Environmental Product Declaration (EPD)

CASSARA SLABS AND BOULEVARD PAVERS

Permacon

Permacon is pleased to present this environmental product declaration (EPD) for Cassara slabs and Boulevard Pavers. This EPD was developed in compliance with CAN/CSA-ISO 14025 and has been verified by Lindita Bushi, Athena Sustainable Materials Institute. The LCA and the EPD were produced by Vertima and Ellio.

The EPD includes cradle-to-gate life cycle assessment (LCA) results.

For more information about Permacon, please go to http://www.permacon.ca/home.

This environmental product declaration (EPD) is in accordance with CAN/CSA-ISO 14025 and the PCR noted below. EPDs from different programs may not be comparable.

Environmental Product Declaration

CSA Group Registered Based on ISO 14025 and Other Requirements

For more information visit csaregistries.ca/epd

#7583-3648

November 2016-2021

PROGRAM OPERATOR	CSA Group 178 Rexdale Blvd Toronto, ON Canada M9W 1R3 www.csagroup.org
PRODUCT	Cassara Slabs and Boulevard Pavers
EPD REGISTRATION NUMBER	7583-3648
EPD RECIPIENT ORGANIZATION	PERMACON THE HARMONY OF SPACE Permacon 8140, rue Bombardier Anjou (Québec) H1J 1A4 CANADA
REFERENCE PCR	Product Category Rules (PCR) For Preparing an Environmental Product Declaration for: Segmental Concrete Paving Products ASTM International April, 2015 to March, 2020 UN CPC 3755
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The PCR review was conducted by:	Nicholas Santero, Apple (Chairperson) Christine Subasic, Consulting Architectural Engineer Juan Tejeda, ORCO Block Company
This EPD and related data were independently verified by an external verifier, Lindita Bushi, Athena Sustainable Materials Institute, according to CAN/CSA-ISO 14025:2006	Lindita Bushi Lindita Bushi, Athena Sustainable Materials Institute

CSA Group

DESCRIPTION OF PERMACON

For over sixty years, Permacon, pioneer, innovator and champion of growth, has been Canada's largest producer of concrete products. Offering an evolving line of over 1000 masonry and landscaping products, Permacon helps diversify and adorn the outdoors of residential, institutional, commercial and industrial environments.

DESCRIPTION OF PRODUCT

Slabs are defined in CSA A231.1 as having a surface area greater than 139.5 in^2 (0.09 m^2); overall length divided by thickness >4; a minimum nominal thickness of 1.2 in. (30 mm); and a maximum overall length or width of 40 in. (1 m).

Cassara slabs exist in three (3) different colors, namely beige, grey and black. They are available in various dimensions, but with constant thickness and width of 60 mm and 300 mm respectively, and a length varying between 400 mm and 700 mm (see: http://www.permacon.ca/product/landscaping-slabs/cassara-slab)

Cassara slabs meet CSA A231.1 requirements for Precast concrete paving slabs and present a compressive strength of 46 Mpa after 28 days.

Pavers are defined in CSA A231.2 as having a surface area less than or equal to 139.5 in^2 (0.09 m^2); overall length divided by its thickness ≤4 for pedestrian applications and ≤3 for vehicular applications; and a minimum nominal thickness of 2.36 in. (60 mm).

The whole "Boulevard" series is covered by this EPD and includes: Boulevard Drain, Boulevard TLI 200 Crescendo 300, Boulevard TLI 150 mm, Boulevard TLI 150 mm Crescendo 125, Boulevard TLI 150 mm Crescendo 320, Boulevard TLI 100 mm, Boulevard TLI 100 mm Crescendo 300, Boulevard TLI 90 mm, Boulevard TLI 90 mm Crescendo 320, Boulevard 3DI, Boulevard TLI 80 mm, Boulevard Format 300 and Boulevard Format 500 (http://www.permaconpro.ca/products.html?cat_id=25&z=pavers).

Boulevard pavers are available in thirteen (13) colors: cinder grey, charcoal, light charcoal, salmon, brown, red, beige grey, beige, Shefford beige, Cambrian black, Cambrian brown, light grey and Stanstead grey. They are manufactured in a wide variety of length and width, and their thickness can vary between 80 mm and 200 mm.

Boulevard pavers meet CSA A231.2 requirements for Precast concrete pavers and present a compressive strength of 50 Mpa after 28 days.

Cassara slabs and Boulevard pavers include post consumer glass powder in replacement of 10% of the cement from the original recipe.

Both products are produced at Permacon manufacturing plant located in Sainte-Eustache, Quebec. Saint-Eustache manufacturing plant address is 500 Saint-Eustache Street, Saint-Eustache, QC J7R 7E7 CANADA.

This EPD represents an average performance per color for each type of paving products, i.e. Cassara slabs and Boulevard pavers. In fact, for each color, there is an average recipe due to variation in dimension.

The raw materials input are detailed in table 1.

Table 1: Material composition of 1 m³ of Cassara slabs and Boulevard pavers

Materials	**Cassara slabs All colors**		**Boulevard Pavers All colors**	
	Average		Average	
	Amount (kg)	Proportion	Amount (kg)	Proportion
Cement – Portland	147.3 – 392.4	6.4% - 16.9%	0 – 411.1	0% – 17.9%
Cement – White	0 – 245.5	0% - 10.7%	0 – 372	0% – 16.2%
Glass powder	43.1 – 43.6	1.9%	41.2 – 45.7	1.8% - 2.0%
Sand	790.8 – 800.3	34.4% - 34.8%	0 – 1129	0% – 49.0%
Natural aggregates	735.3 – 744.1	32.0% - 32.4%	0 – 753.2	0% – 32.8%
Quartz	-	-	0 – 576.2	0% - 25.1%
Sand – White	-	-	0 – 279.3	0% – 12.15%
Aggregates (Cal 1 & Cal 3)	-	-	0 – 1534.8	0% – 66.7%
Mortar sand	313.0 – 316.5	13.6% - 13.8%	0 – 336.6	0% – 14.6%
White stone	-	-	0 – 1128.4	0% – 49.1%
Admixtures	2.0	0.1%	2.0	0.1%
Pigments	0.4 – 27.5	0.02% - 1.2%	0 – 33.7	0% – 1.5%
Water	136 - 138	-	130 – 144	-
TOTAL (without water)	**2300**	**100%**	**2300**	**100%**

SCOPE OF EPD

Reference flow and declared unit

The selected declared unit for this study is **1 m^3 of concrete formed into paving products**.

Pavers and slabs have a density of 2300 kg/m^3. Paver and slabs are available in a wide number of dimensions. Therefore, the reference mass is 2300 kg of product.

System boundaries

This EPD focuses on a Cradle-to-Gate life cycle impact assessment (LCIA) of Cassara slabs and Boulevard pavers. Therefore, three (3) life cycle stages are considered, namely A-1) Raw materials acquisition, A-2) Raw materials transportation to the manufacturing plant, and, A-3) Slabs and pavers manufacturing. Figure 1 illustrates the process flow diagram. The following stages are not included: construction process, use and end-of-life.

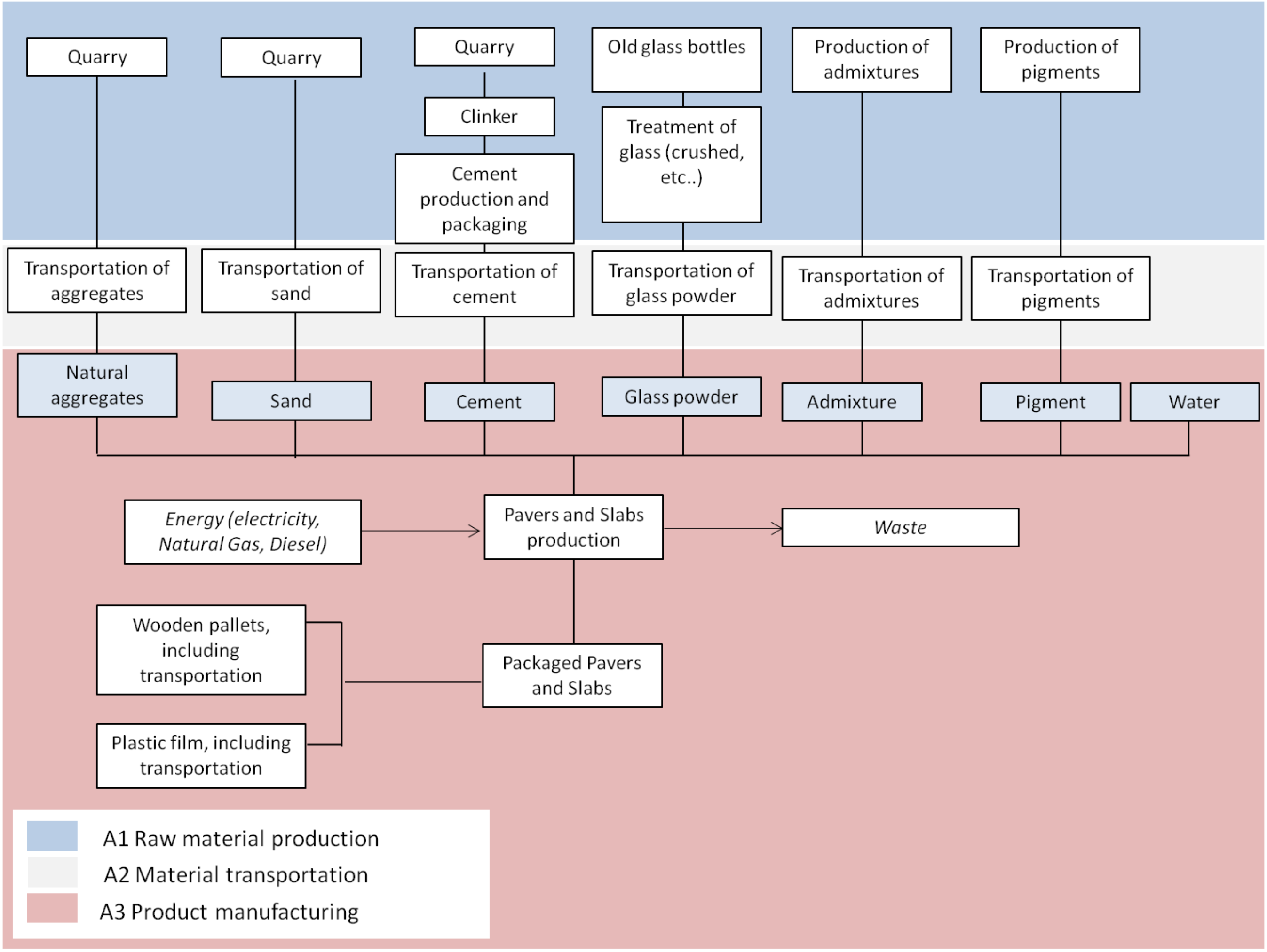

Figure 1: System boundaries for Cassara slabs and Boulevard pavers Cradle-to-Gate LCA

Raw materials acquisition: this includes the extraction from the quarry (sand, aggregates), the production of clinker and cement, the production of pigments and admixtures as well as the glass collection and production of glass powder. Water consumption at plant is mainly linked to water inputs in products' recipe, and is considered negligible for other activities (e.g. employees' needs). Therefore, water is also included in the raw materials stage.

Raw materials transportation: this step includes the transportation of raw materials from Permacon's suppliers to the St-Eustache manufacturing plant.

Slabs and Pavers manufacturing: this step includes the energy requirements (electricity, heat) and emissions to the environment related to the manufacturing of the product, including batching and mixing of the concrete, forming units, curing of units, and applicable post-production finishing of units. Slabs and pavers production generates 3% of losses. This loss of material is considered as waste. This step also includes packaging materials to make the products ready for shipment, as well as the transportation of these materials to Permacon's manufacturing plant.

Calculation method

SimaPro software v 8.0.4.30, developed by PRé Consultants, was used to calculate the inventory and to assess potential environmental impacts associated with the inventoried inputs and outputs.

Data sources

Inventory data was collected from the Permacon manufacturing plant located in Saint-Eustache, QC, using a LCI questionnaire. Inventory data included both the total annual mass of products from Saint-Eustache plant and the total annual mass of the products under study, the amount of raw materials entering the production of Cassara slabs and Boulevard pavers, losses of these materials, distances and transportation mode for the raw materials supply, energy consumption, emissions to the environment, water consumption, and materials needed for packaging.

Data related to energy, materials and waste needed to produce glass powder from post-consumer materials was collected directly from Permacon's suppliers.

Data used to model Admixtures was taken from the European Federation of Concrete Admixtures Associations' EPDs for Concrete admixtures (2015) [1], [2], [3].

When primary data was not available, the unit processes were selected either from the *ecoinvent* v3.1 database, one of the most comprehensive LCI databases currently available [4], or from the US LCI database [5], that is specific to the North American context. When necessary, the electricity grid mix of unit processes has been adapted to specific contexts (Quebec or Ontario).

Data quality

This study is specific to a particular manufacturer: Permacon. The primary data, mostly obtained from the manufacturer, is representative of the current technologies and materials used by the company. As primary data was collected directly from the only plant where Cassara slabs and Boulevard pavers are manufactured, it can be stated that it is 100% representative of the technologies in use and of the geographical areas.

Primary data was also collected from one of Permacon's suppliers, concerning glass powder production. Data was collected so as to be representative of the full year 2015.

Secondary data was used only for upstream processes. For some processes, the *ecoinvent* database provided representative data for a Canadian context. These processes were used in priority. When necessary, the electricity grid mix was changed for the electricity grid mix of the province where the production takes place.

When *ecoinvent* processes were not available for a North American context, processes were taken from the US LCI database.

Allocation

Data relative to energy consumption (electricity, heat) was provided for the whole manufacturing plant. ISO 14040 allocation procedure states that, whenever possible, allocation should be avoided by collecting data related to the process under study or by expanding the product system. In the present case, data was provided by the manufacturing plant as a total value, and not specifically for the Cassara slabs and Boulevard pavers.

According to ISO 14040, step 2 consists of partitioning the inputs and outputs between the different products in a way that reflects the physical relationship between them.

This manufacturing plant produces various concrete masonry blocks, with similar sizes and weights that go through similar manufacturing steps. The difference in their economic value is less than a factor of 10. Therefore, mass allocation is suitable to estimate the share of the total energy that can be assigned to each product.

Cut-off methodology

According to the PCR [6], if a mass flow or energy flow represents less than 1% of the cumulative mass or energy flow of the system, it may be excluded from system boundaries. However, these flows should not have a relevant environmental impact. Also, at least 95% of the energy usage and mass flow shall be included. In the present study, no primary data (input material, energy consumption) was excluded from the system boundaries. Water consumption was assumed to be 100% dedicated to product manufacturing, i.e. used in finished product.

Exclusions

No data on the construction, maintenance or dismantling of the capital assets, daily transport of the employees, office work, business trips and other activity from Permacon employees was included in the model. The model only takes into account processes associated with infrastructures that are already included in *ecoinvent* modules. Water consumption at plant for other purposes (e.g. employees' needs) was excluded from the study.

ENVIRONMENTAL IMPACTS

The five impact indicators required by the PCR, namely global warming potential (GWP), acidification potential, eutrophication potential, smog creation potential and ozone depletion potential were calculated using the TRACI 2.1 impact assessment methodology developed by Bare and Gloria [7].

Always in accordance with the PCR, Table 2 and Table 3 present respectively the LCIA results for 1 m³ of Cassara slabs and for 1 m³ of Boulevard pavers using TRACI methodology, as well as total primary energy consumption, consumption of renewable and non-renewable materials, fresh water consumption, and waste generation.

The Cradle-to-Gate impact assessment results of Permacon's Cassara slabs and Boulevard pavers are summarized below.

Table 2: LCIA results for 1 m³ of Cassara slabs

Environmental indicator	Unit	Cassara		
		Black	Grey	Beige
Ozone depletion potential	kg CFC-11 eq	8.39E-06	8.39E-06	8.75E-06
Global Warming Potential	kg CO_2 eq	537	525	567
Smog creation potential	kg O_3 eq	60	59	64
Acidification potential	kg SO_2 eq	3.63	3.54	3.81
Eutrophication potential	kg N eq	0.57	0.57	0.63
Primary energy consumption				
Renewable (solar, wind, hydroelectric, and geothermal)	MJ	1658	1664	1562
Renewable (biomass)	MJ	34	31	36
Non-renewable nuclear	MJ	373	352	572
Non-renewable fossil	MJ	4589	4405	4953
Resources consumption				
Non-renewable materials	kg	2666	2693	2696
Renewable materials	kg	190	190	190
Fresh water	L	700	698	1005
Waste generated				
Non-hazardous	kg	209	200	200
Hazardous	kg	0.14	0.12	0.12

Table 3: LCIA results of 1 m³ of Boulevard pavers

Environmental indicator	Unit	Boulevard				
		Cinder grey	Charcoal	Light Charcoal	Salmon	Brown
Ozone depletion potential	kg CFC-11 eq	8.20E-06	8.37E-06	8.08E-06	8.17E-06	8.87E-06
Global Warming Potential	kg CO_2 eq	513	526	507	509	549
Smog creation potential	kg O_3 eq	57	59	57	58	60
Acidification potential	kg SO_2 eq	3.46	3.55	3.43	3.45	3.68
Eutrophication potential	kg N eq	0.56	0.57	0.55	0.56	0.61
Primary energy consumption						
Renewable (solar, wind, hydroelectric, and geothermal)	MJ	1655	1662	1649	1649	1678
Renewable (biomass)	MJ	31	32	31	32	34
Non-renewable nuclear	MJ	348	356	349	356	368
Non-renewable fossil	MJ	4338	4433	4328	4362	4564
Resources consumption						
Non-renewable materials	kg	2688	2686	2683	2676	2693
Renewable materials	kg	190	190	190	190	190
Fresh water	L	684	697	678	685	725
Waste generated						
Non-hazardous	kg	197	200	198	200	202
Hazardous	kg	0.12	0.12	0.12	0.12	0.13

Environmental indicator	Unit	Boulevard				
		Red	Grey Beige	Beige	Shefford Beige	Cambrian Black
Ozone depletion potential	kg CFC-11 eq	9.02E-06	8.63E-06	8.73E-06	8.73E-06	8.05E-06
Global Warming Potential	kg CO_2 eq	548	565	579	569	510
Smog creation potential	kg O_3 eq	60	65	68	65	57
Acidification potential	kg SO_2 eq	3.69	3.81	3.91	3.84	3.45
Eutrophication potential	kg N eq	0.61	0.63	0.64	0.64	0.54
Primary energy consumption						
Renewable (solar, wind, hydroelectric, and geothermal)	MJ	1672	1523	1495	1522	1631
Renewable (biomass)	MJ	36	36	38	37	31
Non-renewable nuclear	MJ	383	632	687	637	353
Non-renewable fossil	MJ	4617	5040	5273	5042	4354
Resources consumption						
Non-renewable materials	kg	2685	2689	2686	2692	2671
Renewable materials	kg	190	190	190	190	190
Fresh water	L	728	1075	1145	1087	675
Waste generated						
Non-hazardous	kg	205	198	198	197	200
Hazardous	kg	0.13	0.12	0.12	0.12	0.12

Table 3 (continuation): LCIA results of 1 m³ of Boulevard pavers

Environmental indicator	Unit	Boulevard		
		Cambrian brown	Light grey	Stanstead grey
Ozone depletion potential	kg CFC-11 eq	8.45E-06	8.50E-06	8.24E-06
Global Warming Potential	kg CO_2 eq	527	560	538
Smog creation potential	kg O_3 eq	60	65	62
Acidification potential	kg SO_2 eq	3.57	3.78	3.62
Eutrophication potential	kg N eq	0.59	0.62	0.56
Primary energy consumption				
Renewable (solar, wind, hydroelectric, and geothermal)	MJ	1637	1526	1643
Renewable (biomass)	MJ	35	35	31
Non-renewable nuclear	MJ	378	595	349
Non-renewable fossil	MJ	4518	5002	4696
Resources consumption				
Non-renewable materials	kg	2653	2934	2935
Renewable materials	kg	190	190	190
Fresh water	L	709	1019	682
Waste generated				
Non-hazardous	kg	208	197	197
Hazardous	kg	0.14	0.12	0.12

Interpretation

This LCA showed that raw materials acquisition is the stage with the highest environmental impacts. Because of the clinker component, cement is the raw material with the highest impacts, even though its weight ratio is only 17%. Therefore, any way of reducing the cement (or clinker) proportion in the final product, without impacting on the product quality, is likely to reduce the environmental impacts.

The Cassara slab – black was selected as an example to illustrate the contribution to the impacts of different life cycle stages. Figure 2 and Figure 3 present the relative contribution of raw materials acquisition, transportation and product manufacturing to the LCIA impacts, and to energy consumption. Raw materials acquisition is the main contributor to the environmental impacts (>50%), together with production in the case of smog (40%). Raw materials acquisition and production both contribute significantly to energy consumption.

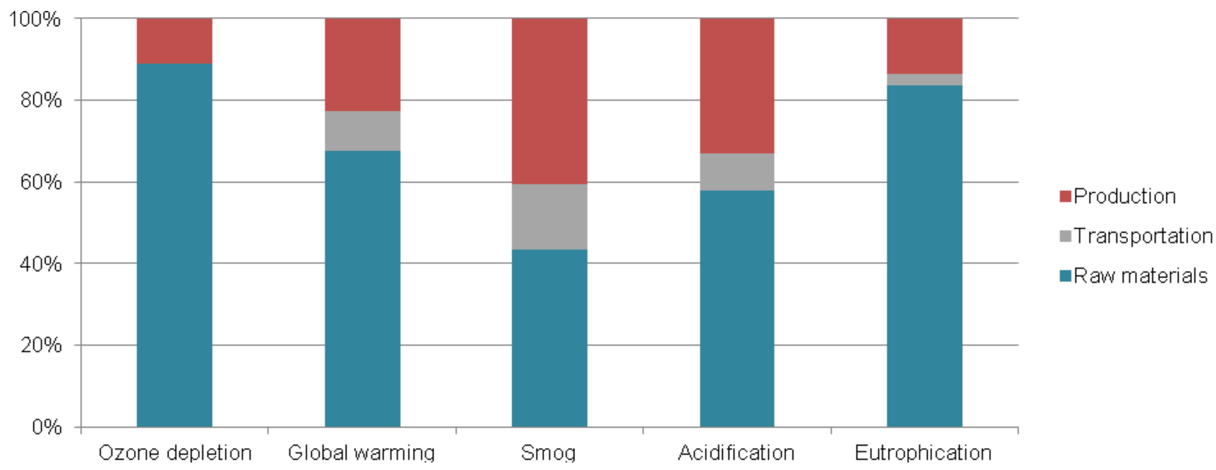

Figure 2: Contribution of life cycle stages to the environmental impacts of 1m^3 of Cassara slab - black, TRACI indicators

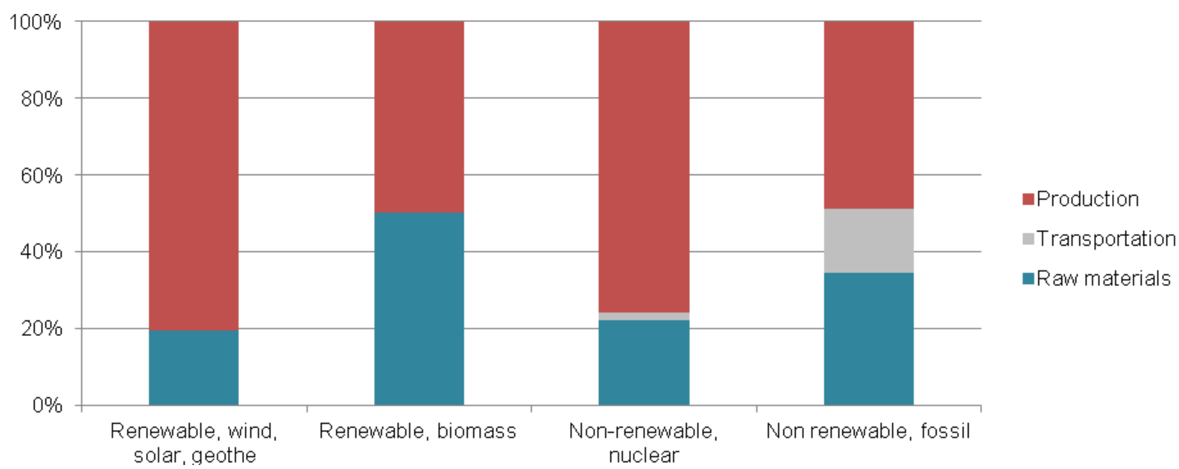

Figure 3: Contribution of life cycle stages to the environmental impacts of 1m^3 of Cassara slab - black, Energy consumption

Additional environmental information

Cassara slabs and Boulevard pavers use glass powder from post consumer sources in replacement of a part of the cement. Also, pigments are produced of iron scrap (cast iron borings), which is a recovered material.

REFERENCES

[1] European Federation of Concrete Admixtures Associations Ltd. (2015) Environmental Product Declaration: Concrete admixtures – Air entrainers 9pp.

[2] European Federation of Concrete Admixtures Associations Ltd. (2015) Environmental Product Declaration: Concrete admixtures – Retarders 9pp.

[3] European Federation of Concrete Admixtures Associations Ltd. (2015) Environmental Product Declaration: Concrete admixtures – Water resisting admixtures 9pp.

[4] Frischknecht R., Jungbluth N., Althaus H.-J., Doka G., Heck T., Hellweg S., Hischier R., Nemecek T., Rebitzer G., Spielmann M., Wernet G. (2007) Overview and Methodology. ecoinvent report No. 1. Swiss Centre for Life Cycle Inventories, Dübendorf, 2007

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[7] Bare, J. C., T. P. Gloria (2008). Environmental impact assessment taxonomy providing comprehensive coverage of midpoints, endpoints, damages, and areas of protection. Journal of Cleaner Production 16: 1021-1035.

[8] CSA Group Environmental Product Declaration (EPD) Program: Program requirements, November 2013.