B-EPD ENVIRONMENTAL PRODUCT DECLARATION

FEDBETON
TYPICAL BELGIAN READY-MIXED CONCRETE

1 m³ of ready-mixed concrete of strength class C30/37, environmental class EE2, consistency-class S4, produced using cement CEM III/A 42,5 N LA and with a (standard) maximum grain size of 22mm, used in various construction works with a reference service life of 100 years

Issued 31.03.2021
Valid until 31.03.2026

Third party verified
Conform to EN 15804+A2 and NBN/DTD B08-001
EN16757:2017 and ISO 14025

Cradle to gate with options

Modules declared					
A123	A4	A5	B2 B4 B6	C	D
•	•	•	•	•	•

[B-EPD n° 21-0069-002-00-01-EN]

OWNER OF THIS ENVIRONMENTAL PRODUCT DECLARATION
FEDBETON vzw

EPD PROGRAM OPERATOR
Federal Public Service of Health, Food Chain Safety and Environment
www.b-epd.be

The intended use of this EPD is to communicate scientifically based environmental information for construction products, for the purpose of assessing the environmental performance of buildings. This EPD is only valid when registered on www.b-epd.be. The FPS Public Health cannot be held responsible for the information provided by the owner of the EPD.

PRODUCT DESCRIPTION

PRODUCT NAME

C30/37-EE2-BA-Dmax 20mm-CEM III/A 42,5 N LA (Typical Belgian ready-mixed concrete)

PRODUCT DESCRIPTION AND INTENDED USE

Ready-mixed concrete is made by weighing and mixing sand, gravel, cement, water and most of the time admixtures. Ready-mixed concrete is produced in a fixed plant and transported with truck mixers to the jobsite right before installation. Here it is poured in formwork and compacted. The surface is finally finished by professionals. Once the concrete is hardened enough, the formwork is removed.
The specific type of concrete this document refers to is widely used in common applications: beams, columns, walls, foundations, slabs, etc., and can be used in various dimensions. For floorings (limited thickness) formwork is only applied at the borders. In structural concrete steel reinforcement is placed in the formwork before the actual pouring of the concrete. This EPD only takes the concrete without reinforcement into consideration and does not consider the formwork as it is re-used many times.

The concrete can be used in dry or wet conditions (environmental class EE2). The strength class is C30/37. The used cement is CEM III/A 42,5 N LA. The fluidity is high (consistency class S4).

The variability within the product group has been investigated using the guidelines of the B-PCR (NBN/DTD B 08-001:2017). The variability assessment revealed that the results present in this EPD are valid for all members of FEDBETON and all their production sites.

REFERENCE FLOW / DECLARED UNIT

The declared unit consists of 1 m^3 of ready-mixed concrete of strength class C30/37, environmental class EE2, consistency-class S4, produced using cement CEM III/A 42,5 N LA and with a (standard) maximum grain size of 22mm, used in various construction works with a reference service life of 100 years.

Packaging is not relevant for ready-mixed concrete.
Pumping and installation are included.
Ancillary materials for installation (formwork) are not included as they are re-used many times.

The weight per reference flow is 2370 kg.

INSTALLATION

The ready-mixed concrete is transported with truck mixers to the jobsite for installation. The concrete is pumped into the formwork and compacted. The impact of the pump, compaction and the concrete mixer of the truck are included. The formwork itself is not included in this study as it is re-used many times.

IMAGES OF THE PRODUCT AND ITS INSTALLATION

Composition and content

Ready-mixed concrete is transported with truck mixers to the jobsite right before installation, no packaging material is needed. The main components of the product are:

Components	Composition / content / ingredients	Quantity (Mass fraction)
Product	Cement	13%
	Sand	35%
	Gravel	44%
	Water	7%
	Admixture	<1%

The product does not contain materials listed in the “Candidate list of Substances of Very High Concern for authorization”.

Reference service life

The reference service life is 100 years. This RSL is marked as a common lifetime for concrete products in the PCR for concrete and concrete elements (NBN EN16757:2017). This RSL is valid for ready-mixed concrete of environmental class EE2 (outdoor applications which may be in contact with frost, but not with rain), as considered in this EPD. 4

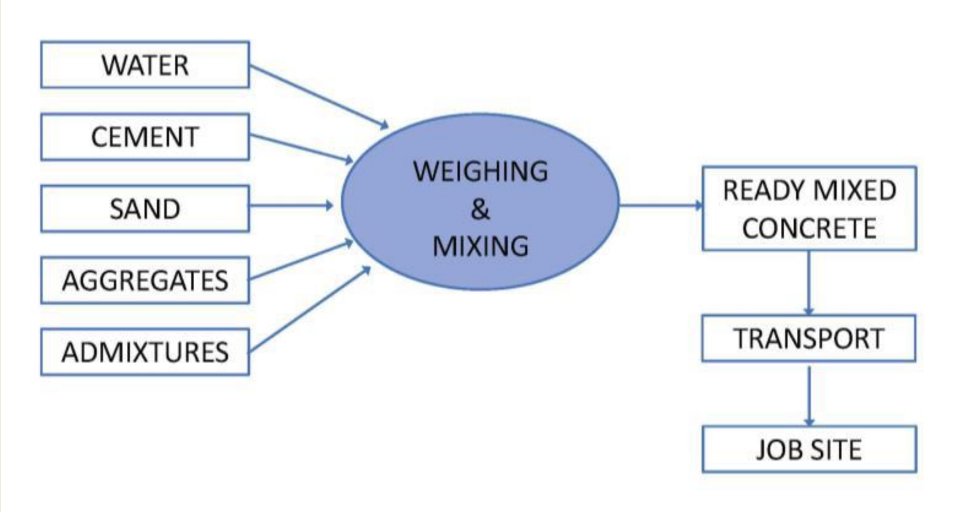
No specific maintenance is required to the concrete. No replacements are necessary over the lifetime of a building.

Description of geographical representativity

The EPD is representative for the Belgian market.
The composed datasets for this life cycle assessment are representative and relevant for ready-mixed concrete produced by the members of FEDBETON in Belgium.

Description of the production process and technology

The required amount of raw materials (aggregates, sand, cement, water and admixtures) are carefully weighed. These materials are then mixed until a homogeneous fluid concrete is obtained. This mixture is brought into the truck mixer and transported to the construction site, where it is processed. The concrete can be poured directly into the formwork or with the help of a crane or concrete pump.



TECHNICAL DATA / PHYSICAL CHARACTERISTICS

Technical property	Standard	Value	Unit	Comment
Compressive strength (at 28d, measured on cubes)	EN 12390-3	45	MPa	Average value
Thermal conductivity	EN 12667	1,3	W/mK	in dry conditions - not reinforced
Bending tensile strength	EN 12390-5	6,3	MPa	Approximate value
E-modulus	EN 12390-13	33.000	MPa	Approximate value
Specific weight	EN 12390-7	2370	kg/m3	Average value

LCA STUDY

DATE OF LCA STUDY
March 2021

SOFTWARE
For the calculation of the LCA results, the software program SimaPro 9.1.1.1 (PRé Consultants, 2021) has been used.

INFORMATION ON ALLOCATION
The production of ready-mixed concrete consists of weighing and mixing the components (aggregates, cement, water, admixtures). Different types of concrete are essentially distinguished by the nature of the raw materials used and the quantity that is dosed from each raw material. The weighing and mixing of the various concrete types takes place in a similar way and has no significant impact on energy consumption and emissions. It can therefore be said that the total energy consumption of a concrete plant on an annual basis compared to the total amount of concrete produced in the same period is an average that can be used for all concrete types. The data per plant is allocated to the specific product using the annual production weight of the product (physical relationship).

INFORMATION ON CUT OFF
The following processes are considered below cut-off: losses during transport are considered to be below cut-off because ready-mixed concrete is transported in a closed truck and cannot break or fall off the truck; environmental impacts caused by the personnel of the production plants are not included in the LCA, e.g. waste from the cafeteria and sanitary installations, accidental pollution caused by human mistakes, or environmental effects caused by commuter traffic. Heating or cooling of the plants in order to ensure a comfortable indoor climate for the personnel for example is also neglected. The total of neglected input flows is less than 5% of energy usage and mass as prescribed by EN15804+A2.

INFORMATION ON EXCLUDED PROCESSES
Only the processes considered below cut-off are excluded from the study. No additional processes are excluded.

INFORMATION ON BIOGENIC CARBON MODELLING
The product does not contain biogenic carbon.

INFORMATION ON CARBON OFFSETTING
Carbon offsetting is not allowed in the EN 15804 and hence not taken into account in the calculations.

INFORMATION ON CARBONATION OF CEMENTITIOUS MATERIALS
Carbonation takes place during the use phase of ready-mixed concrete.[1] The impact of CO_2 removals from carbonation are calculated for different indoor and outdoor applications using the formulas provided in the PCR for concrete and concrete elements (EN16757:2017). $GWP_{carbonation}$ is calculated per m^2 surface of concrete. The concrete considered in this EPD can be used for many different applications with different dimensions, so the carbonation is not scaled to the functional unit of this EPD (1 m^3). The calculation of $GWP_{carbonation}$ is based on the following assumptions: 47% clinker in the cement, 65% reactive CaO, service life of 100 years, 320 kg cement/m^3 concrete, average compressive strength of 45 MPa.

Application	$GWP_{carbonation}$ per m^2 concrete surface	Unit
Outdoor - exposed to rain	0,718	kg CO_2 equiv.
Outdoor - sheltered from rain	1,555	kg CO_2 equiv.
Indoor - with cover	0,830	kg CO_2 equiv.
Indoor - without cover	1,168	kg CO_2 equiv.
In ground	0,326	kg CO_2 equiv.

ADDITIONAL OR DEVIATING CHARACTERISATION FACTORS
The characterization factors from EC-JRC were applied conform EN15804+A2. No additional or deviating characterization factors were used.

[1] The carbonation that takes place in module B1 is not included in the GWP-fossil indicator in the table "Potential environmental impacts per reference flow" because it's not clear where the CO_2-release of the carbonation will take place. The uptake and release of CO_2 coming from carbonation are both not considered in the GWP-fossil indicator.

DESCRIPTION OF THE VARIABILITY

The variability within the product group has been investigated using the guidelines of the B-PCR (NBN/DTD B 08-001:2017). The EPD will be a sector EPD for typical Belgian ready-mixed concrete, from different manufacturers and plants. It's investigated if all the manufacturers covered in one representative EPD is reasonable for the product group represented.

The results of the variability study are in line with theguidelines of the B-PCR (NBN/DTD B 08-001:2017). Therefore, the results of the reference case are considered representative for all considered manufacturers and plants.

DATA

SPECIFICITY

The data used for the LCA are representative for the production of typical Belgian ready-mixed concrete, manufactured by any of the 55 members of FEDBETON in Belgium in any of the 123 concrete plants. The variability within the product group has been investigated using the guidelines of the B-PCR (NBN/DTD B 08-001:2017).

PERIOD OF DATA COLLECTION

Manufacturer specific data have been collected for the year 2018.

INFORMATION ON DATA COLLECTION

Company specific data for the product stage have been collected from its members by FEDBETON and were provided to VITO through an online data collection questionnaire. The LCI data for the product stage have been checked by the EPD verifier (Vinçotte). VITO uses publicly available generic data for all background processes such as the production of electricity, transportation by means of a specific truck, etc.

DATABASE USED FOR BACKGROUND DATA

The main LCI source used in this study is the Ecoinvent 3.6 database (Wernet et al., 2016).

ENERGY MIX

The Belgian electricity mix (consumption mix + import) has been used to model electricity use in life cycle stages A3, A5, C1 and C4. The used record is the Ecoinvent record ‘Electricity, low voltage {BE}| market for | Cut-off, U’ (Wernet et al., 2016).

PRODUCTION SITES

This EPD represents the production of ready-mixed concrete by the members of FEDBETON with following production sites:

APK Casters Beton - Genk	Devamix - Harelbeke	Inter-Beton - Roux
AC Materials - Brugge	Eloy Béton - Sprimont	Inter-Beton - Sint-Pieters-Leeuw
AC Materials - Puurs	Eloy Béton - Grace-Hollogne	Inter-Beton - Temse
AC Materials - Vlierzele	Envemat - Goé	Inter-Beton - Tessenderlo
AC Materials - Wondelgem	Envemat - St Vith	Inter-Beton - Tienen
AC Materials - Heist-op-den-Berg	Envemat - Verviers	Inter-Beton - Villers le Bouillet
Adams Polendam - Beerse	Famenne Béton - Heyd-Durbuy	Inter-Beton - Wellin
Adams Polendam - Geel	Famenne Béton - Marche-en-Famenne	Jacobs Beton - Sint-Katelijne-Waver
Adams Polendam - Massenhoven	Germain Vinckier - Diksmuide	Kerkstoel Beton - Grobbendonk
Ardenne Beton - Libramont-Chevigny	GNB Beton - Bastogne	Lambert Frères - Bastogne
BBE - Béton Bassin de l'Escaut	GNB Beton - Fernelmont	Mermans Beton - Arendonk
Béton Baguette - Thimister Clermont	GNB Beton - Stockem	Multi-Mix - Wondelgem
Bétons Feidt Belgium - Arlon	Goffette et Fils - Jamoigne	NB BETON - Eupen
Bétons Feidt Belgium - Bastogne	Goijens Betoncentrale - Bree	NB BETON - Gouvy
Betoncentrale Blomme - Nieuwpoort	H. Keulen Beton - Lanaken	NB BETON - Malmedy
Betoncentrale De Brabandere - Veurne	Holcim België - Aarschot	NB BETON - Waimes
B-mix Beton - Tessenderlo	Holcim België - Merksem	OBBC - Oosterzele
Bosschaert - Kortrijk	Holcim België - Overijse	OBC Ottevaere - Oudenaarde
Bouffioux - Longchamps	Holcim België - Sint-Truiden	Olivier Construct - Izegem 1
Buysse Beton - Evergem	Holcim Belgique - Bruxelles	Olivier Construct - Izegem 2
CCB - Baudour	Holcim Belgique - Dampremy	Paesen Betonfabriek - Houthalen
CCB - Bruxelles	Holcim Belgique - Gembloux	Ready Beton - Anderlecht
CCB - Couillet	Holcim Belgique - Ghlin	Ready Beton - Bruxelles
CCB - Gaurain-Ramecroix	Inter-Beton - Achêne	Ready Beton - Rotselaar
CCB - Ghislenghien	Inter-Beton - Braine-le-Château	René Pirlot et Fils - Virelles
CCB - Mont-Saint-Guibert	Inter-Beton - Brugge	Roosens Bétons - Bois d'Haine
CCB - Roucourt	Inter-Beton - Bruxelles	Roosens Betorix - Hermalle s/ Argenteau
CCB - Voorde	Inter-Beton - Dendermonde	Seegers Beton - Dilsen
CCB - Wevelgem	Inter-Beton - Flémalle	Stortbeton Hollevoet Rik - Torhout
CMIX - Huy	Inter-Beton - Genk	Tanghe - Ichtegem
CMIX - Liège	Inter-Beton - Gent	Tournai-Béton - Tournai
Coopmans DC	Inter-Beton - Grimbergen	Trans-Beton - Gent
De Rycke François Beton - Stekene	Inter-Beton - Heist o/d Berg	Trans-Beton - Lokeren
De Rycke Gebroeders - Kieldrecht	Inter-Beton - Liège	Trans-Beton - Roeselare
De Rycke Gebroeders - Kallo	Inter-Beton - Lommel	Trans-Beton - Wingene
De Snerck Betontcentrale - Kruishoutem	Inter-Beton - Mechelen	Transportbeton - Boom
De Witte Beton en bouwmaterialen - Herdersem	Inter-Beton - Menen	Transportbeton De Beuckelaer - Schoten
Declercq Stortbeton - Deinze	Inter-Beton - Moeskroen	Van Akelyen Betoncentrale - Zele
Declercq Stortbeton - Harelbeke	Inter-Beton - Mont Saint-Guibert	Wijckmans Bouwmaterialen - Ham
Declercq Stortbeton - Tielt	Inter-Beton - Jambes	Willemen Infra NV - Gent
Declercq Stortbeton - Wielsbeke	Inter-Beton - Oostende	

SYSTEM BOUNDARIES

Product stage			Construction installation stage		Use stage							End of life stage					Beyond the system boundaries
Raw materials	Transport	Manufacturing	Transport	Construction installation stage	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal		Reuse-Recovery-Recycling-potential
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4		D
⊠	⊠	⊠	⊠	⊠	**MND**	⊠	**MND**	⊠	**MND**	⊠	**MND**	⊠	⊠	⊠	⊠		⊠

X = included in the EPD
MND = module not declared

POTENTIAL ENVIRONMENTAL IMPACTS PER REFERENCE FLOW

	Production			Construction process stage		Use stage							End-of-life stage					
	A1 Raw material	A2 Transport	A3 manufacturing	A4 Transport	A5 Installation	B1 Use	B2 Maintenance	B3 Repair	B4 Replacement	B5 Refurbishment	B6 Operational energy use	B7 Operational water use	C1 Deconstruction / demolition	C2 Transport	C3 Waste processing	C4 Disposal	D Reuse, recovery, recycling	Total excl module D
GWP total (kg CO2 equiv/FU)	1,48E+02	2,08E+01	1,58E+00	6,72E+00	1,11E+01	MND	0,00E+00	MND	0,00E+00	MND	0,00E+00	MND	9,21E+00	1,25E+01	3,30E+00	7,44E-01	-8,26E+00	2,14E+02
GWP fossil (kg CO2 equiv/FU)	1,48E+02	2,08E+01	1,57E+00	6,72E+00	1,11E+01	MND	0,00E+00	MND	0,00E+00	MND	0,00E+00	MND	9,20E+00	1,25E+01	3,29E+00	7,43E-01	-8,22E+00	2,13E+02
GWP biogenic (kg CO2 equiv/FU)	7,22E-02	1,10E-02	3,10E-03	2,74E-03	3,18E-03	MND	0,00E+00	MND	0,00E+00	MND	0,00E+00	MND	1,73E-03	5,08E-03	1,28E-02	8,31E-04	-3,45E-02	1,13E-01
GWP luluc (kg CO2 equiv/FU)	8,08E-02	1,71E-02	1,41E-03	2,35E-03	2,69E-03	MND	0,00E+00	MND	0,00E+00	MND	0,00E+00	MND	7,25E-04	4,36E-03	6,34E-03	4,22E-04	-6,90E-03	1,16E-01
ODP (kg CFC 11 equiv/FU)	1,14E-06	4,41E-06	3,30E-07	1,53E-06	1,85E-06	MND	0,00E+00	MND	0,00E+00	MND	0,00E+00	MND	1,99E-06	2,83E-06	5,96E-07	2,78E-07	-1,22E-06	1,50E-05
AP (mol H+ equiv/FU)	4,42E-01	1,24E-01	1,21E-02	2,74E-02	5,26E-02	MND	0,00E+00	MND	0,00E+00	MND	0,00E+00	MND	9,63E-02	5,09E-02	1,49E-02	6,33E-03	-7,07E-02	8,26E-01
EP - freshwater (kg P equiv/FU)	2,33E-04	1,94E-04	1,92E-05	5,27E-05	2,87E-05	MND	0,00E+00	MND	0,00E+00	MND	0,00E+00	MND	3,35E-05	9,78E-05	1,29E-04	9,84E-06	-2,68E-04	7,97E-04
EP - marine (kg N equiv/FU)	1,23E-01	4,56E-02	4,90E-03	8,14E-03	1,91E-02	MND	0,00E+00	MND	0,00E+00	MND	0,00E+00	MND	4,25E-02	1,51E-02	4,13E-03	2,17E-03	-1,91E-02	2,65E-01
EP - terrestrial (mol N equiv/FU)	1,47E+00	5,02E-01	5,50E-02	9,00E-02	2,12E-01	MND	0,00E+00	MND	0,00E+00	MND	0,00E+00	MND	4,66E-01	1,67E-01	4,73E-02	2,40E-02	-2,62E-01	3,04E+00
POCP (kg Ethene equiv/FU)	4,97E-01	1,39E-01	1,48E-02	2,76E-02	6,03E-02	MND	0,00E+00	MND	0,00E+00	MND	0,00E+00	MND	1,28E-01	5,11E-02	1,29E-02	6,92E-03	-6,10E-02	9,37E-01
ADP Elements (kg Sb equiv/FU)	2,51E-05	3,13E-05	2,45E-06	1,31E-05	3,09E-06	MND	0,00E+00	MND	0,00E+00	MND	0,00E+00	MND	2,36E-06	2,43E-05	6,08E-06	7,49E-07	-6,82E-05	1,08E-04

ADP fossil fuels (MJ/FU)	7,51E+02	2,99E+02	3,56E+01	1,01E+02	1,32E+02	MND	0,00E+00	MND	0,00E+00	MND	0,00E+00	MND	1,27E+02	1,88E+02	1,01E+02	2,15E+01	-1,29E+02	1,76E+03
WDP (m^3 water eq deprived /FU)	2,21E+01	9,18E-01	2,35E-01	2,82E-01	5,74E-01	MND	0,00E+00	MND	0,00E+00	MND	0,00E+00	MND	1,70E-01	5,23E-01	9,26E-01	8,00E-01	-2,27E+00	2,65E+01

GWP total = total Global Warming Potential (Climate Change); GWP-luluc = Global Warming Potential (Climate Change) land use and land use change; ODP = Ozone Depletion Potential; AP = Acidification Potential for Soil and Water; EP = Eutrophication Potential; POCP = Photochemical Ozone Creation; ADPE = Abiotic Depletion Potential – Elements; ADPF = Abiotic Depletion Potential – Fossil Fuels; WDP = water use (Water (user) deprivation potential, deprivation-weighted water consumption)

Resource use

	Production			Construction process		Use stage							End-of-life stage					
	A1 Raw material	A2 Transport	A3 manufacturing	A4 Transport	A5 Installation	B1 Use	B2 Maintenance	B3 Repair	B4 Replacement	B5 Refurbishment	B6 Operational energy use	B7 Operational water use	C1 Deconstruction / demolition	C2 Transport	C3 Waste processing	C4 Disposal	D Reuse, recovery, recycling	Total excl module D
PERE (MJ/FU, net calorific value)	1,53E+02	5,09E+00	2,53E+00	1,40E+00	3,97E+00	MND	0,00E+00	MND	0,00E+00	MND	0,00E+00	MND	6,74E-01	2,60E+00	1,09E+01	5,89E-01	-3,14E+01	1,81E+02
PERM (MJ/FU, net calorific value)	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	MND	0,00E+00	MND	0,00E+00	MND	0,00E+00	MND	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PERT (MJ/FU, net calorific value)	1,53E+02	5,09E+00	2,53E+00	1,40E+00	3,97E+00	MND	0,00E+00	MND	0,00E+00	MND	0,00E+00	MND	6,74E-01	2,60E+00	1,09E+01	5,89E-01	-3,14E+01	1,81E+02
PENRE (MJ/FU, net calorific value)	7,59E+02	3,03E+02	3,68E+01	1,02E+02	1,31E+02	MND	0,00E+00	MND	0,00E+00	MND	0,00E+00	MND	1,26E+02	1,89E+02	1,09E+02	2,19E+01	-1,41E+02	1,78E+03
PENRM (MJ/FU, net calorific value)	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	MND	0,00E+00	MND	0,00E+00	MND	0,00E+00	MND	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PENRT (MJ/FU, net calorific value)	7,59E+02	3,03E+02	3,68E+01	1,02E+02	1,31E+02	MND	0,00E+00	MND	0,00E+00	MND	0,00E+00	MND	1,26E+02	1,89E+02	1,09E+02	2,19E+01	-1,41E+02	1,78E+03
SM (kg/FU)	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	MND	0,00E+00	MND	0,00E+00	MND	0,00E+00	MND	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
RSF (MJ/FU, net calorific value)	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	MND	0,00E+00	MND	0,00E+00	MND	0,00E+00	MND	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
NRSF (MJ/FU, net calorific value)	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	MND	0,00E+00	MND	0,00E+00	MND	0,00E+00	MND	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
FW (m^3 water eq/FU)	3,43E+00	3,62E-02	7,26E-03	1,00E-02	7,30E-02	MND	0,00E+00	MND	0,00E+00	MND	0,00E+00	MND	4,99E-03	1,86E-02	3,51E-02	1,91E-02	-8,07E-01	3,63E+00

PERE = Use of renewable primary energy excluding renewable primary energy resources used as raw materials; PERM = Use of renewable primary energy resources used as raw materials; PERT = Total use of renewable primary energy resources; PENRE = Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials; PENRM = Use of non-renewable primary energy resources used as raw materials; PENRT = Total use of non-renewable primary energy resources; SM = Use of secondary material; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels; FW = Net use of fresh water

Waste categories & output flows

	Production			Construction process stage		Use stage							End-of-life stage					
	A1 Raw material	A2 Transport	A3 manufacturing	A4 Transport	A5 Installation	B1 Use	B2 Maintenance	B3 Repair	B4 Replacement	B5 Refurbishment	B6 Operational energy use	B7 Operational water use	C1 Deconstruction / demolition	C2 Transport	C3 Waste processing	C4 Disposal	D Reuse, recovery, recycling	Total excl module D
Hazardous waste disposed (kg/FU)	2,77E-04	7,82E-04	5,92E-05	2,65E-04	3,15E-04	MND	0,00E+00	MND	0,00E+00	MND	0,00E+00	MND	3,45E-04	4,92E-04	9,27E-05	2,98E-05	-5,21E-04	2,66E-03
Non-hazardous waste disposed (kg/FU)	8,68E-01	1,06E+01	1,05E-01	4,84E+00	2,88E+00	MND	0,00E+00	MND	0,00E+00	MND	0,00E+00	MND	1,53E-01	8,99E+00	2,17E-01	1,15E+02	-1,83E+00	1,44E+02
Radioactive waste disposed (kg/FU)	2,29E-02	2,03E-03	3,04E-04	6,91E-04	1,30E-03	MND	0,00E+00	MND	0,00E+00	MND	0,00E+00	MND	8,80E-04	1,28E-03	9,17E-04	1,54E-04	-9,46E-04	3,05E-02
Components for re-use (kg/FU)	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	MND	0,00E+00	MND	0,00E+00	MND	0,00E+00	MND	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Materials for recycling (kg/FU)	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	MND	0,00E+00	MND	0,00E+00	MND	0,00E+00	MND	0,00E+00	0,00E+00	0,00E+00	0,00E+00	2,19E+03	0,00E+00
Materials for energy recovery (kg/FU)	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	MND	0,00E+00	MND	0,00E+00	MND	0,00E+00	MND	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Exported energy (MJ/FU)	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	MND	0,00E+00	MND	0,00E+00	MND	0,00E+00	MND	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00

IMPACT CATEGORIES ADDITIONAL TO EN 15804

	Production			Construction process		Use stage							End-of-life stage					
	A1 Raw material	A2 Transport	A3 manufacturing	A4 Transport	A5 Installation	B1 Use	B2 Maintenance	B3 Repair	B4 Replacement	B5 Refurbishment	B6 Operational energy use	B7 Operational water use	C1 Deconstruction / demolition	C2 Transport	C3 Waste processing	C4 Disposal	D Reuse, recovery, recycling	Total excl module D
PM (disease incidence)	3,56E-06	1,13E-06	2,93E-07	4,67E-07	7,83E-07	MND	0,00E+00	MND	0,00E+00	MND	0,00E+00	MND	1,17E-05	8,67E-07	1,94E-07	1,21E-07	-1,25E-06	1,91E-05
IRHH (kg U235 eq/FU)	3,93E+00	1,32E+00	3,04E-01	4,43E-01	6,15E-01	MND	0,00E+00	MND	0,00E+00	MND	0,00E+00	MND	5,43E-01	8,21E-01	1,05E+00	1,19E-01	-1,15E+00	9,15E+00
ETF (CTUe/FU)	4,36E+03	2,39E+02	1,87E+01	8,11E+01	1,54E+02	MND	0,00E+00	MND	0,00E+00	MND	0,00E+00	MND	7,64E+01	1,50E+02	5,04E+01	1,32E+01	-1,89E+02	5,15E+03
HTCE (CTUh/FU)	3,56E-08	7,88E-09	5,88E-10	2,28E-09	2,14E-09	MND	0,00E+00	MND	0,00E+00	MND	0,00E+00	MND	2,67E-09	4,23E-09	1,91E-09	3,32E-10	-1,43E-08	5,76E-08
HTnCE (CTUh/FU)	1,48E-06	2,37E-07	1,42E-08	8,84E-08	7,54E-08	MND	0,00E+00	MND	0,00E+00	MND	0,00E+00	MND	6,55E-08	1,64E-07	4,13E-08	9,36E-09	-2,37E-07	2,17E-06
Land Use Related impacts (dimension less)	4,27E+02	2,14E+02	1,93E+01	6,98E+01	3,20E+01	MND	0,00E+00	MND	0,00E+00	MND	0,00E+00	MND	1,62E+01	1,30E+02	5,77E+01	3,84E+01	-2,34E+02	1,00E+03

HTCE = Human Toxicity – cancer effects; HTnCE = Human Toxicity – non cancer effects; ETF = Ecotoxicity – freshwater; (potential comparative toxic unit)
PM = Particulate Matter (Potential incidence of disease due to PM emissions);
IRHH = Ionizing Radiation – human health effects (Potential Human exposure efficiency relative to U235);

	Global Warming Potential	*The global warming potential of a gas refers to the total contribution to global warming resulting from the emission of one unit of that gas relative to one unit of the reference gas, carbon dioxide, which is assigned a value of 1.* *It is split up in 4:* *- Global Warming Potential total (GWP-total) which is the sum of GWP-fossil, GWP-biogenic and GWP-luluc* *- Global Warming Potential fossil fuels (GWP-fossil) : The global warming potential related to greenhouse gas (GHG) emissions to any media originating from the oxidation and/or reduction of fossil fuels by means of their transformation or degradation (e.g. combustion, digestion, landfilling, etc).* *- Global Warming Potential biogenic (GWP-biogenic) : The global warming potential related to carbon emissions to air (CO2, CO and CH4) originating from the oxidation and/or reduction of aboveground biomass by means of its transformation or degradation (e.g. combustion, digestion, composting, landfilling) and CO2 uptake from the atmosphere through photosynthesis during biomass growth – i.e. corresponding to the carbon content of products, biofuels or above ground plant residues such as litter and dead wood.*[2] *- Global Warming Potential land use and land use change (GWP-luluc): The global warming potential related to carbon uptakes and emissions (CO2, CO and CH4) originating from carbon stock changes caused by land use change and land use. This sub-category includes biogenic carbon exchanges from deforestation, road construction or other soil activities (including soil carbon emissions).*
	Ozone Depletion	*Destruction of the stratospheric ozone layer which shields the earth from ultraviolet radiation harmful to life. This destruction of ozone is caused by the breakdown of certain chlorine and/or bromine containing compounds (chlorofluorocarbonsor halons), Which break down when they reach the stratosphere and then catalytically destroy ozone molecules.*
	Acidification potential	*Acid depositions have negative impacts on natural ecosystems and the man-made environment incl. buildings. The main sources for emissions of acidifying substances are agriculture and fossil fuel combustion used for electricity production, heating and transport.*
	Eutrophication potential	*The potential to cause over-fertilization of water and soil, which can result in increased growth of biomass and following adverse effects.* *It is split up in 3:* *- Eutrophication potential – freshwater: The potential to cause over-fertilization of freshwater, which can result in increased growth of biomass and following adverse effects.* *- Eutrophication potential – marine: The potential to cause over-fertilization of marine water, which can result in increased growth of biomass and following adverse effects.* *- Eutrophication potential – terrestrial: The potential to cause over-fertilization of soil, which can result in increased growth of biomass and following adverse effects.*
	Photochemical ozone creation	*Chemical reactions brought about by the light energy of the sun creating photochemical smog. The reaction of nitrogen oxides with hydrocarbons in the presence of sunlight to form ozone is an example of a photochemical reaction.*
	Abiotic depletion potential for non-fossil ressources	*Consumption of non-renewable resources, thereby lowering their availability for future generations. Expressed in comparison to Antimonium (Sb).* *The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experienced with the indicator.*
	Abiotic depletion potential for fossil ressources	*Measure for the depletion of fossil fuels such as oil, natural gas, and coal. The stock of the fossil fuels is formed by the total amount of fossil fuels, expressed in Megajoules (MJ).* *The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experienced with the indicator.*
	Ecotoxicity for aquatic fresh water	*The impacts of chemical substances on ecosystems (freshwater).* *The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experienced with the indicator.*
	Human toxicity (carcinogenic effects)	*The impacts of chemical substances on human health via three parts of the environment: air, soil and water.*

[2] Carbon exchanges from native forests shall be modelled under GWP - luluc (including connected soil emissions, derived products or residues), while their CO2 uptake is excluded.

		The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experienced with the indicator.
	*Human toxicity (non-carcinogenic effects)*	*The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experienced with the indicator.*
	*Particulate matter*	*Accounts for the adverse health effects on human health caused by emissions of Particulate Matter (PM) and its precursors (NOx, SOx, NH3)*
	*Resource depletion (water)*	*Accounts for water use related to local scarcity of water as freshwater is a scarce resource in some regions, while in others it is not.* *The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experienced with the indicator.*
	*Ionizing radiation - human health effects*	*This impact category deals mainly with the eventual impact on human health of low dose ionizing radiation of the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents, occupational exposure nor due to radioactive waste disposal in underground facilities. Potential ionizing radiation from the soil, from radon and from some construction materials is also not measured by this indicator.*
	*Land use related impacts*	*The indicator is the "soil quality index" which is the result of an aggregation of following four aspects:* - *Biotic production* - *Erosion resistance* - *Mechanical filtration* - *Groundwater* *The aggregation is done based on a JRC model. The four aspects are quantified through the LANCA model for land use.* *The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experienced with the indicator.*

DETAILS OF THE UNDERLYING SCENARIOS USED TO CALCULATE THE IMPACTS

A1 – RAW MATERIAL SUPPLY

This module takes into account the extraction of all raw materials (sand, gravel, cement, water and admixtures) and energy which occur upstream to the studied manufacturing process.

A2 – TRANSPORT TO THE MANUFACTURER

The raw materials are transported to the manufacturing site.

A3 – MANUFACTURING

This module takes into account the production process (internal transport, weighing and mixing of all raw materials).

A4 – TRANSPORT TO THE BUILDING SITE

The concrete is transported with truck mixers to the jobsite right before installation.

Fuel type and consumption of vehicle or vehicle type used for transport	Truck 16-32 ton 0,260 l diesel / km (Ecoinvent scenario)
Distance	17 km
Capacity utilisation (including empty returns)	Ecoinvent scenario
Bulk density of transported products	Ecoinvent scenario
Volume capacity utilisation factor	Ecoinvent scenario

A5 – INSTALLATION IN THE BUILDING

The concrete is pumped into the formwork and compacted. The formwork itself is not included in this study as it is re-used many times. 4% material losses and leftover have been taken into account, it is assumed that half of this material is lost and treated as waste (2% of the reference flow), and half is leftover concrete that is reused internally by the manufacturer in its concrete production.

Ancillary materials for installation (specified by material);	Not applicable
Water use	Not applicable
Other resource use	Not applicable
Quantitative description of energy type (regional mix) and consumption during the installation process	• 21,6 MJ diesel burned for concrete pump • 0,15 kWh electricity from Belgian grid mix for compaction • 1,39 kg diesel burned by truck (concrete mixer)
Waste materials on the building site before waste processing, generated by the product's installation (specified by type)	47,4 kg ready-mixed concrete (2% material loss)
Output materials (specified by type) as result of waste processing at the building site e.g. of collection for recycling, for energy recovery, disposal (specified by route)	Not applicable
Direct emissions to ambient air, soil and water	Not applicable
Distance	Not applicable

B – USE STAGE (EXCLUDING POTENTIAL SAVINGS)

Ready-mixed concrete is commonly used in applications such as beams, columns, walls, foundations, slabs, etc. Ready-mixed concrete doesn't need any specific maintenance or cleaning. Most of the concrete is not visible during its lifetime (e.g. foundations, slabs in office buildings or apartments) and doesn't need any specific care or replacements during its life span of 100 years. Since no maintenance, replacement or operational energy use are necessary during the RSL of the product, no environmental impacts occur during these modules.

B1: Module not declared
B2: Ready mixed concrete doesn't need any specific maintenance or cleaning
B3: Module not declared
B4: No replacement is needed
B5: Module not declared
B6: No operational energy use needed

C – END OF LIFE

The default scenario provided by the B-PCR, being 5% to landfill and 95% to recycling, has been used as end-of-life scenario. The B-PCR also provides default scenarios for transport of waste which are:

- 30 km with a 16-32 ton EURO 5 lorry from demolition site to sorting plant/crusher/collection point;
- 50 km with a 16-32 ton EURO 5 lorry from sorting plant to landfill;
- 100 km with a 16-32 ton EURO 5 lorry from sorting plant to incineration plant/energy recovery.

C1: Demolition of 2300 kg concrete
C2-C4: The default scenario provided by the B-PCR describes for the concrete that 95% is recycled and 5% is landfilled.

The burdens of recycling of the concrete (95% * 2300 kg) are included in the C3 module because the end-of-waste state is reached after breaking and seaving of the concrete (inside the system boundaries).

Module C2 – Transport to waste processing					
Type of vehicle (truck/boat/etc.)	Fuel consumption (litres/km)	Distance (km)	Capacity utilisation (%)	Density of products (kg/m³)	Assumptions
Truck 16-32 ton	0,260 l diesel/km (Ecoinvent scenario)	30	Ecoinvent scenario	Ecoinvent scenario	Ecoinvent scenario
Truck 16-32 ton	0,260 l diesel/km (Ecoinvent scenario)	50	Ecoinvent scenario	Ecoinvent scenario	Ecoinvent scenario
Truck 16-32 ton	0,260 l diesel/km (Ecoinvent scenario)	100	Ecoinvent scenario	Ecoinvent scenario	Ecoinvent scenario

End-of-life modules – C3 and C4		
Parameter	Unit	Value
Wastes collected separately	kg	0
Wastes collected as mixed construction waste	kg	2300
Waste for re-use	kg	0
Waste for recycling	kg	2185
Waste for energy recovery	kg	0
Waste for final disposal	kg	115

D – BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARIES

The benefits beyond the system boundaries include the avoided production of virgin material (crushed gravel): 95% recycling during end of life + 95% recycling of losses during A5.

Quantitative description of the loads beyond the system boundaries	0
Quantitative description of the benefits beyond the system boundaries	Avoided production of 2230kg of crushed gravel

ADDITIONAL INFORMATION ON RELEASE OF DANGEROUS SUBSTANCES TO INDOOR AIR, SOIL AND WATER DURING THE USE STAGE

INDOOR AIR

No emissions to indoor air are expected.

SOIL AND WATER

The horizontal standards on measurement of release of regulated dangerous substances from construction products using harmonized test methods are not yet available, therefore the EPD can lack this information (CEN TC 351).

DEMONSTRATION OF VERIFICATION

EN 15804+A2 serves as the core PCR
Independent verification of the environmental declaration and data according to standard EN ISO 14025:2010 Internal ☐ External☒
Third party verifier: Evert Vermaut Jan Olieslagerslaan 35 1800 Vilvoorde evermaut@vincotte.be

APPLICATION UNIT

This paragraph gives information on the applied product and how the reference flow relate to different applications. For ready mixed concrete there are 7 applications, all for a fixed 1 m^3 ready mixed concrete with a ratio to the declared unit of 1 for each application. The 7 different element types for application are:

- Floors
- Foundations
- Floors, galleries, balconies, walkways
- Beams and columns
- Outer walls
- Roofs
- Ground finishing (outside)

ADDITIONAL INFORMATION ON REVERSIBILITY

For the application unit a qualitative assessment of the reversibility can be given (based on BAMB – buildings as material banks). This is shown in the table below.

Table 1: Reversibility of the typical Belgian ready-mixed concrete

Reversibility	Simplicity of dissassembly	Speed of dissassembly	Ease of handling (size and weight)	Robustness of material (material resistance to disassembly)
Non-reversible fixing	*Simple dissassembly use of dismantling tools required*	*speedy disassembly*	*handling requires mechanical devices*	*n/a: the element is not reversible*

Bibliography

- ISO 14040:2006: Environmental Management-Life Cycle Assessment-Principles and framework.
- ISO 14044:2006: Environmental Management-Life Cycle Assessment-Requirements and guidelines.
- ISO 14025:2006: Environmental labels and Declarations-Type III Environmental Declarations-Principles and procedures.
- NBN EN 15804+A2:2019. CEN TC350. Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products. European standard.
- NBN/DTD B 08-001 (BE-PCR)
- Allacker K., Debacker W., Delem L., De Nocker L., De Troyer F., Janssens A., Peeters K., Van Dessel J., Servaes R, Rossi E., Deproost M., Bronchart S. 2018. Environmental profile of building elements, update 2017. 46p.
- CEN/TR 16970:2016. Sustainability of construction works - Guidance for the implementation of EN 15804
- De Lhoneux B., Akers S., Alderweireldt L., Carmeliet J., Hikasa J., Kalbskopf R., Li V., Vidts D. 2003. Durability of synthetic fibers in fiber-cement building materials 2003 – Engineering with fibers – Spring Symp. Advanced flexible mat. and structures, Loughborough/UK
- Doka G. 2009. Life Cycle Inventories of Waste Treatment Services. Ecoinvent report No. 13. Swiss Centre for Life Cycle Inventories, Dübendorf, 2009.
- EN15804:2012+A1:2013. CEN TC 350. Sustainability of construction works – Environmental product declarations – Core rules for the product category of construction products. European standard.
- EN 16485:2014. Round and sawn timber - Environmental Product Declarations - Product category rules for wood and wood-based products for use in construction.
- Frischknecht R, Steiner R, & Jungbluth N, The Ecological Scarcity Method - Eco-Factors. 2008 A method for impact assessment in LCA. 2009, Federal Office for the Environment FOEN: Zürich und Bern.
- Humbert, S. 2009. Geographically Differentiated Life-cycle Impact Assessment of Human Health. Doctoral dissertation, University of California, Berkeley, Berkeley, California, USA.
- JRC. 2018. https://eplca.jrc.ec.europa.eu/ELCD3/
- Kalbskopf R., De Lhoneux B., Van der Heyden L., Alderweireldt L. (Redco NV). 2002. Durability of Fiber-Cement Roofing Products – 2002 – Inorganic-bonded wood and fiber composite materials Conference
- Milà i Canals L., Romanyà J. and Cowell S.J. (2007): Method for assessing impacts on life support functions (LSF) related to the use of ‘fertile land’ in Life Cycle Assessment (LCA). Journal of Cleaner Production 15: 1426-1440.
- NBN/DTD B 08-001:2017. Delem L., Wastiels L. 2016. B-PCR. Sustainability of construction works – Environmental product declarations – Core rules for the product category of construction products – National annex to NBN EN 15804+A1.
- Peeters, K., Damen L. 2019. Life cycle assessment of SVK fiber cement flat sheets.
- Rosenbaum R.K., Bachmann T.M., Gold L.S., Huijbregts M.A.J., Jolliet O., Juraske R., Köhler A., Larsen H.F., MacLeod M., Margni M., McKone T.E., Payet J., Schuhmacher M., van de Meent D. and Hauschild M.Z. (2008): USEtox - The UNEP-SETAC toxicity model: recommended characterisation factors for human toxicity and freshwater ecotoxicity in Life Cycle Impact Assessment. International Journal of Life Cycle Assessment 13(7): 532-546, 2008
- Servaes, R., Allacker, K., Debacker, W., Delem L., De Nocker, L., De Troyer, F. Janssen, A., Peeters, K., Spirinckx, C., Van Dessel, J. (2013). Milieuprofiel van gebouwelementen. Te raadplegen via: www.ovam.be/materiaalprestatie-gebouwen.
- Van der Heyden L. 2012. Fiber cement: a perfectly recyclable building material – 2012 - Conference Paper for the International Inorganic-bonded fiber composites Conference - (Service Life and Performance Review – BRE)
- Wernet, G., Bauer, C., Steubing, B., Reinhard, J., Moreno-Ruiz, E., and Weidema, B., 2016. The ecoinvent database version 3 (part I): overview and methodology. The International Journal of Life Cycle Assessment, [online] 21(9), pp.1218–1230. Available at: <http://link.springer.com/10.1007/s11367-016-1087-8> .
- Project report of Fedbeton: Life cycle assessment of typical Belgian ready-mixed concrete; February 2021; version 1; authors: Lisa Damen, Hannah Van Hees.

General information

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Based on following PCR documents	EN 15804+A2:2019 NBN/DTD B 08-001 and its complement EN16757:2017
PCR review conducted by	Federal Public Service of Health and Environment & PCR Review committee
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Identification of the project report	Life cycle assessment of typical Belgian ready-mixed concrete (VITO, 2021)
Verification	External independent verification of the declaration and data according to EN ISO 14025 and relevant PCR documents
Name of the third party verifier Date of verification	Evert Vermaut (Vinçotte) 23/03/2021
www.b-epd.be	**www.environmentalproductdeclarations.eu**

Comparing EPDs is not possible unless they are conform to the same PCR and taking into account the building context.
The program operator cannot be held responsible for the information supplied by the owner of the EPD nor LCA practitioner.

LCA practitioner

Building calculator of the regiona authorities

www.totem-building.be

Federal Public Service of Health, Food Chain Safety and Environment

www.b-epd.be

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((Signature