



## Environmental Product Declaration

A cradle-to-gate EPD according to ISO 14025 and ISO 21930

**Precast Concrete Products as Manufactured  
by Hard Precast Building Systems**



ASTM  
INTERNATIONAL

## About Hard Precast Building Systems

Hard Precast Building Systems (HPBS) is one of the leading precast concrete companies in the UAE.



HPBS delivers “Total Precast Solutions” from design & value engineering to manufacture, logistics and installation of precast cement products.

Established 11 years ago, HPBS pioneered the market with high quality precast elements such as: Insulated Sandwich Walls (load & non-load bearing), Solid/Internal Walls (load & non-load bearing), Cladding Walls (exposed aggregates, grey and pigmented finishes), Pre-stressed Hollow Core Slabs covering spans up to 24m, Precast & Pre-stressed Beams & Columns, Boundary Walls & Footings, GRC, etc.





## ASTM International Certified EPD

This is a business-to-business Type III environmental product declaration (EPD) for precast concrete products as manufactured by Hard Precast Building Systems. This declaration has been prepared in accordance with ISO 14025 and ISO 21930, and the ASTM product category rules (PCR) and EPD program operator rules.

The intent of this document is to further the development of environmentally compatible and more sustainable construction products by providing comprehensive environmental information related to potential impacts of precast concrete products available in the UAE in accordance with international standards.

### Program Operator



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### EPD Information

#### Product Names

Façade Cladding Panels, Structural Elements & Hollowcore Slabs

#### Product Definition

See Table I

#### Declared Unit

1 tonne precast concrete product

#### Declaration Number

EPD 081

#### Declaration Type

A “cradle-to-gate” EPD - activity stages or information modules covered include production (modules A1 to A3). The declaration is intended for use in Business-to-Business (B-to-B) communication. This EPD of precast concrete products (UN CPC 3755) is applicable to those manufactured at the Hard Precast Building Systems facility.

#### Content of the Declaration

The declaration follows Section 11, Content of the EPD, ASTM International, ASTM International, Product Category Rules for Preparing an Environmental Product Declaration For Precast Concrete.

## EPD Information

### Declaration Comparability Limitation Statement

The following ISO statement indicates the EPD comparability limitations and intent to avoid any market distortions or misinterpretation of EPDs based on the ASTM's PCR: 2015:

- EPDs from different programs (using different PCR) may not be comparable.
- Declarations based on the ASTM PCR are not comparative assertions; that is, no claim of environmental superiority may be inferred or implied.

### Applicable Countries

United Arab Emirates

### Date of Issue

June 22 2018

### Period of Validity

5 years

### EPD Prepared by



**Athena**  
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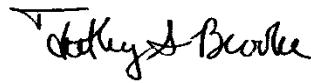
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This EPD was independently verified  
by ASTM in accordance with ISO 14025:

Internal

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## EPD Project Report Information

### EPD Project Report

*A Cradle-to-Gate Life Cycle Assessment of Precast Concrete Products Manufactured by Hard Precast Building Systems in the Emirate of Dubai, UAE, April 2018.*

The report is available upon request at [cert@astm.org](mailto:cert@astm.org).

### EPD Project Prepared by



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## PCR Information

Reference PCR

ASTM International, Product Category Rules for Preparing an  
Environmental Product Declaration For Precast Concrete

Date of Issue

March 2015

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## 1. PRODUCT IDENTIFICATION

This EPD reports environmental information for the three precast concrete products types shown in Figure 1 below, produced by Hard Precast Building Systems in Dubai, United Arab Emirates.



Façade Cladding Panels



Structural Elements (columns pictured here)



Hollowcore Slabs

**Figure 1: Hard Precast Building Systems Products**

See Table 1 for a summary of the products reported in this EPD, for each product type. There are eight façade cladding panel products for each of the two concrete mixes considered (a total of 16 unique products). Structural elements and hollowcore slabs are typically designed specifically for the construction project they are intended for. To provide LCA results applicable to any future structural element or hollowcore slab design, the rebar quantities of the four concrete mix designs applicable to these products were varied between 0<sup>1</sup> and 500 kg/m<sup>3</sup>, in increments of 50 kg/m<sup>3</sup> (an additional 4\*11 = 44 unique products). It is intended that users of this EPD can reference the LCA results applicable to their design or interpolate between results.

**Table 1: Summary of Products Applicable to this EPD**

Product Type	Product Definition	Concrete Mix <sup>2</sup>	Reference No	Products
Façade Cladding Panels (insulated)	Non-structural panels that are conventionally reinforced or prestressed with a continuous layer of rigid insulation; typically used for building envelope	C40/10CU COLORED	HPBS-PC-W-01	<ul style="list-style-type: none"> <li>• Blank Cladding Panels (EWS-BP)</li> <li>• Column Cap Facade Panels (EWS-CC)</li> <li>• Corner Facade Panels (EWS-FC)</li> <li>• Intermediate Facade Panels (EWS-FP)</li> <li>• Capping Panels (EWS-SP)</li> <li>• Link Bridge Panels (EWS-LB)</li> <li>• Lift Overrun Cladding Panels - 100mm</li> <li>• Precast Siding</li> </ul>
		C40/20CU	HPBS-PC-01	
Structural Elements	Precast structural members of conventionally reinforced or prestressed concrete, e.g. beams, columns, walls, stairs, etc.	C50/20CU	HPBS-PC-PSC-002	
		C60/20CU	HPBS-PC-PSC-003	
Hollowcore Slabs	Precast slabs of conventionally reinforced or prestressed concrete typically used in the construction of floors	C50/10CU	HPBS-HC-001	
		C60/10CU	HPBS-HC-02	

## 2. DECLARED UNIT

The declared unit is 1 tonne of precast concrete product.

## 3. MATERIAL CONTENT

Table 2 through Table 7 below present the material content by input material for the various precast concrete products, as provided by Hard Precast Building Systems.

<sup>1</sup> Note that 0 kg/m<sup>3</sup> is not a realistic amount of rebar for these products and is intended only for interpolating results for designs that have between 0 and 50 kg/m<sup>3</sup> rebar.

<sup>2</sup> Concrete mix designations refer to the 28-day compressive strength of a concrete cube sample (in MPa) and maximum aggregate size (in mm), e.g. “C40/20CU” is 40 MPa strength concrete with 10mm maximum aggregate size.

**Table 2: Material Content for HPBS-PC-W-01 Façade Cladding Panels – kg per m<sup>3</sup> product**

Material	Blank Cladding Panels (EWS-BP)	Column Cap Façade Panels (EWS-CC)	Corner Façade Panels (EWS-FC)	Intermediate Façade Panels (EWS-FP)	Capping Panels (EWS-SP)	Link Bridge Panels (EWS-LB)	Lift Overrun Cladding Panels - 100mm	Precast Siding
Water	91	91	90	89	92	90	92	92
Portland Cement	241	239	238	234	241	236	241	241
Crushed Coarse Aggregate, 5-12mm	558	555	552	542	560	548	559	559
Crushed Fine Aggregate, 0-3mm	335	333	331	325	336	329	336	336
Natural Fine Aggregate, beach sand	268	267	265	261	269	263	269	269
Low Range Water Reducing Admixture	5	5	5	5	5	5	5	5
Rebar	60	87	118	198	47	151	54	54
Rockwool Insulation	50	50	50	50	50	50	50	50
<b>Total</b>	<b>1,609</b>	<b>1,627</b>	<b>1,648</b>	<b>1,703</b>	<b>1,600</b>	<b>1,671</b>	<b>1,605</b>	<b>1,605</b>

**Table 3: Material Content for HPBS-PC-01 Façade Cladding Panels – kg per m<sup>3</sup> product**

Material	Blank Cladding Panels (EWS-BP)	Column Cap Façade Panels (EWS-CC)	Corner Façade Panels (EWS-FC)	Intermediate Façade Panels (EWS-FP)	Capping Panels (EWS-SP)	Link Bridge Panels (EWS-LB)	Lift Overrun Cladding Panels - 100mm	Precast Siding
Water	87	87	86	85	87	86	87	87
Portland Cement	154	153	152	150	154	151	154	154
Slag Cement (GGBFS)	87	86	86	84	87	85	87	87
Crushed Coarse Aggregate, 20mm	418	416	413	406	419	410	419	419
Crushed Coarse Aggregate, 10mm	235	233	232	228	235	230	235	235
Crushed Fine Aggregate, 0-5mm	392	390	388	381	393	385	393	393
Natural Fine Aggregate, dune sand	137	136	136	133	138	135	137	137
Low Range Water Reducing Admixture	3	3	3	3	3	3	3	3
Rebar	60	87	118	198	47	151	54	54
Rockwool Insulation	50	50	50	50	50	50	50	50
<b>Total</b>	<b>1,624</b>	<b>1,642</b>	<b>1,663</b>	<b>1,717</b>	<b>1,614</b>	<b>1,685</b>	<b>1,619</b>	<b>1,619</b>



**Table 4: Material Content for HPBS-PC-PSC-002 Structural Elements – kg per m<sup>3</sup> product**

Material	Rebar (kg/m <sup>3</sup> )										
	0	50	100	150	200	250	300	350	400	450	500
Water	140	139	138	137	136	136	135	134	133	132	131
Portland Cement	275	273	271	270	268	266	264	263	261	259	257
Slag Cement (GGBFS)	155	154	153	152	151	150	149	148	147	146	145
Crushed Coarse Aggregate, 20mm	685	681	676	672	668	663	659	654	650	646	641
Crushed Coarse Aggregate, 10mm	390	388	385	383	380	378	375	373	370	368	365
Crushed Fine Aggregate, 0-5mm	652	648	644	640	635	631	627	623	619	615	610
Natural Fine Aggregate, dune sand	212	211	209	208	207	205	204	203	201	200	198
Low Range Water Reducing Admixture	6	6	6	6	6	6	6	6	6	6	6
Rebar	0	50	100	150	200	250	300	350	400	450	500
<b>Total</b>	<b>2,515</b>	<b>2,549</b>	<b>2,583</b>	<b>2,617</b>	<b>2,651</b>	<b>2,685</b>	<b>2,719</b>	<b>2,753</b>	<b>2,787</b>	<b>2,821</b>	<b>2,855</b>

**Table 5: Material Content for HPBS-PC-PSC-003 Structural Elements – kg per m<sup>3</sup> product**

Material	Rebar (kg/m <sup>3</sup> )										
	0	50	100	150	200	250	300	350	400	450	500
Water	148	147	146	145	144	143	142	141	140	140	139
Portland Cement	355	353	350	348	346	344	341	339	337	335	332
Slag Cement (GGBFS)	125	124	123	123	122	121	120	119	119	118	117
Crushed Coarse Aggregate, 20mm	670	666	661	657	653	649	644	640	636	632	627
Crushed Coarse Aggregate, 10mm	400	397	395	392	390	387	385	382	380	377	375
Crushed Fine Aggregate, 0-5mm	615	611	607	603	599	595	591	588	584	580	576
Natural Fine Aggregate, dune sand	200	199	197	196	195	194	192	191	190	189	187
Low Range Water Reducing Admixture	7	7	7	7	7	7	7	7	7	7	7
Rebar	0	50	100	150	200	250	300	350	400	450	500
<b>Total</b>	<b>2,520</b>	<b>2,554</b>	<b>2,588</b>	<b>2,622</b>	<b>2,656</b>	<b>2,690</b>	<b>2,724</b>	<b>2,758</b>	<b>2,792</b>	<b>2,826</b>	<b>2,859</b>





**Table 6: Material Content for HPBS-HC-001 Hollowcore Slabs – kg per m<sup>3</sup> product**

Material	Rebar (kg/m <sup>3</sup> )										
	0	50	100	150	200	250	300	350	400	450	500
Water	130	129	128	128	127	126	125	124	123	123	122
Portland Cement	275	273	271	270	268	266	264	263	261	259	257
Slag Cement (GGBFS)	155	154	153	152	151	150	149	148	147	146	145
Crushed Coarse Aggregate, 10mm	1,070	1,063	1,056	1,050	1,043	1,036	1,029	1,022	1,015	1,009	1,002
Crushed Fine Aggregate, 0-5mm	560	556	553	549	546	542	539	535	531	528	524
Crushed Fine Aggregate, 0-5mm	352	350	348	345	343	341	339	336	334	332	330
Low Range Water Reducing Admixture	4	4	4	4	4	4	4	4	4	4	4
Rebar	0	50	100	150	200	250	300	350	400	450	500
<b>Total</b>	<b>2,546</b>	<b>2,580</b>	<b>2,614</b>	<b>2,647</b>	<b>2,681</b>	<b>2,715</b>	<b>2,749</b>	<b>2,782</b>	<b>2,816</b>	<b>2,850</b>	<b>2,884</b>

**Table 7: Material Content for HPBS-HC-02 Hollowcore Slabs – kg per m<sup>3</sup> product**

Material	Rebar (kg/m <sup>3</sup> )										
	0	50	100	150	200	250	300	350	400	450	500
Water	140	139	138	137	136	136	135	134	133	132	131
Portland Cement	340	338	336	334	331	329	327	325	323	321	318
Slag Cement (GGBFS)	120	119	118	118	117	116	115	115	114	113	112
Crushed Coarse Aggregate, 10mm	1,060	1,053	1,046	1,040	1,033	1,026	1,019	1,013	1,006	999	992
Crushed Fine Aggregate, 0-5mm washed	545	542	538	535	531	528	524	521	517	514	510
Crushed Fine Aggregate, 0-5mm	325	323	321	319	317	315	313	311	308	306	304
Low Range Water Reducing Admixture	5	5	5	5	5	5	5	5	5	5	5
Rebar	0	50	100	150	200	250	300	350	400	450	500
<b>Total</b>	<b>2,535</b>	<b>2,569</b>	<b>2,603</b>	<b>2,637</b>	<b>2,670</b>	<b>2,704</b>	<b>2,738</b>	<b>2,772</b>	<b>2,806</b>	<b>2,840</b>	<b>2,874</b>



## 4. SYSTEM BOUNDARY

As per the ASTM PCR, the system boundary is the product stage, which includes the following modules:

- A1 Raw material supply;
- A2 Transport (to the manufacturer); and
- A3 Manufacturing.

Figure 2 shows the production stage system boundary for precast concrete products.

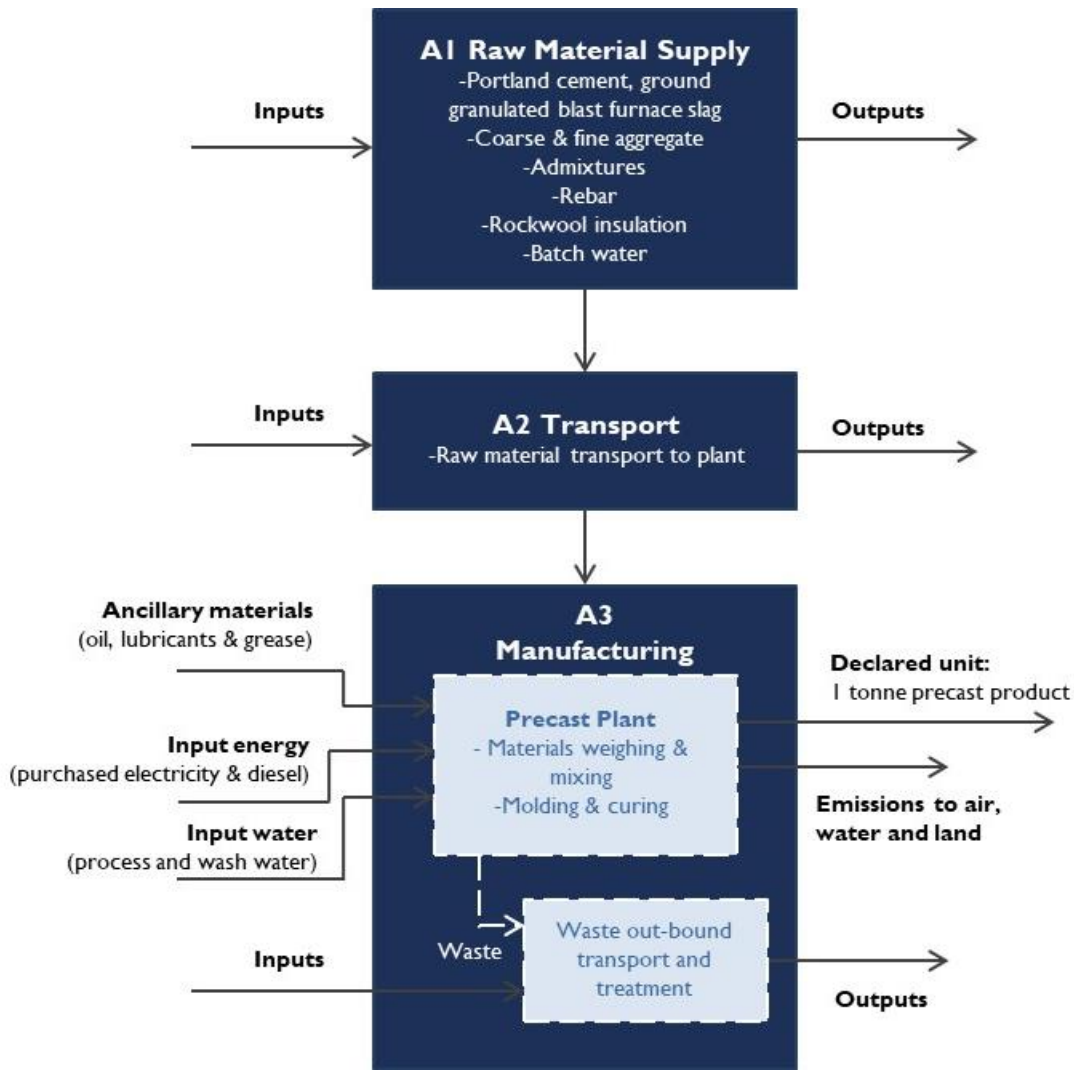


Figure 2: Product Stage (module A1 to A3) System Boundary

## 5. LIFE CYCLE ASSESSMENT

This section summarizes the results of the life cycle impact assessment (LCIA) based on the cradle-to-gate life cycle inventory inputs and outputs analysis. The results are calculated on the basis of 1 tonne precast concrete product (Tables 4 and 5). As per the ASTM PCR, Section 8, US EPA Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI, version 2.1) impact categories are used for the mandatory category indicators to be included in this EPD. These are relative expressions only and do not predict category impact end-points, the exceeding of thresholds, safety margins or risks. Total primary and sub-set energy consumption was compiled using a cumulative energy demand model. Material resource consumption and generated waste reflect cumulative life cycle inventory flow information.

**Table 8: LCA Results (A1-A3): HPBS-PC-W-01 Façade Cladding Panels, per tonne product**

Environmental Indicator	Unit	Blank Cladding Panels (EWS-BP)	Column Cap Façade Panels (EWS-CC)	Corner Façade Panels (EWS-FC)	Intermediate Façade Panels (EWS-FP)	Capping Panels (EWS-SP)	Link Bridge Panels (EWS-LB)	Lift Overrun Cladding Panels - 100mm	Precast Siding
Global warming potential (GWP)	kg CO <sub>2</sub> eq.	308	343	381	478	291	423	300	300
Acidification potential	kg SO <sub>2</sub> eq.	1.298	1.473	1.666	2.154	1.209	1.874	1.254	1.254
Eutrophication potential	kg N eq.	0.340	0.343	0.346	0.354	0.338	0.349	0.339	0.339
Smog creation potential	kg O <sub>3</sub> eq.	11.6	11.6	11.5	11.5	11.6	11.5	11.6	11.6
Ozone depletion potential	kg CFC-11 eq.	4.44E-05	4.38E-05	4.30E-05	4.12E-05	4.48E-05	4.23E-05	4.46E-05	4.46E-05
Nonrenewable energy resources	MJ (HHV)	3,483	3,975	4,521	5,897	3,233	5,105	3,359	3,359
Renewable energy resources	MJ (HHV)	74.1	90.9	109.4	156.2	65.6	129.3	69.9	69.9
Nonrenewable material resources	kg	1,078	1,080	1,082	1,087	1,077	1,084	1,077	1,077
Renewable material resources	kg	0.734	0.828	0.932	1.193	0.687	1.043	0.711	0.711
Net fresh water (inputs minus outputs)	L	1,605	1,637	1,672	1,760	1,589	1,709	1,597	1,597
Non-hazardous waste generated	kg	71.5	70.3	69.0	65.6	72.1	67.6	71.8	71.8
Hazardous waste generated	kg	1.982	2.823	3.756	6.110	1.555	4.756	1.769	1.769

**Table 9: LCA Results (A1-A3): HPBS-PC-01 Façade Cladding Panels, per tonne product**

Environmental Indicator	Unit	Blank Cladding Panels (EWS-BP)	Column Cap Façade Panels (EWS-CC)	Corner Façade Panels (EWS-FC)	Intermediate Façade Panels (EWS-FP)	Capping Panels (EWS-SP)	Link Bridge Panels (EWS-LB)	Lift Overrun Cladding Panels - 100mm	Precast Siding
Global warming potential (GWP)	kg CO <sub>2</sub> eq.	266	301	340	438	249	382	257	257
Acidification potential	kg SO <sub>2</sub> eq.	1.328	1.501	1.692	2.175	1.240	1.897	1.284	1.284
Eutrophication potential	kg N eq.	0.279	0.282	0.287	0.297	0.277	0.291	0.278	0.278
Smog creation potential	kg O <sub>3</sub> eq.	11.2	11.2	11.2	11.1	11.2	11.1	11.2	11.2
Ozone depletion potential	kg CFC-11 eq.	4.19E-05	4.13E-05	4.06E-05	3.89E-05	4.22E-05	3.99E-05	4.21E-05	4.21E-05
Nonrenewable energy resources	MJ (HHV)	3,249	3,740	4,285	5,662	2,999	4,870	3,124	3,124
Renewable energy resources	MJ (HHV)	74.2	90.8	109.2	155.6	65.8	128.9	70.0	70.0
Nonrenewable material resources	kg	1,055	1,057	1,060	1,066	1,054	1,063	1,055	1,055
Renewable material resources	kg	0.699	0.793	0.896	1.157	0.652	1.007	0.676	0.676
Net fresh water (inputs minus outputs)	L	1,211	1,248	1,290	1,396	1,191	1,335	1,201	1,201
Non-hazardous waste generated	kg	70.9	69.7	68.4	65.1	71.5	67.0	71.2	71.2
Hazardous waste generated	kg	1.966	2.800	3.725	6.061	1.542	4.717	1.755	1.755



**Table 10: LCA Results (A1-A3): HPBS-PC-PSC-002 Structural Elements, per tonne product**

Environmental Indicator	Unit	Rebar (kg/m <sup>3</sup> )										
		0	50	100	150	200	250	300	350	400	450	500
Global warming potential (GWP)	kg CO <sub>2</sub> eq.	157	200	243	284	324	363	402	439	475	511	545
Acidification potential	kg SO <sub>2</sub> eq.	0.683	0.898	1.108	1.312	1.512	1.706	1.895	2.079	2.260	2.435	2.607
Eutrophication potential	kg N eq.	0.187	0.193	0.198	0.204	0.209	0.214	0.219	0.224	0.229	0.234	0.238
Smog creation potential	kg O <sub>3</sub> eq.	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	9.9
Ozone depletion potential	kg CFC-11 eq.	4.20E-05	4.12E-05	4.05E-05	3.98E-05	3.91E-05	3.85E-05	3.78E-05	3.72E-05	3.66E-05	3.60E-05	3.54E-05
Nonrenewable energy resources	MJ (HHV)	1,711	2,322	2,916	3,495	4,059	4,608	5,144	5,667	6,177	6,675	7,160
Renewable energy resources	MJ (HHV)	18.0	38.7	58.8	78.4	97.5	116.1	134.2	151.9	169.2	186.0	202.5
Nonrenewable material resources	kg	1,048	1,051	1,054	1,056	1,059	1,062	1,064	1,066	1,069	1,071	1,073
Renewable material resources	kg	0.144	0.264	0.380	0.493	0.603	0.711	0.816	0.918	1.018	1.115	1.210
Net fresh water (inputs minus outputs)	L	917	966	1,014	1,060	1,106	1,150	1,193	1,235	1,276	1,316	1,355
Non-hazardous waste generated	kg	76.0	74.5	73.1	71.7	70.3	69.0	67.7	66.4	65.2	64.0	62.8
Hazardous waste generated	kg	0.020	1.048	2.048	3.023	3.972	4.898	5.800	6.680	7.539	8.376	9.194

**Table 11: LCA Results (A1-A3): HPBS-PC-PSC-003 Structural Elements, per tonne product**

Environmental Indicator	Unit	Rebar (kg/m <sup>3</sup> )										
		0	50	100	150	200	250	300	350	400	450	500
Global warming potential (GWP)	kg CO <sub>2</sub> eq.	184	228	271	309	349	387	425	462	498	533	567
Acidification potential	kg SO <sub>2</sub> eq.	0.724	0.943	1.156	1.350	1.549	1.742	1.930	2.113	2.293	2.467	2.638
Eutrophication potential	kg N eq.	0.225	0.232	0.238	0.240	0.244	0.249	0.253	0.257	0.262	0.266	0.270
Smog creation potential	kg O <sub>3</sub> eq.	10.8	10.9	10.9	10.7	10.7	10.7	10.7	10.7	10.6	10.6	10.6
Ozone depletion potential	kg CFC-11 eq.	4.32E-05	4.27E-05	4.22E-05	4.10E-05	4.03E-05	3.96E-05	3.89E-05	3.83E-05	3.76E-05	3.70E-05	3.64E-05
Nonrenewable energy resources	MJ (HHV)	1,892	2,510	3,111	3,662	4,221	4,767	5,299	5,818	6,324	6,818	7,301
Renewable energy resources	MJ (HHV)	18.9	39.7	59.8	79.1	98.2	116.7	134.8	152.5	169.7	186.5	202.9
Nonrenewable material resources	kg	1,061	1,071	1,080	1,069	1,071	1,073	1,076	1,078	1,080	1,082	1,084
Renewable material resources	kg	0.163	0.283	0.399	0.510	0.620	0.727	0.831	0.933	1.032	1.129	1.224
Net fresh water (inputs minus outputs)	L	1,143	1,195	1,245	1,273	1,314	1,354	1,393	1,432	1,469	1,505	1,541
Non-hazardous waste generated	kg	75.9	74.9	73.9	71.5	70.2	68.8	67.5	66.3	65.0	63.8	62.7
Hazardous waste generated	kg	0.020	1.046	2.044	3.017	3.965	4.889	5.789	6.668	7.525	8.362	9.179

**Table 12: LCA Results (A1-A3): HPBS-HC-001 Hollowcore Slabs, per tonne product**

Environmental Indicator	Unit	Rebar (kg/m <sup>3</sup> )										
		0	50	100	150	200	250	300	350	400	450	500
Global warming potential (GWP)	kg CO <sub>2</sub> eq.	158	201	242	283	323	362	400	436	472	508	542
Acidification potential	kg SO <sub>2</sub> eq.	0.688	0.901	1.108	1.310	1.507	1.699	1.886	2.069	2.248	2.422	2.592
Eutrophication potential	kg N eq.	0.187	0.193	0.198	0.203	0.209	0.214	0.219	0.224	0.228	0.233	0.237
Smog creation potential	kg O <sub>3</sub> eq.	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.1
Ozone depletion potential	kg CFC-11 eq.	4.21E-05	4.14E-05	4.06E-05	4.00E-05	3.93E-05	3.86E-05	3.80E-05	3.74E-05	3.67E-05	3.62E-05	3.56E-05
Nonrenewable energy resources	MJ (HHV)	1,731	2,333	2,920	3,492	4,050	4,594	5,124	5,642	6,147	6,640	7,121
Renewable energy resources	MJ (HHV)	17.5	37.9	57.8	77.2	96.1	114.5	132.5	150.0	167.1	183.9	200.2
Nonrenewable material resources	kg	1,053	1,056	1,059	1,061	1,063	1,066	1,068	1,070	1,073	1,075	1,077
Renewable material resources	kg	0.147	0.265	0.380	0.492	0.601	0.707	0.811	0.912	1.011	1.108	1.202
Net fresh water (inputs minus outputs)	L	909	958	1,005	1,051	1,096	1,140	1,183	1,224	1,265	1,305	1,344
Non-hazardous waste generated	kg	75.1	73.6	72.2	70.8	69.5	68.2	66.9	65.7	64.5	63.3	62.1
Hazardous waste generated	kg	0.020	1.035	2.024	2.988	3.928	4.844	5.737	6.609	7.460	8.291	9.102



**Table 13: LCA Results (A1-A3): HPBS-HC-02 Hollowcore Slabs, per tonne product**

Environmental Indicator	Unit	Rebar (kg/m <sup>3</sup> )										
		0	50	100	150	200	250	300	350	400	450	500
Global warming potential (GWP)	kg CO <sub>2</sub> eq.	179	222	264	304	344	382	420	457	492	527	561
Acidification potential	kg SO <sub>2</sub> eq.	0.711	0.924	1.132	1.334	1.532	1.724	1.912	2.095	2.273	2.448	2.618
Eutrophication potential	kg N eq.	0.218	0.223	0.228	0.233	0.237	0.242	0.246	0.251	0.255	0.259	0.263
Smog creation potential	kg O <sub>3</sub> eq.	10.8	10.8	10.8	10.7	10.7	10.7	10.7	10.7	10.6	10.6	10.6
Ozone depletion potential	kg CFC-11 eq.	4.31E-05	4.24E-05	4.16E-05	4.09E-05	4.02E-05	3.96E-05	3.89E-05	3.83E-05	3.76E-05	3.70E-05	3.64E-05
Nonrenewable energy resources	MJ (HHV)	1,873	2,475	3,062	3,634	4,191	4,734	5,264	5,781	6,285	6,777	7,258
Renewable energy resources	MJ (HHV)	18.0	38.5	58.5	77.9	96.9	115.4	133.4	151.0	168.2	184.9	201.3
Nonrenewable material resources	kg	1,062	1,065	1,067	1,069	1,072	1,074	1,076	1,078	1,080	1,082	1,084
Renewable material resources	kg	0.163	0.281	0.396	0.508	0.617	0.723	0.827	0.929	1.027	1.124	1.218
Net fresh water (inputs minus outputs)	L	1,096	1,141	1,185	1,228	1,270	1,311	1,351	1,389	1,427	1,464	1,500
Non-hazardous waste generated	kg	75.4	73.9	72.5	71.1	69.8	68.5	67.2	65.9	64.7	63.5	62.3
Hazardous waste generated	kg	0.020	1.040	2.033	3.000	3.943	4.862	5.759	6.634	7.487	8.321	9.134