Environmental Product Declaration for Average Precast Concrete Element

Dubai Precast LLC, UAE

ISO 14025:2006, ISO 14044:2006, EN 15804:2012

EPD registration number:	S-P-01294
Publication date:	2018-06-07
Validity date:	2023-05-31
Geographical scope:	United Arab Emirates

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1. Introduction

The current document is developed for providing a measurable and verifiable input for the environmental assessment of precast concrete element manufactured by Dubai Precast LLC in United Arab Emirates (UAE).

Dubai Precast L.L.C. is a company specialized in the supply of precast concrete building components. It is a design, manufacturing and installation company established in April 2006 in Jebel Ali, Dubai with a paid-up capital of AED 10 million. Dubai Precast LLC is intently working on building tomorrow's vision in the rapidly growing Precast Industry.

Dubai Precast LLC is an ISO certified company and holds the supply of high quality components as a key priority. The concrete production and delivery facility of Dubai Precast is assessed and certified by the Dubai Central Laboratory (DCL) for its conformity with DMS-026 Standard. Dubai Precast also hold the membership from Precast/Prestressed Concrete Institute (PCI) for its Engineering and Design development as foreign producer of precast.

Dubai Precast L.L.C. is a part of the Eastern Pretech Group, which for the last three decades have been the market leader in the precast concrete industry in South East Asia. Dubai Precast L.L.C. was established in April 2006 with our local partner is Mr. Khalfan Saeed Jumaa Al Kaabi. He brings the local relationship and experience to our company.

Dubai Precast L.L.C. aims to be one of the most reliable and innovative precast concrete companies in U.A.E, with firm commitments to our customer's requirements, and have executed various high profile projects in the last decade Our services consist of design, manufacture, delivery and erection of all types of precast concrete products, including Pre-stressed Hollow core Slabs, Architectural Sandwich Panels, solid panels, pre stressed beams, columns, tunnel segments etc. The facilities can produce Pre-Stressed Hollow Core Slabs in thicknesses from 150 mm up to 520 mm, spanning up to 22 m. Furthermore, Dubai Precast L.L.C. has facilities to produce all other types of precast concrete items.

Dubai Precast's internal design department is equipped with design software, e.g. CAD system, structural design software, and planning and delivery software, to ensure high quality output to the agreed time.

The Dubai office and factory facilities are located in Jebel Ali Industrial Area-3 and are spread over a plot area of 37,000 m^2. Dubai Precast L.L.C. has an annual production capacity of 400,000 m^3 of Pre-Stressed Hollow Core Slabs and 60,000 m^3 of precast concrete panels, slabs, claddings, beams, columns, staircases etc.

The production facility is situated in Jebel Ali Industrial Area #3, Dubai with two automated batching plants having capacity of producing 400 m^3 each in a day.

The declaration is established for the average product of the manufacturing plants in UAE. The average is based on the weighted average production volume of each precast concrete product. This EPD is based on a declared unit of 1 ton of average precast concrete element.

2. General information

2.1 EPD, PCR, LCA information

Table 1: EPD Information

Programme	The International EPD® System, www.environdec.com
Programme operator	EPD International AB Box 210 60, SE- 100 31 Stockholm, Sweden.
Declaration holder	Mr. Cherian P. Mathew Dubai Precast LLC Jebel Ali Industrial Area # 3, Dubai, UAE. PO Box 61055 United Arab Emirates Email: cherian@dubaiprecast.ae
Product	Precast Concrete Elements
EPD registration number	S-P-01294
Publication date	2018-06-07
Validity date	2023-05-31
Geographical scope	United Arab Emirates
Reference standards	ISO 14025:2006, ISO 14044:2006, UN CPC 314, UN CPC 375

Table 2: PCR Information

Reference PCR	PCR for 'Construction Products and Construction Services' Version 2.2, 2012
Date of Issue	2017-05-30 (Version 2.2)
Period of Validity	2019-03-03

Table 3: Verification Information

Demonstration of verification	External, independent verification
Third party verifier	Dr Hudai Kara, Metsims Sustainability Consulting, 4 Clear Water Place, Oxford OX2 7NL, UK Email: hudai.kara@metsims.com

Table 4: LCA Information

Title	Life Cycle Assessment Report – 2018 Precast Concrete Element, Dubai Precast LLC, UAE.
Preparer	Dr. Rajesh Kumar Singh Thinkstep Sustainability Solutions Pvt. Ltd. 421, MIDAS, Sahar Plaza, Andheri Kurla Road, Andheri East, Mumbai, India – 400059 Email: rajesh.singh@thinkstep.com
Reference standards	ISO 14040/44 standard

2.2 Reference period of EPD data
The reference period for the data used within this EPD is the year 2017 (January to December).

2.3 Geographical scope of EPD application
The geographical scope of this EPD is UAE

2.4 Additional information about EPD
This EPD provides information concerning the production of precast concrete manufactured at Dubai Precast LLC, UAE at Jebel Ali. This EPD is in accordance with ISO 14025 and EN 15804. EPD of construction products may not be comparable if they do not comply with EN 15804. The target group of EPD are Green Building Certification Program holders and consultants, customers, project developers, statutory agencies and government (Dubai Municipal Corporation, Expo 2020 Dubai UAE).

Product Category Rules (PCR) for the assessment of the environmental performance of precast concrete is PCR for 'Construction Products and Construction Services' Version 2.2. This PCR is applicable to the product "Precast Concrete" complying with the standard EN 15804. The CPC codes for the precast concrete products includes UN CPC 314 (Boards and panels) and UN CPC 375 (Articles of concrete, cement and plaster).

The environmental impacts are calculated on the basis of the functional unit wherein each flow related to material consumption, energy consumption, emissions, effluent and waste is scaled to the reference flow.

3. Product description and system boundaries

3.1 Product identification and usage
Precast concrete is a construction product produced by casting concrete in a reusable mold or "form" which is then cured in a controlled environment, transported to the construction site and lifted into place. Concrete is a composite material obtained through the homogenization of cement, aggregates, water and additives. Precast concretes covered by this EPD are constituted from cement, coarse and fine aggregates, steel rebars, secondary materials, recycled or fresh water and admixtures.

The EPD covers wide range of precast concrete products for building projects like columns, beams, hollow core slabs, solid slabs, staircases and landings, solid walls, sandwich walls and cladding panels.

The weighted average composition by mass of precast concretes in this EPD are as follows:

- Portland cement (OPC): 10.66%
- Slag cement (GGBFS- PSC): 4.53%
- Crushed coarse and natural fine aggregates: 70.28%
- Water (fresh or recycled): 9.02%.
- Plasticizer: 0.20%
- Form release agent: 0.04%
- Rebar: 5.13%
- Pigment: 0.01%
- Insulation: 0.12%

Usage and application of product
The application of precast concrete products includes hollow core slabs for precast flooring, pre-stressed beams for flyover bridges, pedestrian bridges, marine jetties; load bearing walls, cladding panels, stairs and landing, beams, columns and boundary walls. In addition, the precast concrete element can be used

to cast any size, shape or texture for other customized structural application. The technical specifications of the standard product (Hollow core slab) manufactured at Dubai Precast LLC, UAE is shown in Table 5

Table 5: Technical specifications of the standard product manufactured at Dubai Precast LLC, UAE.

Profile	Height	Width	Weight (joints filled)	Cross sectional Area	Moment of Inertia	Nominal cover to strand	Fire resistance	Airborne sound reduction index
	(mm)	(mm)	(kN/m^2)	(m^2)	(m^4)	(mm)	(hours)	Rw (dB)
DP8 - 150	150	1196	2.36	0.108164	0.000287	30	1.5	50
DP6 - 200	200	1196	2.76	0.123886	0.000626	30	1.5	53
DP5 - 265	265	1196	3.45	0.156327	0.001416	30	1.5	56
DP4 - 320	320	1196	4.22	0.191177	0.002532	30	1.5	58
DP4 - 400	400	1196	4.60	0.209069	0.004386	30	1.5	60
DP4 - 500	500	1196	6.82	0.306585	0.009351	30	1.5	63

3.2 Product manufacturing

The main steps in precast concrete production process are:

- Raw material supply and storage
- Raw material preparation
- Mixing and Casting with reinforcement

These processes are illustrated in Figure 1.

3.2.1 Raw material preparation

The process flow of production of cement and aggregates is considered upstream to precast concrete production and directly considered as materials ready for consumption in this EPD.

3.2.2 Mixing

The ingredients are blended in a mechanical mixer. Energy for the precast concrete production is supplied by electricity

3.3 System boundaries

The selected system boundaries comprise the production of precast concrete including raw material extraction up to the finished product at the factory gate.

Table 6: System boundary and product stages

Module	Product stages
A1	Materials
A2	Upstream Transport (Inbound)
A3	Manufacturing

This declaration qualifies as an attributional LCA, as it describes the environmentally relevant physical flows to and from the processes associated with the life cycle of precast concrete.

The system boundary does not include:

- Capital equipment and maintenance of production facility
- Maintenance and operation of equipment
- Human labour
- Internal transportation of materials
- Distribution of the product
- Use phase of the product

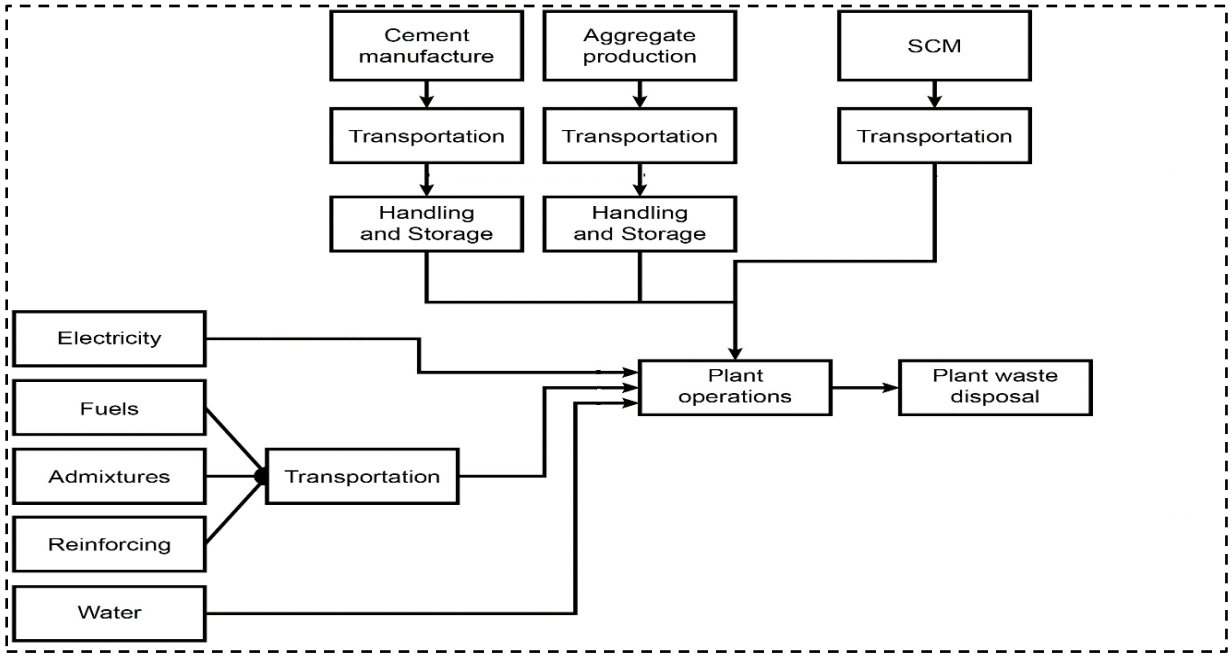

Figure 1: Schematic of precast concrete production flow in Dubai Precast LLC, UAE

4. LCA

4.1 Information sources and data quality

It is important that data quality is in accordance with the requirements of the study‘s goal and scope. This is essential to the reliability of the study and achievement of the intended application. The quality of the LCI data for modelling the life cycle stages have been assessed according to ISO 14044 (ISO, 2006b). Data quality is judged by its precision (measured, calculated or estimated), completeness (e.g. are there unreported emissions?), consistency (degree of uniformity of the methodology applied on a study serving as a data source) and representativeness (geographical, time period, technology). To cover these requirements and to ensure reliable results, first-hand industry data in combination with consistent, upstream LCA information is used. The datasets have been used in LCA-models worldwide for several years in industrial and scientific applications for internal as well as critically reviewed studies. In the process of providing these datasets, they have been cross-checked with other databases and values from industry and science.

Dubai Precast LLC, UAE provided the most accurate and representative data for precast concrete production. For all data requirements, primary data were used where possible, and finally upstream LCA data from the GaBi 8 professional database.

4.2 Estimations and methodology

The data collection is related to one year of operation and the year of the data is indicated in the questionnaire for each data point. The majority of data was derived from the period January 2017 to December 2017.

4.2.1 Allocation Procedures

As no co-products are produced, the flow of materials and energy and also the associated release of substances and energy into the environment is related exclusively to the precast concrete elements produced. Any allocation performed in the background processes is according to the PCR.

4.2.2 Average Precast Concrete

The inventory data of the precast concrete elements produced at Dubai Precast Jebel Ali manufacturing unit is used to calculate the declared average cement, aggregates, admixtures, rebars and other inputs and outputs. The average is determined based on the produced amounts by weight in 2017.

4.2.3 Declared unit

The declared unit for the EPD is 1 ton of precast concrete element leaving the factory gate.

4.2.4 Impact Assessment

A list of relevant impact categories and category indicators is defined and associated with the inventory data. Various environmental impacts and emissions are associated with production of precast concrete, from raw material production, transport of materials to manufacturing site to precast concrete production.

CML 2001 (January 2016) method developed by Institute of Environmental Sciences, Leiden University, Netherlands have been selected for evaluation of environmental impacts. These indicators are scientifically and technically valid. Environment impacts indicators considered for evaluation are listed in Table 7

The environmental impact per declared unit for the following environmental impact categories shall be reported in the EPD according with EN15804, and divided into core, upstream (and downstream, if included) module.

Table 7. Environmental impacts indicators

Impact Indicator	LCIA Method	Unit
Acidification	CML	kg SO_2 equivalent
Eutrophication	CML	kg PO_4^{3-} equivalent
Climate Change	CML	kg CO_2 equivalent
Ozone Depletion	CML	kg CFC-11 equivalent
Photochemical Ozone Creation	CML	kg Ethene equivalent
Abiotic Depletion- Elements	CML	kg Sb- equivalent
Abiotic Depletion- Fossil	CML	MJ

The consumption of natural resources per declared or function unit is reported in the EPD. Input parameters, according with EN15804, describing resource use are shown in Table 8.

Table 8. Natural resources use parameters

Parameter	Unit
Abiotic depletion potential for fossil resources	MJ, net calorific value
Renewable primary energy as energy carrier	MJ, net calorific value
Renewable primary energy resources as material utilization	MJ, net calorific value
Total use of renewable primary energy resources	MJ, net calorific value
Non-renewable primary energy as energy carrier	MJ, net calorific value
Non-renewable primary energy as material utilization	MJ, net calorific value
Total use of non-renewable primary energy resources	MJ, net calorific value
Use of net fresh water	m^3

4.3 Cut off Rules

Input and output data have been collected through detailed questionnaires which have been developed and refined. In practice, this means that, at least, all material flows going into the cement production processes (inputs) higher than 1% of the total mass flow (t) or higher than 1% of the total primary energy input (MJ) are part of the system and modelled in order to calculate elementary flows. All material flows leaving the product system (outputs) accounting for more than 1% of the total mass flow is part of the system. All available inputs and outputs, even below the 1% threshold, have been considered for the LCI calculation.

4.4 Background Data

Background data is included based on generic datasets from the GaBi 8 Database of thinkstep in the version of 2016. The background data is based on reviewed data from life cycle inventories. As all datasets are validated, the data quality for the entire study can be judged as very good.

4.5 System Boundaries

4.5.1 Technical System Boundaries

The technical system boundaries are defined according to the provisions of the PCR. The LCA model of Precast Concrete represents a cradle-to-gate system. Primary raw material is accounted from the quarry, including all processes including transportation to the production facilities. The scope covers the ecological information to be divided into raw material production, transportation, precast concrete production and disposal and transport of wastes. The material production includes the raw material extraction, production of the raw materials and auxiliary material production. The production contains the in-house manufacturing processes.

Material flows and emissions not associated with the production process, such as energy used for personal transportation, are not included in this study.

4.5.2 Geographical System Boundaries

The geographical coverage of this declaration covers the production of precast concrete in UAE. Wherever possible, the country specific boundaries have been adapted and other datasets were chosen from EU and DE, if no UAE datasets were available.

4.5.3 Temporal System Boundaries

All material flows of the processes are based on company and site-specific data gathered for the year 2017. All background data originates from the GaBi database version of 2016.

4.6 Comparability

The EPD is established on the basis of the product category rules (PCR) for precast concrete. According to these standards, EPDs do not compare the environmental performance of products in the construction sector. Any comparison of the declared environmental performance of products lies outside the scope of these standards and is suggested to be feasible only if all compared declarations follow equal standard provisions.

4.7 Results

Based on 2017 data, the results shown in Table 10, Table 11 and Table 12 have been obtained for the average precast concrete element produced in the Dubai Precast LLC, UAE plant. The declared unit is 1 ton of average precast concrete element.

Table 9: Description of the system boundary (X = Included in LCA, MND = Module Not Declared)

Product Stage			**Installation Stage**		**Use stage**							**End-of-Life Stage**				**Benefits beyond system boundary**
Raw material supply	Transport	Manufacturing	Transport to building site	Installation into building	Use / application	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Deconstruction / demolition	Transport to EoL	Waste processing for reuse, recovery or recycling	Disposal	Reuse, recovery or recycling potential
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
X	X	X	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND

Table 10: LCIA result for 1 ton of average precast concrete element

Parameter	Unit	Module A1-A3
Global Warming Potential (GWP)	kg CO_2-eq	2.71E+02
Ozone Layer Depletion Potential (ODP)	kg CFC 11-eq	5.29E-08
Acidification Potential (AP)	kg SO_2-eq	1.02E+00
Eutrophication Potential (EP)	kg PO_4^{3-}-eq	1.10E-01
Photochemical Ozone Creation Potential (POCP)	kg Ethene-eq	9.41E-02
Abiotic Depletion Potential for Non-Fossil Resources (ADPE)	kg Sb-eq	1.67E-04

Table 11: Use of natural resources analysis for 1 ton of average precast concrete element

Parameter	Unit	Module A1-A3
Abiotic depletion potential for fossil resources	MJ	2.60E+03
Renewable primary energy as energy carrier	MJ	9.44E+01
Renewable primary energy resources as material utilization	MJ	0.00E+00
Total use of renewable primary energy resources	MJ	9.44E+01
Non-renewable primary energy as energy carrier	MJ	2.68E+03
Non-renewable primary energy as material utilization	MJ	0.00E+00
Total use of non-renewable primary energy resources	MJ	2.68E+03
Use of net fresh water	m^3	1.91E+02

Table 12: Supplementary indicators for 1 ton of average precast concrete element

Parameter	Unit	Module A1-A3
Non-hazardous waste	kg	1.10E+02
Hazardous waste	kg	5.81E-03
Radioactive waste	kg	3.86E-02

4.8 Interpretation

Table 13: Interpretation of most significant contributors to life cycle parameters

Parameter	Most significant contributor
ADP Elements	Abiotic depletion potential (ADP element) is 1.67E-04 kg Sb-Equiv. of which major contribution is done by 95.72%, plasticizer contributes 1.47%.
ADP Fossil	Abiotic depletion potential (ADP Fossil) is 2.60E+03 MJ of which maximum contribution is from 70.01%, OPC production contributes 13.23%, 4.34% is contributed by electricity, 2.32% comes from plasticizer, 2.38% is contributed by PSC production.
Acidification Potential	Acidification potential is 1.02E+00 kg SO_2-Equiv. The contribution of OPC production is 14.65%, PSC contributes 2.50% and rebars contributes 76.84% AP
Eutrophication Potential	Eutrophication Potential is 1.10E-01 kg Phosphate-Equiv. The major contribution comes from rebars i.e. 65.68%, OPC contributes 19.43%, 2.03% is contributed by electricity, 3.28% comes from PSC production and 1.19% is contributed by solid waste disposal to landfill.
Global Warming Potential	Global warming potential is 2.71E+02 kg CO_2-Equiv. The contribution of Ordinary Portland Cement (OPC) production is 36.11%, Portland Slag Cement (PSC) contributes 5.68%, while rebars contribute 48.95% GWP.
Ozone Depletion Potential	Ozone layer depletion potential is 5.29E-08 kg CFC 11-Equiv. The contribution of OPC production is 96.08%, PSC production contributes 2.23% and plasticizer contributes 1.03% ODP.
Primary Energy Demand	Primary energy demand is 2.78E+03 MJ. Rebars contributes 65.66 %, OPC contributes 15.76%. Fine aggregate, coarse aggregate, plasticizer, PSC and diesel mix contribute around 2% each. Electricity contributes 4.07%.
Photochemical Ozone Creation Potential	Photochemical ozone creation potential is 9.41E-02 kg Ethene-Equiv. Major contributions is seen from rebars i.e. 84.74%, 17.12% is contributed by OPC production.
Waste Generation	The amount of hazardous waste generated is majorly associated with plasticizer production which is nearly 99.91%. The amount of non-hazardous waste generated is majorly coming from production of solid waste disposal to landfill, 2.2% from fine aggregate and 5.4% from coarse aggregate.
Water Demand	The water demand is 1.91E+02 m^3. Around 99.85% is contributed by rebars production.

Concluding, the use of energy is the most significant contributor to environmental impacts associated with precast concrete products. Energy is used as electricity and fuel, by far dominated by the kiln. Also contributing is the energy demand related to the transportation of raw materials. The contribution to global warming (carbon emissions) is dominated by the production of steel used as reinforcement/rebars and decarbonation of clinker - a process necessary to produce cement.

5. Other Environmental Information

The constituent materials used within our products are responsibly sourced and we apply the principles of Sustainable Development and of Environmental Stewardship as a standard business practice in our operations. Protecting the environment by preserving non-renewable natural resources, increasing energy efficiency, reducing the environmental emissions, limiting the impact of materials transportation to and from our operations is part of our way in doing business.

6. References

- EN 15804: 2012, Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products
- GaBi 8 2017: Dokumentation der GaBi-Datensätze der Datenbank zur Ganzheitlichen Bilanzierung. LBP, Universität Stuttgart und PE International, 2012
- GaBi 8 2017: Software und Datenbank zur Ganzheitlichen Bilanzierung. LBP, Universität Stuttgart und PE International, 2012
- 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 Environmental management- Life cycle assessment - Principles and framework
- ISO 14044:2006 Environmental management - Life cycle assessment - Requirements and guidelines
- Product Category Rules - Articles of concrete, cement and plaster (UN CPC 375). The International EPD System
- Product Category Rules - Boards and panels (UN CPC 314). The International EPD System
- Product Category Rules - Construction Products and CPC 54 Construction Services/ Prepared by IVL Swedish Environmental Research Institute, Swedish Environmental Protection Agency, SP Trä, Swedish Wood Preservation Institute, Swedisol, SCDA, Svenskt Limträ AB, SSAB, The International EPD System, 2012:01 Version 2.2, Date 2017-05-30.