders and are manufactured by grinding cement clinker and other constituents into a finely ground, usually grey colored mineral powder. When mixed with water, cement acts as a glue to bind together the sand, gravel or crushed stone to form concrete, one of the most durable, resilient and widely used construction materials in the world.

Products and Standards

The plant's Type I/II and Type III cements are comparable in make-up to similar products available on the US market and comply with the following standard:

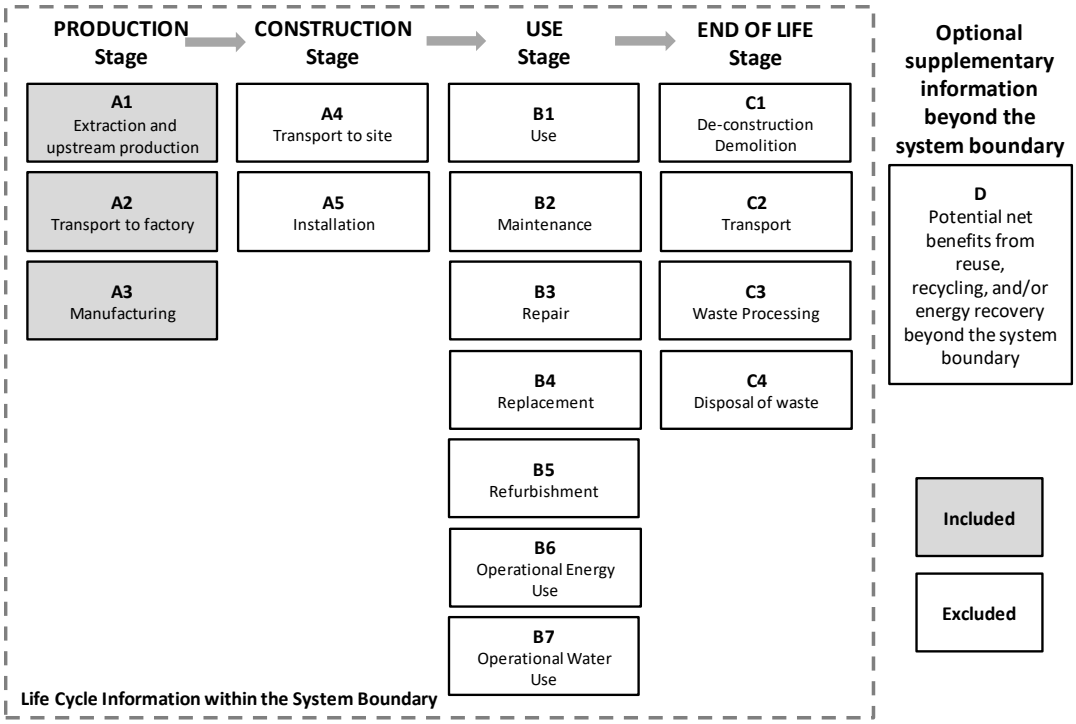
ASTM C150 / C150M – Standard Specification for Portland Cement

Declared Unit

The declared unit is one metric ton of cement.

System Boundary

This is a cradle-to-gate EPD covering the production stage (A1-A3) as depicted in the figure below; inclusive of transport to four cement import ports. The production stage includes extraction of raw materials (cradle) through the manufacture and transport of cements ready for shipment (gate). Transportation reflects mode and distances from the plant to the South Korean export port and bulk carrier delivery to four US port destinations. Cement off-loading is the responsibility of the receiving customer and as such, off-loading effects are excluded from this EPD.



Items *excluded* from the system boundary include:

- Production, manufacture, and construction of manufacturing capital goods and infrastructure
- Production and manufacture of production equipment, delivery vehicles, and laboratory equipment
- Personnel-related activities (travel, furniture, and 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

Cut-off Criteria

The cut-off criteria per NSF PCR, Section 7.1.8 [3] and ISO 21930, 7.1.8 [4] were followed. Per ISO 21930, 7.1.8, all input/output data required were collected and included in the LCI modelling. No substances with hazardous and toxic properties that pose a concern for human health and/or the environment were identified in the framework of this EPD

Data Collection

Gate-to-gate input/output flow data were collected for the following processes for the reference year 2020:

- Limestone quarry operations, clinker production and cement manufacture.
- Transport mode and distance from plants (average) to South Korean port (truck), Soth Korean port to US port (bulk carrier). Bulk cement off-loading is the responsibility of the receiving customer.

Allocation Rules

Allocation of inventory flows and subsequently environmental impact is relevant when assets are shared between product systems. The allocation method prescribed by the PCR [3] is applied in the underlying LCA model. The sub-category PCR recognizes fly ash, furnace bottom ash, bypass dust, mill scale, polluted soils, spent catalyst, aluminum oxide waste, silica fume, granulated blast furnace slag, iron rich waste, cement kiln dust (CKD), flue gas desulfurization (FGD) gypsum, calcium fluoride rich waste and postconsumer gypsum as recovered materials and thus, the environmental impacts allocated to these materials are limited to the treatment and transportation required to use as a cement material input. Further, used tires, plastics, solvents, used oil and oily waste, coal/carbon waste, roofing asphalt, household refuse-derived waste, non-hazardous liquid waste, industrial sludge, and agricultural waste are considered non-renewable and/or renewable secondary fuels. Only the materials, water, energy, emissions, and other elemental flows associated with reprocessing, handling, sorting and transportation from the point of the generating industrial process to their use in the production process are considered. All emissions from combustion at the point of use are considered. For co-products, no credit is considered, and no allocation is applied. See the LCA model and LCA database reports of GCCA's Industry Tool for EPDs of cement and concrete for more information [1], [2].

Data Quality Requirements and Assessment

Data Quality Requirements	Description
Technology Coverage	Data represents the prevailing technology in use at the Donghae Cement plant in South Korea. Whenever available, for all upstream and core material and processes, both International and North American typical or global average industry LCI datasets were utilized. The Donghae cement plant operates seven kilns. Five kilns utilize *preheater and precalciner kiln technology*, and two kilns utilize *preheater technology.* *Technological representativeness is characterized as "high".*
Geographic Coverage	The geographic region considered is Global. *Geographical representativeness is characterized as "high".*
Time Coverage	Activity (primary) data are representative of 2022 calendar years (12 months) and includes the following: - Plant limestone quarrying - Plant clinker production, - Plant Type I/II and Type III cement manufacturing, - In-bound/out-bound transportation data - cement manufacturing plant and transport to four cement customers on the pacific coast. *Temporal representativeness is characterized as "high".*
Completeness	All relevant, specific processes, including inputs (raw materials, energy and ancillary materials) and outputs (emissions and production volume) were considered and modeled in the GCCA Tool to complete the production (inclusive of outbound transport) profile for the cements of interest. The completeness of the foreground process chain in terms of process steps was rigorously assessed.

Consistency	To ensure consistency, cross checks of the material and energy inputs against the PCA Industry Average for Portland cement was conducted [15].
Reproducibility	External reproducibility is not possible as the source LCI data and subsequent LCA background reports are confidential.
Transparency	Activity datasets are disclosed in the project LCI compilation and the background reports generated by the GCCA Tool.
Uncertainty	A *sensitivity check* was conducted relative to the PCA industry average [15]. The variation across significant inputs were found to be well within the expected range and hence, there is high degree of confidence in the results.

Life Cycle Impact Assessment Results: SSY Plant to Import Terminals

This section summarizes the production stage life cycle impact assessment (LCIA) results including resource use and waste generated metrics based on the cradle-to-gate life cycle inventory inputs and outputs analysis. The results are calculated based on 1 metric ton of each cement type as produced at the two plants inclusive of transportation to each cement customer port.

It should be noted that LCIA results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks [4], [8]. Further, many LCA impact categories and inventory items are still emerging or under development and can have high levels of uncertainty that preclude international acceptance pending further development. Use caution when interpreting results for these categories – identified with an "*" [3].

Only EPDs prepared from cradle-to-grave life-cycle results and based on the same function, quantified by the same functional unit, and taking account of replacement based on the product reference service life (RSL) relative to an assumed building service life, can be used to assist purchasers and users in making informed comparisons between products [3]. Environmental declarations from different programs may not be comparable [6]. EPDs are comparable only if they comply with ISO 21930, 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 [3] [4].

Production stage EPD Results – per metric ton delivered to import terminals

Impact category and inventory indicators	**Unit**	**Anchorage, AK Type I/II** ASTM C150	**Seattle, WA Type I/II** ASTM C150	**Portland, OR Type I/II** ASTM C150	**Stockton, CA Type I/II** ASTM C150
Global warming potential, GWP 100, AR5	kg CO2 eq	**956**	**965**	**966**	**969**
Ozone depletion potential, ODP	kg CFC-11 eq	**1.69E-05**	**1.88E-05**	**1.89E-05**	**1.96E-05**
Smog formation potential, SFP	kg O3 eq	**35.4**	**36.9**	**36.9**	**37.4**
Acidification potential, AP	kg SO2 eq	**3.1**	**3.3**	**3.3**	**3.4**
Eutrophication potential, EP	kg N eq	**1.3**	**1.4**	**1.4**	**1.4**
Abiotic depletion potential for non-fossil, mineral resources ADP elements*	kg Sb eq	**1.19E-04**	**1.22E-04**	**1.09E-04**	**1.09E-04**
Abiotic depletion potential for fossil resources, ADP fossil*	MJ LHV	**3738**	**3873**	**3880**	**3925**

Impact category and inventory indicators	Unit	Anchorage, AK Type I/II ASTM C150	Seattle, WA Type I/II ASTM C150	Portland, OR Type I/II ASTM C150	Stockton, CA Type I/II ASTM C150
Renewable primary resources used as an energy carrier (fuel), RPRE*	MJ LHV	**101**	**104**	**104**	**106**
Renewable primary resources with energy content used as material, RPRM*	MJ LHV	**0**	**0**	**0**	**0**
Non-renewable primary resources used as an energy carrier (fuel), NRPRE*	MJ LHV	**3737**	**3872**	**3879**	**3924**
Non-renewable primary resources with energy content used as material, NRPRM*	MJ LHV	**0**	**0**	**0**	**0**
Secondary materials, SM*	kg	**92.6**	**92.6**	**92.6**	**92.6**
Renewable secondary fuels, RSF *	MJ LHV	**50.3**	**50.3**	**50.3**	**50.3**
Non-renewable secondary fuels, NRSF *	MJ LHV	**3017**	**3017**	**3017**	**3017**
Recovered energy, RE*	MJ LHV	**28.0**	**28.0**	**28.0**	**28.0**
Consumption of freshwater, FW*	m3	**1.83**	**1.86**	**1.86**	**1.87**
Hazardous waste disposed, HWD*	kg	**0.029**	**0.029**	**0.029**	**0.029**
Non-hazardous waste disposed, NHWD *	kg	**1.20E-03**	**1.20E-03**	**1.20E-03**	**1.20E-03**
High-level radioactive waste, conditioned, to final repository, HLRW*	kg	**x[1])**	**x[1])**	**x[1])**	**x[1])**
Intermediate- and low-level radioactive waste, conditioned, to final repository, ILLRW*	kg	**x[1])**	**x[1])**	**x[1])**	**x[1])**
Components for re-use, CRU*	kg	**0**	**0**	**0**	**0**
Materials for recycling, MFR*	kg	**0.44**	**0.44**	**0.44**	**0.44**
Materials for energy recovery, MER*	kg	**0**	**0**	**0**	**0**
Recovered energy exported from the product system, EE*	MJ LHV	**0**	**0**	**0**	**0**
Additional Indicators:					
Global warming potential - biogenic, GWP-bio*	kg CO_2 eq	**0.12**	**0.12**	**0.13**	**0.13**
Emissions from calcination*	kg CO_2 eq	**492**	**492**	**492**	**492**
Emissions from combustion of waste from renewable sources*	kg CO_2 eq	**0.01**	**0.01**	**0.01**	**0.01**
Emissions from combustion of waste from non-renewable sources*	kg CO_2 eq	**244**	**244**	**244**	**244**

Impact category and inventory indicators	Unit	Anchorage, AK Type III ASTM C150	Seattle, WA Type III ASTM C150	Portland, OR Type III ASTM C150	Stockton, CA Type III ASTM C150
Global warming potential, GWP 100, AR5	kg CO2 eq	**981**	**990**	**991**	**994**
Ozone depletion potential, ODP	kg CFC-11 eq	**1.75E-05**	**1.95E-05**	**1.96E-05**	**2.02E-05**
Smog formation potential, SFP	kg O3 eq	**36**	**37.5**	**37.5**	**38**
Acidification potential, AP	kg SO2 eq	**3.2**	**3.4**	**3.4**	**3.4**
Eutrophication potential, EP	kg N eq	**1.7**	**1.8**	**1.8**	**1.8**
Abiotic depletion potential for non-fossil, mineral resources ADP elements*	kg Sb eq	**1.49E-04**	**1.52E-04**	**1.52E-04**	**1.52E-04**
Abiotic depletion potential for fossil resources, ADP fossil*	MJ LHV	**4370**	**4505**	**4512**	**4557**
Renewable primary resources used as an energy carrier (fuel), RPRE*	MJ LHV	**116**	**119**	**120**	**121**
Renewable primary resources with energy content used as material, RPRM*	MJ LHV	**0**	**0**	**0**	**0**
Non-renewable primary resources used as an energy carrier (fuel), NRPRE*	MJ LHV	**4369**	**4503**	**4511**	**4556**
Non-renewable primary resources with energy content used as material, NRPRM*	MJ LHV	**0**	**0**	**0**	**0**
Secondary materials, SM*	kg	**162.9**	**162.9**	**162.9**	**162.9**
Renewable secondary fuels, RSF *	MJ LHV	**49.8**	**49.8**	**49.8**	**49.8**
Non-renewable secondary fuels, NRSF *	MJ LHV	**2987**	**2987**	**2987**	**2987**
Recovered energy, RE*	MJ LHV	**27.8**	**27.8**	**27.8**	**27.8**
Consumption of freshwater, FW*	m3	**2.69**	**2.72**	**2.72**	**2.73**
Hazardous waste disposed, HWD*	kg	**0.029**	**0.029**	**0.029**	**0.029**
Non-hazardous waste disposed, NHWD *	kg	**1.20E-03**	**1.20E-03**	**1.20E-03**	**1.20E-03**
High-level radioactive waste, conditioned, to final repository, HLRW*	kg	**x[1])**	**x[1])**	**x[1])**	**x[1])**
Intermediate- and low-level radioactive waste, conditioned, to final repository, ILLRW*	kg	**x[1])**	**x[1])**	**x[1])**	**x[1])**
Components for re-use, CRU*	kg	**0**	**0**	**0**	**0**
Materials for recycling, MFR*	kg	**0.43**	**0.43**	**0.43**	**0.43**
Materials for energy recovery, MER*	kg	**0**	**0**	**0**	**0**
Recovered energy exported from the product system, EE*	MJ LHV	**0**	**0**	**0**	**0**

Impact category and inventory indicators	Unit	Anchorage, AK Type III ASTM C150	Seattle, WA Type III ASTM C150	Portland, OR Type III ASTM C150	Stockton, CA Type III ASTM C150
Additional Indicators:					
Global warming potential - biogenic, GWP-bio*	kg CO_2 eq	**0.12**	**0.13**	**0.13**	**0.13**
Emissions from calcination*	kg CO_2 eq	**487**	**487**	**487**	**487**
Emissions from combustion of waste from renewable sources*	kg CO_2 eq	**0.01**	**0.01**	**0.01**	**0.01**
Emissions from combustion of waste from non-renewable sources*	kg CO_2 eq	**241**	**241**	**241**	**241**

Table Notes:
x[1)] – The GCCA EPD Tool does not support these indicators.
* Use caution when interpreting results for these categories

LCA Interpretation

The Manufacturing module (A3) drives most of the potential environmental impacts. Manufacturing impacts are primarily driven by energy use (electricity and thermal fuels) during the pyroprocessing of limestone in the production of clinker. Clinker content in cement similarly defines the relative environmental profile of the final cement product. Raw material extraction (A1) is the second largest contributor to the Production stage EPD results, followed by transportation (A2). It is noted that long distance transport contributes about 40 to 55 kg CO_2e to the overall GWP profile of the imported cements.

Additional Environmental Information

No additional environmental information is reported.

References

[1] Global Cement and Concrete Association (GCCA) and Portland Cement Association (PCA), *GCCA Industry EPD Tool for Cement and Concrete (V4.2), User's Manual, North American version*, Prepared by Quantis, December 2023. https://concrete-epd-tool.org/

[2] Global Cement and Concrete Association (GCCA) LCA Database, North American version (V4.2), Prepared by Quantis, December 2023. https://concrete-epd-tool.org/assets/GCCA_EPD-Tool_LCA-Database-v4.2_2023-12-18.xlsx

[3] NSF International, Product Category Rule Environmental Product Declarations, PCR for Portland, Blended, Masonry, Mortar, and Plastic (Stucco) Cements, V3.2, September 2021.

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

[5] ISO 14020:2000 Environmental labels and declarations — General principles

[6] ISO 14025:2006 Environmental labeling and declarations - Type III environmental declarations - Principles and procedures.

[7] ISO 14040:2006/Amd1:2020 Environmental management - Life cycle assessment - Principles and framework.

[8] ISO 14044:2006/Amd1:2017/Amd2:2020 Environmental management - Life cycle assessment - Requirements and guidelines.

[9] ASTM General Program Instructions. V.8.0, April 29, 2020.

[10] NSF International, Product Category Rule Environmental Product Declarations, PCR for Concrete, V2.1, August 2021.

[11] ASTM C150 / C150M – 20 Standard Specification for Portland Cement.

[12] API 10a – Specification for Cements and Materials for Well Cementing

[13] ASTM C595 / C595M - 21 Standard Specification for Blended Hydraulic Cements

[14] AASHTO M 85-21 Standard Specification for Portland Cement (ASTM Designation: C150/C150M-21)

[15] Portland Cement Association Environmental Product Declaration – Portland Cement, ASTM International, March 12, 2021. https://www.cement.org/docs/default-source/default-document-library/pca_epds_2021_rev01312022.pdf?sfvrsn=d26ffbf_2