# ENVIRONMENTAL PRODUCT DECLARATION
# no. 01-08/2022

## LOW CARBON CONCRETE II and LOW CARBON CONCRETE III produced by WARBUD BETON sp. z.o.o.

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| Owner of the EPD: | Warbud Beton sp. z.o.o. |
| Programme owner: | Sieć Badawcza Łukasiewicz – Instytut Ceramiki i Materiałów Budowlanych Centrum inżynierii Środowiska |
| Name of programme: | Deklaracje Środowiskowe Produktów – B2B |
| Issued: | **2022.08.10** |
| Valid until: | **2027.08.10** |

# ENVIRONMENTAL PRODUCT DECLARATION no. 01-08/2022

## 1. GENERAL INFORMATION

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|---|---|
| **Owner of the EPD:**<br><br>**Warbud Beton Sp. z o.o.** | **Products covered by the EPD:**<br><br>**LCC II 902 C35/45**<br>**LCC II 903 C30/37**<br>**LCC III 904 C35/45**<br>**LCC III 905 C30/37** |
| **Programme owner:**<br><br>Łukasiewicz Research Network - Institute for Ceramics And Building Materials<br>Environmental Engineering Center<br>**http://www.icimb.pl/opole/** | **Owner of the EPD:**<br><br>Warbud Beton sp. z o.o.<br>Gniewkowska str. 44<br>01-253 Warszawa<br>Telephone: +48 22 567 63 71<br>E-mail: jacek.zychowicz@warbud.pl<br>**https://www.warbud-beton.pl/** |
| **Date of issuance:**<br><br>**2022.08.10** | **Declared product/declared unit:**<br><br>The declared unit (DU) for the products covered by the EPD is 1 ton (1000 kg) of concrete mix. In addition, the results of the life cycle assessment were given per 1 $m^3$ of concrete mix with a specific density. |
| **EPD valid until:**<br><br>**2027.08.10** | **Scope:**<br><br>EPD covers two groups of concrete mix: |
| | **Low Carbon Concrete II (LCC II)** and<br>**Low Carbon Concrete III (LCC III)**<br><br>in two compressive strength classes (concrete grades): **C35/45** and **C30/37**, produced in the Warbud Beton sp. z.o.o. plant in Warsaw.<br>It contains information on the environmental impact of the declared products.<br><br>All data on the production cycle was collected by Warbud Beton from 01/01/2021 to 31/12/2021 (12 months) and corresponds to the production technology of the time.<br><br>The life cycle assessment was developed in accordance with the requirements of PN-EN ISO 15804 + A2: 2020, PN-EN ISO 14025 and PN-EN ISO 14040. The product categorization rules were adopted in accordance with PN-EN 15804 and PN-EN 16757.<br><br>The owner of the declaration is responsible for the information and underlying evidence. The Łukasiewicz Research Network - Institute of Ceramics and Building Materials, Environmental Engineering Center is not responsible for the |

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|---|---|
| | manufacturer's information, data and evidence regarding the life cycle assessment.<br><br>Declarations resulting from different programs or not performed according to the standards may not be comparable. |
| **Product category rules (PCR)** | According to:<br><br>PN-EN 15804 + A2: 2020-03 Sustainability of construction works. Environmental product declarations. Basic principles of categorization of construction products.<br><br>PN-EN 16757: 2017 Sustainable nature of construction works. Environmental product declarations. Product Categorization Rules for concrete and concrete products. |
| **Representativeness:** | Polish product, year 2021 |
| **Reference Service Life (RSL):** | 50 years |
| **Reasons for performing LCA:** | B2B |
| **Life Cycle Analysis (LCA):** | LCA covers modules A1-A3 according to PN-EN 15804+A2 standard (Cradle-to-Gate) |

**Łukasiewicz Research Network - Institute of Ceramics and Building Materials, Environmental Engineering Division provides access to the type III EPD for Low Carbon Concrete II and Low Carbon Concrete III concrete mixes to interested parties.**

| **Authors:** | **Verification:** |
|---|---|
| Mateusz Krzyśko, MSc Eng.<br><br>Katarzyna Kiprian, MSc Eng.<br><br>**Approved by:**<br><br>Joanna Poluszyńska, PhD<br>Director of the environmental engineering center<br><br>Ewa Głodek-Bucyk, PhD Eng.<br>Leader of Process Engineering Research Group | CEN PN-EN 15804+A2 standard serves as main PCR.<br>Independent EPD and data verification according to PN-EN ISO 14025:2010 standard.<br><br>☐ internal ☒ external<br><br>Katarzyna Grzesik, PhD Eng. |

## 2. MANUFACTURER AND PRODUCT DESCRIPTION

Warbud Beton sp. z.o.o. is a producer of a wide range of concrete mixtures for various applications, mainly in specialized construction. It specializes in concrete mixes intended for residential construction, intended for the construction of concrete structures in the strength classes specified in the construction design or technical specification, manufactured in compressive strength classes from C8/10 to C70/85 according to PN-EN 206-1: 2003, contracted concrete used for making diaphragm walls and foundation piles, floor concrete intended for floors with increased abrasion resistance, architectural concrete intended for the implementation of various building elements for enhanced visual effects of the object, concrete intended for massive structures and road-bridge concrete intended for the construction of engineering structures.

The company has the following certificates:

- ISO Certificate (PCBC) - PN EN 9001: 2015 and PN EN ISO 14001: 2015, in the field of design, production and delivery of concrete mixtures, No. JS-191/3/2020,
- iQnet (PCBC) certificate - PN EN 9001: 2015 and PN EN ISO 14001: 2015, in the field of design, production and delivery of concrete mixtures, No. JS-191/3/2020,
- ISO Certificate (PCBC) - PN ISO 45001: 2018, in the field of design, production and delivery of concrete mixtures, no. B-97/1/2020
- iQnet (PCBC) certificate - PN ISO 45001: 2018, in the field of design, production and delivery of concrete mixtures, no. B-97/1/2020

LCC II and LCC III concrete mixes are made in accordance with the PN-EN 206 standard. They are manufactured on the premises of the plant using the same technology and delivered by concrete trucks to the construction site. Concrete mixes are made on the basis of specific recipes in order to achieve the desired physical and strength properties. By using waste materials (fly ash from a coal-fired power plant), the negative impact of the product on the environment is reduced. Additionally, cements with the addition of non-carbonate components (CEM II and CEM III) are used, for which the carbon dioxide emission factors are reduced. The diagram below shows the concrete production process at the Warbud Beton plant.

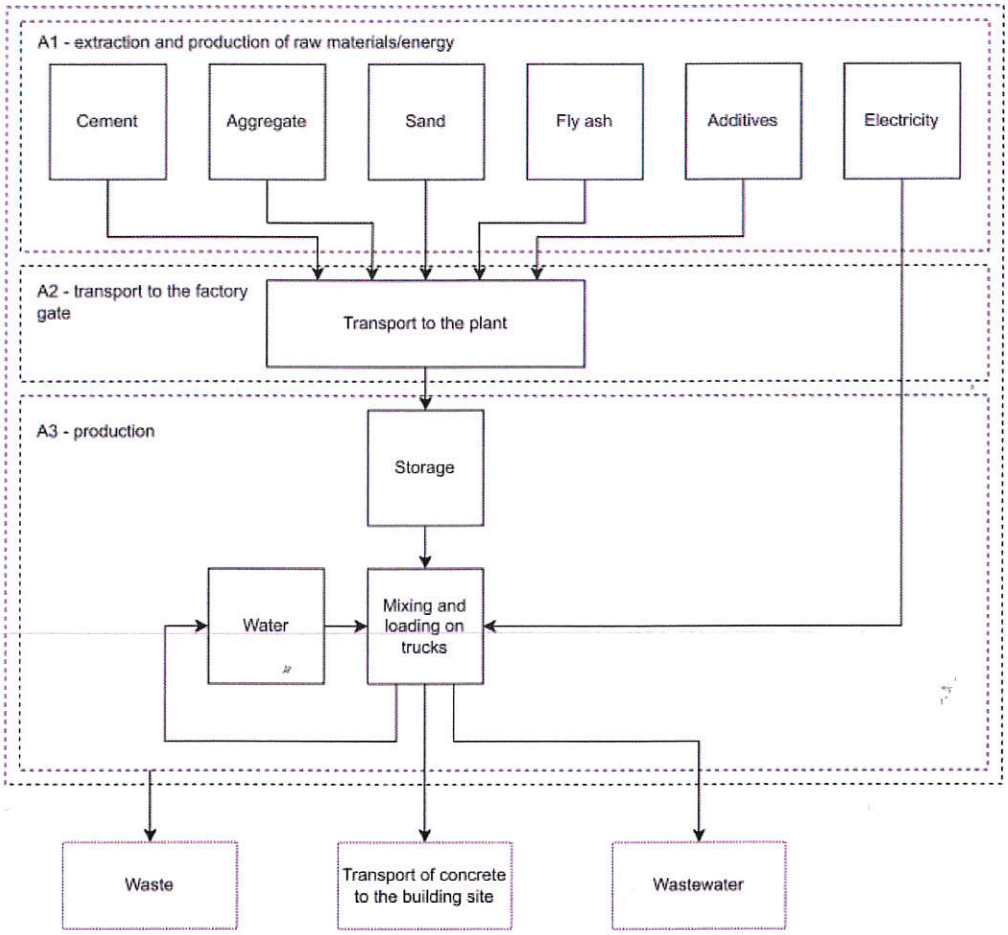


**Figure 1 Block diagram of the production process of LCC II and LCC II concrete mixes in Warbud Beton**

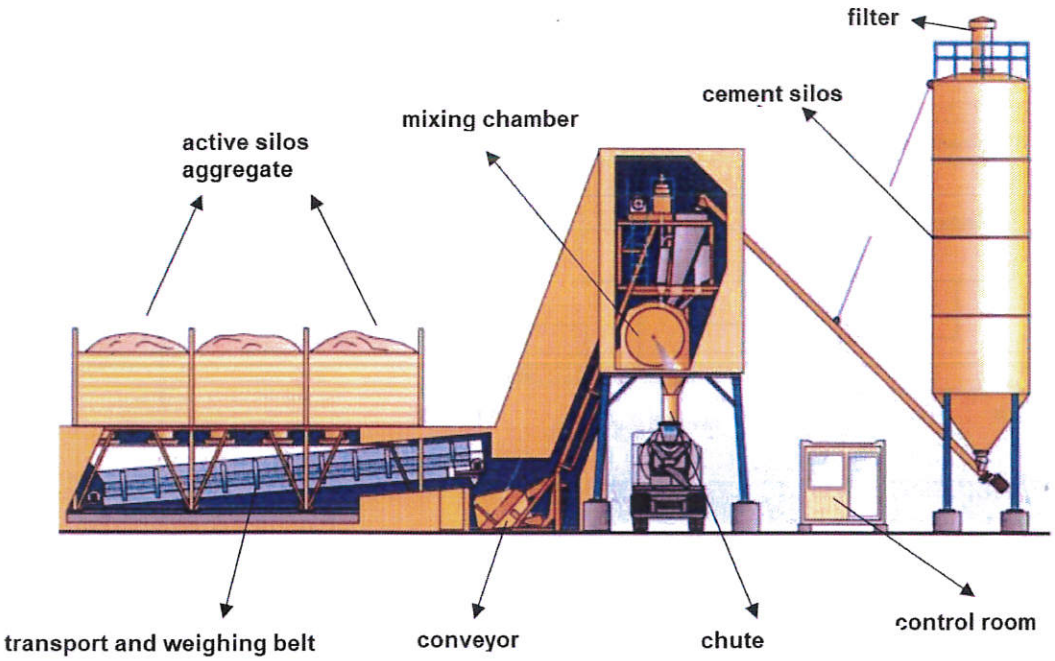


**Figure 2: Diagram of concrete production process in Warbud Beton**

Main ingredients of concrete mixes are:

1. **Aggregate** – gravel, according to PN-EN 12620 standard, extracted from mines in Poland,
2. **Fine aggregate** – river sand, according to PN-EN 12620 standard,
3. **Binders** – Portland cements - CEM II (for LCC II mixtures) or CEM III (for LCC III mixtures), according to PN-EN 197-1, containing fly ash or blast furnace slag,
4. **Additives** – fly ash, additive meeting the requirements of PN-EN 450, which is a by-product of coal combustion in power plants,
5. **Admixtures** – components improving the properties of concrete mixtures, meeting the requirements of PN-EN 934-2,
6. **Water** – added to liquefy the concrete mix and enable the concrete setting process, meeting the requirements of PN-EN 1008

The ingredients are delivered to the plant by rail and trucks and stored in closed or open silos. Then they are dosed usng scales and fed to the mixer. Mixing is an automatic process, following a developed recipe, taking into account the achievement of homogeneity, designed consistency, aeration and other designed properties. The concrete truck is loaded with the concrete mix through a chute. Transport to the place of delivery takes place with constant agitation.

LCC II concrete is offered in compressive strength classes C35/45 and C30/37. It is a concrete mix for structural applications in accordance with the requirements of the PN-EN 206: 2016 standard on CEM II 42.5N BM (SV) cement with the addition of fly ash. The main applications of the LCC II concrete mix are reinforced concrete structures of walls, reinforced concrete columns and massive reinforced concrete structures.

LCC III concrete is offered in compressive strength classes C 35/45 and C 30/37. It is a concrete mix for structural applications in accordance with the requirements of PN EN 206: 2016 on CEM III / A 42.5N LH HSR NA cement with the addition of fly ash. The main applications of the LCC III concrete mix are massive, weakly reinforced concrete structures, retaining blocks, footings, slabs and footings.

## 3. LCA: CALCULATION RULES

**System boundaries**

The life cycle analysis of the tested products includes A1-A3 (Cradle to Gate) modules in accordance with PN-EN 15804. It includes the following modules:

- A1 - extraction and preparation of raw materials, generation of electricity and energy carriers for auxiliary processes,

- A2 - transport of raw materials to the gate of the production plant,

- A3 - production, including ancillary processes and emissions.

**Data collection period**

The production process data is from 2021.

**Declared unit (DU)**

The environmental product declaration is for 1 ton (1000 kg) of concrete mix.

**Additional unit**

In addition, the results are given per 1 $m^3$ of concrete mix with a specific density.

**Assumptions**

A1 - extraction and consumption of raw materials refers to specific mass shares in the production process per declared unit of the product,

A2 - distances from the place of obtaining raw materials to the production plant individual for each raw material, means of transport differentiated due to the method of raw materials delivery,

A3 - values of CO2, NOx, SO2, dust and other emissions from the production process obtained as a result of measurements carried out at the plant, other estimated on the basis of fuel consumption.

**Cut-off criteria**

99% of all mass flows involved in the production process were taken into account.
All the energy used in the process has been taken into account in the EPD.

**Generic data**

The main source of general and auxiliary data is the EcoInvent 3.8, ELCD 2.0, Industrial Data 2.0 database and manufacturer's reports.

**Allocation**

The products covered by the environmental declaration are produced in the plant in Warsaw. All data provided by the manufacturer were related to the declared unit (DU) of the product - 1 ton of concrete mix and additionally to 1 m3 of concrete mix with a specific density.

## 4. LCA: SCENARIOS AND ADDITIONAL TECHNICAL DATA

No additional information is required for LCA "cradle-to-gate".

## 5. LCA: RESULTS

The table below shows the LCA modules considered for the calculation of the environmental impact categories for the products covered by the declaration.

| SYSTEM BOUNDARIES (X – MODULE INCLUDED IN LCA, MND – MODULE NOT DECLARED, INA – INDICATOR NOT ASSESSED) | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Product stage** | | | **Construction process stage** | | **Use stage** | | | | | | | **End-of-life stage** | | | | **Benefits and loads beyond the system boundary** |
| Raw material supply | Transport | Production | Transport to the construction site | Construction proces | Use | Maintenance | Repair | Replacement | Refurbishment | Operational energy use | Operational water use | Deconstruction | Transport | Waste processing | Disposal | Reuse-recovery-recycling potential |
| **A1** | **A2** | **A3** | **A4** | **A5** | **B1** | **B2** | **B3** | **B4** | **B5** | **B6** | **B7** | **C1** | **C2** | **C4** | **C4** | **D** |
| **X** | **X** | **X** | **MND** | **MND** | **MND** | **MND** | **MND** | **MND** | **MND** | **MND** | **MND** | **MND** | **MND** | **MND** | **MND** | **MND** |

The following tables present the results of the LCA analysis for the following products: LCC II 902, LCC II 903, LCC III 904 and LCC III 905. The results were given for the declared unit (1 ton of concrete mix) and additionally for 1 $m^3$ of concrete mix with a specified density.

## Low Carbon Concrete II (LCC II 902 C35/45)
## 1 ton of concrete mix, concrete grade C35/45

**CORE ENVIRONMENTAL IMPACT INDICATORS (1 ton, LCC II 902 C35/45)**

| | | Life Cycle Stage | | |
|---|---|---|---|---|
| **Indicator** | **Unit** | **A1** | **A2** | **A3** |
| Global Warming Potential total (GWP-total) | kg $CO_2$ eq. | 9,43E+01 | 6,67E+00 | 3,85E+00 |
| Global Warming Potential fossil fuels (GWP-fossil) | kg $CO_2$ eq. | 8,76E+01 | 6,65E+00 | 3,77E+00 |
| Global Warming Potential biogenic (GWP-biogenic) | kg $CO_2$ eq. | 6,62E+00 | 2,66E-02 | 7,84E-02 |
| Global Warming Potential land use and land change (GWP-luluc) | kg $CO_2$ eq. | 8,27E-02 | 2,71E-03 | 1,13E-03 |
| Depletion potential of the stratospheric ozone layer (ODP) | kg CFC11 eq. | 3,48E-06 | 1,52E-06 | 1,49E-07 |
| Acidification potential, Accumulated Exceedance (AP) | mol H+ eq. | 2,64E-01 | 1,93E-02 | 2,80E-02 |
| Eutrophication potential, fraction of nutritients reaching freshwater end compartment (EP-freshwater) | kg $PO_4$ eq. | 1,10E-02 | 5,22E-04 | 4,70E-03 |
| Eutrophication potential, fraction of nutritients reaching marine end compartment (EP-marine) | kg N eq. | 6,84E-02 | 3,97E-03 | 3,98E-03 |
| Eutrophication potential, Accumulated Exceedance (EP-terrestial) | mol N eq. | 7,76E-01 | 4,31E-02 | 3,42E-02 |
| Formation potential of tropospheric ozone (POCP) | kg NMVOC eq. | 1,79E-01 | 1,11E-02 | 9,19E-03 |
| Abiotic depletion potential for non-fossil resources (ADP-minerals&metals) | kg Sb eq. | 2,16E-04 | 2,19E-05 | 3,84E-06 |
| Abiotic depletion potential for fossil resources (ADP-fossil) | MJ, net calorific value | 5,30E+02 | 1,01E+02 | 4,73E+01 |
| Water (user) deprivation potential, deprivation-weighted water consumption (WDP) | WDP ($m^3$ world eq. deprived) | 3,80E+01 | 3,49E-01 | 3,39E+00 |

**ADDITIONAL ENVIRONMENTAL IMPACT INDICATORS (1 ton, LCC II 902 C35/45)**

| | | Life Cycle Stage | | |
|---|---|---|---|---|
| **Indicator** | **Unit** | **A1** | **A2** | **A3** |
| Potential incidence of disease due to PM emissions (PM) | Disease incidence | 1,71E-06 | 4,22E-07 | 4,71E-08 |
| Potential human exposure efficiency relative to U235 (IRP) | kBq U235 eq. | 1,71E-06 | 4,22E-07 | 4,71E-08 |
| Potential comparative toxic unit for ecosystems (ETP-fw) | CTUe | 8,70E+02 | 7,99E+01 | 5,39E+01 |
| Potential comparative toxic unit for humans (HTP-c) | CTUh | 2,00E-08 | 2,44E-09 | 1,24E-09 |
| Potential comparative toxic unit for humans (HTP-nc) | CTUh | 7,34E-07 | 7,86E-08 | 5,79E-08 |
| Potential soil quality index (SQP) | - | 2,35E+02 | 7,30E+01 | 9,48E+00 |

**PARAMETERS DESCRIBING RESOURCE USE (1 ton, LCC II 902 C35/45)**

| | | Life Cycle Stage | | |
|---|---|---|---|---|
| **Indicator** | **Unit** | **A1** | **A2** | **A3** |
| Use of renewable primary energy resources excluding renewable primary energy resources used as raw materials (PERE) | MJ, net calorific value | INA | INA | INA |
| Use of renewable primary energy resources used as raw materials (PERM) | MJ, net calorific value | INA | INA | INA |

| | | | | |
|---|---|---|---|---|
| Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials) (PERT) | MJ, net calorific value, | INA | INA | INA |
| Use of non-renewable primary energy resources excluding non-renewable primary energy resources used as raw materials (PEN-RE) | MJ, net calorific value, | 4,52E+02 | 9,79E+01 | 5,79E+01 |
| Use of non-renewable primary energy resources used as raw materials (RE) | MJ, net calorific value, | 0,00 | 0,00 | 0,00 |
| Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials) (PENRT) | MJ, net calorific value, | 4,52E+02 | 9,79E+01 | 5,79E+01 |
| Use of secondary material (SM) | kg | INA | INA | INA |
| Use of renewable secondary fuels (RSF) | MJ, net calorific value, | 3,68E+01 | INA | INA |
| Use of non-renewable secondary fuels (NRSF) | MJ, net calorific value, | 1,93E+02 | INA | INA |
| Net use of fresh water | $m^3$ | 1,06E+02 | 7,07E+00 | 6,24E+00 |

**ENVIRONMENTAL INFORMATION DESCRIBING WASTE AND OUTPUT FLOWS (1 ton, LCC II 902 C35/45)**

| | | Life Cycle Stage | | |
|---|---|---|---|---|
| **Indicator** | **Unit (expressed pre functional unit or per declared unit)** | **A1** | **A2** | **A3** |
| Hazardous waste disposed | kg | INA | INA | 7,80E-06 |
| Non-hazardous waste disposed | kg | INA | INA | 1,43E-06 |
| Radioactive waste disposed | kg | INA | INA | 0,00 |
| Components for re-use | kg | INA | INA | 0,00 |
| Materials for recycling | kg | INA | INA | 1,61E-07 |
| Materials for energy recovery | kg | INA | INA | 0,00 |
| Exported energy | MJ, net calorific value per energy carrier | INA | INA | 0,00 |

## Low Carbon Concrete II (LCC II 902 C35/45)
## 1 m³ of concrete mix, concrete grade C35/45 (ρ = 2317 kg/m³)

**CORE ENVIRONMENTAL IMPACT INDICATORS (1 m³, LCC II 902 C35/45)**

| | | Life Cycle Stage | | |
|---|---|---|---|---|
| **Indicator** | **Unit** | **A1** | **A2** | **A3** |
| Global Warming Potential total (GWP-total) | kg $CO_2$ eq. | 2,18E+02 | 1,55E+01 | 8,92E+00 |
| Global Warming Potential fossil fuels (GWP-fossil) | kg $CO_2$ eq. | 2,03E+02 | 1,54E+01 | 8,73E+00 |
| Global Warming Potential biogenic (GWP-biogenic) | kg $CO_2$ eq. | 1,54E+01 | 6,15E-02 | 1,82E-01 |
| Global Warming Potential land use and land change (GWP-luluc) | kg $CO_2$ eq. | 1,91E-01 | 6,29E-03 | 2,61E-03 |
| Depletion potential of the stratospheric ozone layer (ODP) | kg CFC11 eq. | 8,03E-06 | 3,51E-06 | 3,46E-07 |
| Acidification potential, Accumulated Exceedance (AP) | mol H+ eq. | 6,10E-01 | 4,48E-02 | 6,49E-02 |
| Eutrophication potential, fraction of nutritients reaching freshwater end compartment (EP-freshwater) | kg $PO_4$ eq. | 2,54E-02 | 1,21E-03 | 1,09E-02 |
| Eutrophication potential, fraction of nutritients reaching marine end compartment (EP-marine) | kg N eq. | 1,58E-01 | 9,21E-03 | 9,23E-03 |
| Eutrophication potential, Accumulated Exceedance (EP-terrestial) | mol N eq. | 1,79E+00 | 9,99E-02 | 7,94E-02 |
| Formation potential of tropospheric ozone (POCP) | kg NMVOC eq. | 4,14E-01 | 2,58E-02 | 2,13E-02 |
| Abiotic depletion potential for non-fossil resources (ADP-minerals&metals) | kg Sb eq. | 4,78E-04 | 5,07E-05 | 8,89E-06 |
| Abiotic depletion potential for fossil resources (ADP-fossil) | MJ, net calorific value | 1,22E+03 | 2,33E+02 | 1,10E+02 |
| Water (user) deprivation potential, deprivation-weighted water consumption (WDP) | WDP (m3 world eq. deprived) | 8,78E+01 | 8,08E-01 | 7,86E+00 |

**ADDITIONAL ENVIRONMENTAL IMPACT INDICATORS (1 m³, LCC II 902 C35/45)**

| | | Life Cycle Stage | | |
|---|---|---|---|---|
| **Indicator** | **Unit** | **A1** | **A2** | **A3** |
| Potential incidence of disease due to PM emissions (PM) | Disease incidence | 3,93E-06 | 9,79E-07 | 1,09E-07 |
| Potential human exposure efficiency relative to U235 (IRP) | kBq U235 eq. | 8,58E+00 | 1,30E+00 | 3,30E-01 |
| Potential comparative toxic unit for ecosystems (ETP-fw) | CTUe | 2,00E+03 | 1,85E+02 | 1,25E+02 |
| Potential comparative toxic unit for humans (HTP-c) | CTUh | 4,57E-08 | 5,66E-09 | 2,87E-09 |
| Potential comparative toxic unit for humans (HTP-nc) | CTUh | 1,68E-06 | 1,82E-07 | 1,34E-07 |
| Potential soil quality index (SQP) | - | 5,40E+02 | 1,69E+02 | 2,20E+01 |

**PARAMETERS DESCRIBING RESOURCE USE (1 m³, LCC II 902 C35/45)**

| | | Life Cycle Stage | | |
|---|---|---|---|---|
| **Indicator** | **Unit** | **A1** | **A2** | **A3** |
| Use of renewable primary energy resources excluding renewable primary energy resources used as raw materials (PERE) | MJ, net | INA | INA | INA |

| | | | | |
|---|---|---|---|---|
| | calorific value | | | |
| Use of renewable primary energy resources used as raw materials (PERM) | MJ, net calorific value | INA | INA | INA |
| Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials) (PERT) | MJ, net calorific value | INA | INA | INA |
| Use of non-renewable primary energy resources excluding non-renewable primary energy resources used as raw materials (PEN-RE) | MJ, net calorific value | 1,04E+03 | 2,27E+02 | 1,34E+02 |
| Use of non-renewable primary energy resources used as raw materials (RE) | MJ, net calorific value | 0,00 | 0,00 | 0,00 |
| Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials) (PENRT) | MJ, net calorific value | 1,04E+03 | 2,27E+02 | 1,34E+02 |
| Use of secondary material (SM) | kg | INA | INA | INA |
| Use of renewable secondary fuels (RSF) | MJ, net calorific value | 8,52E+01 | INA | INA |
| Use of non-renewable secondary fuels (NRSF) | MJ, net calorific value | 4,47E+02 | INA | INA |
| Net use of fresh water | $m^3$ | 2,30E+02 | 1,57E+01 | 1,47E+01 |

**PARAMETERS DESCRIBING WASTE AND OUTPUT FLOWS (1 $m^3$, LCC II 902 C35/45)**

| | | Life Cycle Stage | | |
|---|---|---|---|---|
| **Indicator** | **Unit ()** | **A1** | **A2** | **A3** |
| Hazardous waste disposed | kg | INA | INA | 1,81E-05 |
| Non-hazardous waste disposed | kg | INA | INA | 3,32E-06 |
| Radioactive waste disposed | kg | INA | INA | 0,00 |
| Components for re-use | kg | INA | INA | 0,00 |
| Materials for recycling | kg | INA | INA | 3,74E-07 |
| Materials for energy recovery | kg | INA | INA | 0,00 |
| Exported energy | MJ, net calorific value per energy carrier | INA | INA | 0,00 |

## Low Carbon Concrete II (LCC II 903 C30/37)
## 1 ton of concrete mix, concrete grade C30/37

**CORE ENVIRONMENTAL IMPACT INDICATORS (1 ton, LCC II 903 C30/37)**

| | | Life Cycle Stage | | |
|---|---|---|---|---|
| **Indicator** | **Unit** | **A1** | **A2** | **A3** |
| Global Warming Potential total (GWP-total) | kg $CO_2$ eq. | 8,94E+01 | 1,42E+01 | 3,85E+00 |
| Global Warming Potential fossil fuels (GWP-fossil) | kg $CO_2$ eq. | 8,30E+01 | 1,41E+01 | 3,77E+00 |
| Global Warming Potential biogenic (GWP-biogenic) | kg $CO_2$ eq. | 6,31E+00 | 5,74E-02 | 7,83E-02 |
| Global Warming Potential land use and land change (GWP-luluc) | kg $CO_2$ eq. | 7,86E-02 | 5,81E-03 | 1,13E-03 |
| Depletion potential of the stratospheric ozone layer (ODP) | kg CFC11 eq. | 7,86E-02 | 5,81E-03 | 1,13E-03 |
| Acidification potential, Accumulated Exceedance (AP) | mol H+ eq. | 2,50E-01 | 4,12E-02 | 2,80E-02 |
| Eutrophication potential, fraction of nutritients reaching freshwater end compartment (EP-freshwater) | kg $PO_4$ eq. | 1,04E-02 | 1,12E-03 | 4,69E-03 |
| Eutrophication potential, fraction of nutritients reaching marine end compartment (EP-marine) | kg N eq. | 6,51E-02 | 8,46E-03 | 3,98E-03 |
| Eutrophication potential, Accumulated Exceedance (EP-terrestial) | mol N eq. | 7,38E-01 | 9,18E-02 | 3,42E-02 |
| Formation potential of tropospheric ozone (POCP) | kg NMVOC eq. | 1,70E-01 | 2,37E-02 | 9,18E-03 |
| Abiotic depletion potential for non-fossil resources (ADP-minerals&metals) | kg Sb eq. | 2,04E-04 | 4,65E-05 | 3,83E-06 |
| Abiotic depletion potential for fossil resources (ADP-fossil) | MJ, net calorific value | 4,90E+02 | 2,14E+02 | 4,72E+01 |
| Water (user) deprivation potential, deprivation-weighted water consumption (WDP) | WDP (m3 world eq. deprived) | 3,73E+01 | 7,46E-01 | 3,35E+00 |

**ADDITIONAL ENVIRONMENTAL IMPACT INDICATORS (1 ton, LCC II 903 C30/37)**

| | | Life Cycle Stage | | |
|---|---|---|---|---|
| **Indicator** | **Unit** | **A1** | **A2** | **A3** |
| Potential incidence of disease due to PM emissions (PM) | Disease incidence | 1,62E-06 | 8,96E-07 | 4,71E-08 |
| Potential human exposure efficiency relative to U235 (IRP) | kBq U235 eq. | 3,53E+00 | 1,19E+00 | 1,42E-01 |
| Potential comparative toxic unit for ecosystems (ETP-fw) | CTUe | 8,23E+02 | 1,70E+02 | 5,38E+01 |
| Potential comparative toxic unit for humans (HTP-c) | CTUh | 1,86E-08 | 5,21E-09 | 1,23E-09 |
| Potential comparative toxic unit for humans (HTP-nc) | CTUh | 6,96E-07 | 1,67E-07 | 5,78E-08 |
| Potential soil quality index (SQP) | - | 2,28E+02 | 1,55E+02 | 9,47E+00 |

**PARAMETERS DESCRIBING RESOURCE USE (1 ton, LCC II 903 C30/37)**

| | | Life Cycle Stage | | |
|---|---|---|---|---|
| **Indicator** | **Unit** | **A1** | **A2** | **A3** |
| Use of renewable primary energy resources excluding renewable primary energy resources used as raw materials (PERE) | MJ, net calorific value | INA | INA | INA |
| Use of renewable primary energy resources used as raw materials (PERM) | MJ, net | INA | INA | INA |

| | | | | |
|---|---|---|---|---|
| | calorific value | | | |
| Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials) (PERT) | MJ, net calorific value | INA | INA | INA |
| Use of non-renewable primary energy resources excluding non-renewable primary energy resources used as raw materials (PEN-RE) | MJ, net calorific value | 4,20E+02 | 2,08E+02 | 5,79E+01 |
| Use of non-renewable primary energy resources used as raw materials (RE) | MJ, net calorific value | 0,00 | 0,00 | 0,00 |
| Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials) (PENRT) | MJ, net calorific value | 4,20E+02 | 2,08E+02 | 5,79E+01 |
| Use of secondary material (SM) | kg | INA | INA | INA |
| Use of renewable secondary fuels (RSF) | MJ, net calorific value | 3,50E+01 | INA | INA |
| Use of non-renewable secondary fuels (NRSF) | MJ, net calorific value | 1,84E+02 | INA | INA |
| Net use of fresh water | $m^3$ | 1,00E+02 | 1,52E+01 | 6,23E+00 |

**PARAMETERS DESCRIBING WASTE AND OUTPUT FLOWS (1 ton, LCC II 903 C30/37)**

| | | Life Cycle Stage | | |
|---|---|---|---|---|
| **Indicator** | **Unit (expressed pre functional unit or per declared unit)** | **A1** | **A2** | **A3** |
| Hazardous waste disposed | kg | INA | INA | 1,76E-05 |
| Non-hazardous waste disposed | kg | INA | INA | 3,23E-06 |
| Radioactive waste disposed | kg | INA | INA | 0,00 |
| Components for re-use | kg | INA | INA | 0,00 |
| Materials for recycling | kg | INA | INA | 3,74E-07 |
| Materials for energy recovery | kg | INA | INA | 0,00 |
| Exported energy | MJ, net calorific value per energy carrier | INA | INA | 0,00 |

## Low Carbon Concrete II (LCC II 903 C30/37)
## 1 $m^3$ of concrete mix, concrete grade C30/37 ($\rho$ = 2319 kg/$m^3$)

**CORE ENVIRONMENTAL IMPACT INDICATORS (1 $m^3$, LCC II 903 C30/37)**

| | | Life Cycle Stage | | |
|---|---|---|---|---|
| **Indicator** | **Unit** | **A1** | **A2** | **A3** |
| Global Warming Potential total (GWP-total) | kg $CO_2$ eq. | 2,07E+02 | 3,29E+01 | 8,92E+00 |
| Global Warming Potential fossil fuels (GWP-fossil) | kg $CO_2$ eq. | 1,92E+02 | 3,27E+01 | 8,74E+00 |
| Global Warming Potential biogenic (GWP-biogenic) | kg $CO_2$ eq. | 1,46E+01 | 1,33E-01 | 1,82E-01 |
| Global Warming Potential land use and land change (GWP-luluc) | kg $CO_2$ eq. | 1,82E-01 | 1,35E-02 | 2,62E-03 |
| Depletion potential of the stratospheric ozone layer (ODP) | kg CFC11 eq. | 7,59E-06 | 7,45E-06 | 3,46E-07 |
| Acidification potential, Accumulated Exceedance (AP) | mol H+ eq. | 5,79E-01 | 9,54E-02 | 6,49E-02 |
| Eutrophication potential, fraction of nutritients reaching freshwater end compartment (EP-freshwater) | kg $PO_4$ eq. | 2,40E-02 | 2,60E-03 | 1,09E-02 |
| Eutrophication potential, fraction of nutritients reaching marine end compartment (EP-marine) | kg N eq. | 1,51E-01 | 1,96E-02 | 9,23E-03 |
| Eutrophication potential, Accumulated Exceedance (EP-terrestial) | mol N eq. | 1,71E+00 | 2,13E-01 | 7,94E-02 |
| Formation potential of tropospheric ozone (POCP) | kg NMVOC eq. | 3,94E-01 | 5,49E-02 | 2,13E-02 |
| Abiotic depletion potential for non-fossil resources (ADP-minerals&metals) | kg Sb eq. | 4,51E-04 | 1,08E-04 | 8,91E-06 |
| Abiotic depletion potential for fossil resources (ADP-fossil) | MJ, net calorific value | 1,14E+03 | 4,96E+02 | 1,10E+02 |
| Water (user) deprivation potential, deprivation-weighted water consumption (WDP) | WDP (m3 world eq. deprived) | 8,66E+01 | 1,73E+00 | 8,20E+00 |

**ADDITIONAL ENVIRONMENTAL IMPACT INDICATORS (1 $m^3$, LCC II 903 C30/37)**

| | | Life Cycle Stage | | |
|---|---|---|---|---|
| **Indicator** | **Unit** | **A1** | **A2** | **A3** |
| Potential incidence of disease due to PM emissions (PM) | Disease incidence | 3,74E-06 | 2,08E-06 | 1,09E-07 |
| Potential human exposure efficiency relative to U235 (IRP) | kBq U235 eq. | 8,18E+00 | 2,77E+00 | 3,31E-01 |
| Potential comparative toxic unit for ecosystems (ETP-fw) | CTUe | 1,90E+03 | 3,94E+02 | 1,25E+02 |
| Potential comparative toxic unit for humans (HTP-c) | CTUh | 4,26E-08 | 1,21E-08 | 2,88E-09 |
| Potential comparative toxic unit for humans (HTP-nc) | CTUh | 1,60E-06 | 3,87E-07 | 1,34E-07 |
| Potential soil quality index (SQP) | - | 5,24E+02 | 3,59E+02 | 2,20E+01 |

**PARAMETERS DESCRIBING RESOURCE USE (1 $m^3$, LCC II 903 C30/37)**

| | | Life Cycle Stage | | |
|---|---|---|---|---|
| **Indicator** | **Unit** | **A1** | **A2** | **A3** |
| Use of renewable primary energy resources excluding renewable primary energy resources used as raw materials (PERE) | MJ, net | INA | INA | INA |

| | | | | |
|---|---|---|---|---|
| | calorific value | | | |
| Use of renewable primary energy resources used as raw materials (PERM) | MJ, net calorific value | INA | INA | INA |
| Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials) (PERT) | MJ, net calorific value | INA | INA | INA |
| Use of non-renewable primary energy resources excluding non-renewable primary energy resources used as raw materials (PEN-RE) | MJ, net calorific value | 9,74E+02 | 4,82E+02 | 1,34E+02 |
| Use of non-renewable primary energy resources used as raw materials (RE) | MJ, net calorific value | 0,00 | 0,00 | 0,00 |
| Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials) (PENRT) | MJ, net calorific value | 9,74E+02 | 4,82E+02 | 1,34E+02 |
| Use of secondary material (SM) | kg | INA | INA | INA |
| Use of renewable secondary fuels (RSF) | MJ, net calorific value | 8,12E+01 | INA | INA |
| Use of non-renewable secondary fuels (NRSF) | MJ, net calorific value | 4,26E+02 | INA | INA |
| Net use of fresh water | $m^3$ | 2,32E+02 | 3,53E+01 | 1,45E+01 |

**PARAMETERS DESCRIBING WASTE AND OUTPUT FLOWS (1 $m^3$, LCC II 903 C30/37)**

| | | Life Cycle Stage | | |
|---|---|---|---|---|
| **Indicator** | **Unit (expressed pre functional unit or per declared unit)** | **A1** | **A2** | **A3** |
| Hazardous waste disposed | kg | INA | INA | 4,09E-05 |
| Non-hazardous waste disposed | kg | INA | INA | 7,50E-06 |
| Radioactive waste disposed | kg | INA | INA | 0,00 |
| Components for re-use | kg | INA | INA | 0,00 |
| Materials for recycling | kg | INA | INA | 8,45E-07 |
| Materials for energy recovery | kg | INA | INA | 0,00 |
| Exported energy | MJ, net calorific value per energy carrier | INA | INA | 0,00 |

## Low Carbon Concrete III (LCC III 904 C35/45)
## 1 ton of concrete mix, concrete grade C35/45

**CORE ENVIRONMENTAL IMPACT INDICATORS (1 ton, LCC III 904 C35/45)**

| | | Life Cycle Stage | | |
|---|---|---|---|---|
| **Indicator** | **Unit** | **A1** | **A2** | **A3** |
| Global Warming Potential total (GWP-total) | kg $CO_2$ eq. | 5,94E+01 | 2,82E+01 | 3,84E+00 |
| Global Warming Potential fossil fuels (GWP-fossil) | kg $CO_2$ eq. | 5,61E+01 | 2,81E+01 | 3,76E+00 |
| Global Warming Potential biogenic (GWP-biogenic) | kg $CO_2$ eq. | 3,27E+00 | 1,21E-01 | 7,81E-02 |
| Global Warming Potential land use and land change (GWP-luluc) | kg $CO_2$ eq. | 7,78E-02 | 1,19E-02 | 1,12E-03 |
| Depletion potential of the stratospheric ozone layer (ODP) | kg CFC11 eq. | 3,07E-06 | 6,38E-06 | 1,49E-07 |
| Acidification potential, Accumulated Exceedance (AP) | mol H+ eq. | 2,23E-01 | 8,25E-02 | 2,79E-02 |
| Eutrophication potential, fraction of nutritients reaching freshwater end compartment (EP-freshwater) | kg $PO_4$ eq. | 1,13E-02 | 2,34E-03 | 4,68E-03 |
| Eutrophication potential, fraction of nutritients reaching marine end compartment (EP-marine) | kg N eq. | 5,21E-02 | 1,70E-02 | 3,97E-03 |
| Eutrophication potential, Accumulated Exceedance (EP-terrestial) | mol N eq. | 5,69E-01 | 1,84E-01 | 3,41E-02 |
| Formation potential of tropospheric ozone (POCP) | kg NMVOC eq. | 1,43E-01 | 4,75E-02 | 9,16E-03 |
| Abiotic depletion potential for non-fossil resources (ADP-minerals&metals) | kg Sb eq. | 8,00E-04 | 9,31E-05 | 3,82E-06 |
| Abiotic depletion potential for fossil resources (ADP-fossil) | MJ, net calorific value | 4,87E+02 | 4,26E+02 | 4,71E+01 |
| Water (user) deprivation potential, deprivation-weighted water consumption (WDP) | WDP (m3 world eq. deprived) | 3,78E+01 | 1,52E+00 | 3,34E+00 |

**ADDITIONAL ENVIRONMENTAL IMPACT INDICATORS (1 ton, LCC III 904 C35/45)**

| | | Life Cycle Stage | | |
|---|---|---|---|---|
| **Indicator** | **Unit** | **A1** | **A2** | **A3** |
| Potential incidence of disease due to PM emissions (PM) | Disease incidence | 2,09E-06 | 1,78E-06 | 4,71E-08 |
| Potential human exposure efficiency relative to U235 (IRP) | kBq U235 eq. | 3,62E+00 | 2,42E+00 | 1,42E-01 |
| Potential comparative toxic unit for ecosystems (ETP-fw) | CTUe | 8,10E+02 | 3,39E+02 | 5,37E+01 |
| Potential comparative toxic unit for humans (HTP-c) | CTUh | 4,73E-08 | 1,05E-08 | 1,23E-09 |
| Potential comparative toxic unit for humans (HTP-nc) | CTUh | 7,61E-07 | 3,33E-07 | 5,77E-08 |
| Potential soil quality index (SQP) | - | 2,34E+02 | 3,09E+02 | 9,45E+00 |

**PARAMETERS DESCRIBING RESOURCE USE (1 ton, LCC III 904 C35/45)**

| | | Life Cycle Stage | | |
|---|---|---|---|---|
| **Indicator** | **Unit** | **A1** | **A2** | **A3** |
| Use of renewable primary energy resources excluding renewable primary energy resources used as raw materials (PERE) | MJ, net calorific value | INA | INA | INA |
| Use of renewable primary energy resources used as raw materials (PERM) | MJ, net calorific value | INA | INA | INA |

| | | | | |
|---|---|---|---|---|
| Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials) (PERT) | MJ, net calorific value | INA | INA | INA |
| Use of non-renewable primary energy resources excluding non-renewable primary energy resources used as raw materials (PEN-RE) | MJ, net calorific value | 3,90E+02 | 4,13E+02 | 5,77E+01 |
| Use of non-renewable primary energy resources used as raw materials (RE) | MJ, net calorific value | 0,00 | 0,00 | 0,00 |
| Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials) (PENRT) | MJ, net calorific value | 3,90E+02 | 4,13E+02 | 5,77E+01 |
| Use of secondary material (SM) | kg | INA | INA | INA |
| Use of renewable secondary fuels (RSF) | MJ, net calorific value | 1,66E+01 | INA | INA |
| Use of non-renewable secondary fuels (NRSF) | MJ, net calorific value | 8,74E+01 | INA | INA |
| Net use of fresh water | $m^3$ | 1,05E+02 | 3,15E+01 | 6,22E+00 |

**PARAMETERS DESCRIBING WASTE AND OUTPUT FLOWS (1 ton, LCC III 904 C35/45)**

| | | Life Cycle Stage | | |
|---|---|---|---|---|
| **Indicator** | **Unit (expressed pre functional unit or per declared unit)** | **A1** | **A2** | **A3** |
| Hazardous waste disposed | kg | INA | INA | 4,13E-05 |
| Non-hazardous waste disposed | kg | INA | INA | 7,57E-06 |
| Radioactive waste disposed | kg | INA | INA | 0,00 |
| Components for re-use | kg | INA | INA | 0,00 |
| Materials for recycling | kg | INA | INA | 8,53E-07 |
| Materials for energy recovery | kg | INA | INA | 0,00 |
| Exported energy | MJ, net calorific value per energy carrier | INA | INA | 0,00 |

## Low Carbon Concrete II (LCC III 904 C35/45)
## 1 $m^3$ of concrete mix, concrete grade C35/45 ($\rho$ = 2325 kg/$m^3$)

**CORE ENVIRONMENTAL IMPACT INDICATORS (1 $m^3$, LCC III 904 C35/45)**

| | | Life Cycle Stage | | |
|---|---|---|---|---|
| **Indicator** | **Unit** | **A1** | **A2** | **A3** |
| Global Warming Potential total (GWP-total) | kg $CO_2$ eq. | 1,36E+02 | 6,56E+01 | 8,93E+00 |
| Global Warming Potential fossil fuels (GWP-fossil) | kg $CO_2$ eq. | 1,28E+02 | 6,53E+01 | 8,74E+00 |
| Global Warming Potential biogenic (GWP-biogenic) | kg $CO_2$ eq. | 7,64E+00 | 2,81E-01 | 1,82E-01 |
| Global Warming Potential land use and land change (GWP-luluc) | kg $CO_2$ eq. | 1,80E-01 | 2,76E-02 | 2,61E-03 |
| Depletion potential of the stratospheric ozone layer (ODP) | kg CFC11 eq. | 6,84E-06 | 1,48E-05 | 3,46E-07 |
| Acidification potential, Accumulated Exceedance (AP) | mol H+ eq. | 4,94E-01 | 1,92E-01 | 6,49E-02 |
| Eutrophication potential, fraction of nutritients reaching freshwater end compartment (EP-freshwater) | kg $PO_4$ eq. | 2,61E-02 | 5,43E-03 | 1,09E-02 |
| Eutrophication potential, fraction of nutritients reaching marine end compartment (EP-marine) | kg N eq. | 1,15E-01 | 3,95E-02 | 9,23E-03 |
| Eutrophication potential, Accumulated Exceedance (EP-terrestial) | mol N eq. | 1,26E+00 | 4,28E-01 | 7,94E-02 |
| Formation potential of tropospheric ozone (POCP) | kg NMVOC eq. | 3,15E-01 | 1,10E-01 | 2,13E-02 |
| Abiotic depletion potential for non-fossil resources (ADP-minerals&metals) | kg Sb eq. | 1,84E-03 | 2,17E-04 | 8,89E-06 |
| Abiotic depletion potential for fossil resources (ADP-fossil) | MJ, net calorific value | 1,09E+03 | 9,90E+02 | 1,10E+02 |
| Water (user) deprivation potential, deprivation-weighted water consumption (WDP) | WDP (m3 world eq. deprived) | 8,75E+01 | 3,54E+00 | 7,77E+00 |

**ADDITIONAL ENVIRONMENTAL IMPACT INDICATORS (1 $m^3$, LCC III 904 C35/45)**

| | | Life Cycle Stage | | |
|---|---|---|---|---|
| **Indicator** | **Unit** | **A1** | **A2** | **A3** |
| Potential incidence of disease due to PM emissions (PM) | Disease incidence | 4,60E-06 | 4,14E-06 | 1,10E-07 |
| Potential human exposure efficiency relative to U235 (IRP) | kBq U235 eq. | 7,98E+00 | 5,62E+00 | 3,29E-01 |
| Potential comparative toxic unit for ecosystems (ETP-fw) | CTUe | 1,86E+03 | 7,89E+02 | 1,25E+02 |
| Potential comparative toxic unit for humans (HTP-c) | CTUh | 1,09E-07 | 2,45E-08 | 2,86E-09 |
| Potential comparative toxic unit for humans (HTP-nc) | CTUh | 1,75E-06 | 7,74E-07 | 1,34E-07 |
| Potential soil quality index (SQP) | - | 5,39E+02 | 7,18E+02 | 2,20E+01 |

**PARAMETERS DESCRIBING RESOURCE USE (1 $m^3$, LCC III 904 C35/45)**

| | | Life Cycle Stage | | |
|---|---|---|---|---|
| **Indicator** | **Unit** | **A1** | **A2** | **A3** |
| Use of renewable primary energy resources excluding renewable primary energy resources used as raw materials (PERE) | MJ, net calorific value | INA | INA | INA |
| Use of renewable primary energy resources used as raw materials (PERM) | MJ, net calorific value | INA | INA | INA |

| | | | | |
|---|---|---|---|---|
| Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials) (PERT) | MJ, net calorific value | INA | INA | INA |
| Use of non-renewable primary energy resources excluding non-renewable primary energy resources used as raw materials (PEN-RE) | MJ, net calorific value | 9,02E+02 | 9,60E+02 | 1,34E+02 |
| Use of non-renewable primary energy resources used as raw materials (RE) | MJ, net calorific value | 0,00 | 0,00 | 0,00 |
| Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials) (PENRT) | MJ, net calorific value | 9,02E+02 | 9,60E+02 | 1,34E+02 |
| Use of secondary material (SM) | kg | INA | INA | INA |
| Use of renewable secondary fuels (RSF) | MJ, net calorific value | 3,87E+01 | INA | INA |
| Use of non-renewable secondary fuels (NRSF) | MJ, net calorific value | 2,03E+02 | INA | INA |
| Net use of fresh water | $m^3$ | 2,43E+02 | 7,32E+01 | 1,45E+01 |

**PARAMETERS DESCRIBING WASTE AND OUTPUT FLOWS (1 $m^3$, LCC III 904 C35/45)**

| | | Life Cycle Stage | | |
|---|---|---|---|---|
| **Indicator** | **Unit (expressed pre functional unit or per declared unit)** | **A1** | **A2** | **A3** |
| Hazardous waste disposed | kg | INA | INA | 9,59E-05 |
| Non-hazardous waste disposed | kg | INA | INA | 1,76E-05 |
| Radioactive waste disposed | kg | INA | INA | 0,00 |
| Components for re-use | kg | INA | INA | 0,00 |
| Materials for recycling | kg | INA | INA | 1,98E-06 |
| Materials for energy recovery | kg | INA | INA | 0,00 |
| Exported energy | MJ, net calorific value per energy carrier | INA | INA | 0,00 |

## Low Carbon Concrete III (LCC III 905 C30/37)
## 1 ton of concrete mix, concrete grade C30/37

**CORE ENVIRONMENTAL IMPACT INDICATORS (1 ton, LCC III 905 C30/37)**

| | | Life Cycle Stage | | |
|---|---|---|---|---|
| **Indicator** | **Unit** | **A1** | **A2** | **A3** |
| Global Warming Potential total (GWP-total) | kg $CO_2$ eq. | 5,59E+01 | 2,43E+01 | 3,83E+00 |
| Global Warming Potential fossil fuels (GWP-fossil) | kg $CO_2$ eq. | 5,27E+01 | 2,42E+01 | 3,76E+00 |
| Global Warming Potential biogenic (GWP-biogenic) | kg $CO_2$ eq. | 3,15E+00 | 1,06E-01 | 7,80E-02 |
| Global Warming Potential land use and land change (GWP-luluc) | kg $CO_2$ eq. | 7,48E-02 | 1,03E-02 | 1,12E-03 |
| Depletion potential of the stratospheric ozone layer (ODP) | kg CFC11 eq. | 2,82E-06 | 5,49E-06 | 1,49E-07 |
| Acidification potential, Accumulated Exceedance (AP) | mol H+ eq. | 2,04E-01 | 7,12E-02 | 2,79E-02 |
| Eutrophication potential, fraction of nutritients reaching freshwater end compartment (EP-freshwater) | kg $PO_4$ eq. | 1,08E-02 | 2,04E-03 | 4,68E-03 |
| Eutrophication potential, fraction of nutritients reaching marine end compartment (EP-marine) | kg N eq. | 4,79E-02 | 1,47E-02 | 3,97E-03 |
| Eutrophication potential, Accumulated Exceedance (EP-terrestial) | mol N eq. | 5,22E-01 | 1,59E-01 | 3,41E-02 |
| Formation potential of tropospheric ozone (POCP) | kg NMVOC eq. | 1,30E-01 | 4,10E-02 | 9,15E-03 |
| Abiotic depletion potential for non-fossil resources (ADP-minerals&metals) | kg Sb eq. | 7,68E-04 | 8,04E-05 | 3,82E-06 |
| Abiotic depletion potential for fossil resources (ADP-fossil) | MJ, net calorific value | 4,42E+02 | 3,67E+02 | 4,71E+01 |
| Water (user) deprivation potential, deprivation-weighted water consumption (WDP) | WDP (m3 world eq. deprived) | 3,73E+01 | 1,32E+00 | 3,30E+00 |

**ADDITIONAL ENVIRONMENTAL IMPACT INDICATORS (1 ton, LCC III 905 C30/37)**

| | | Life Cycle Stage | | |
|---|---|---|---|---|
| **Indicator** | **Unit** | **A1** | **A2** | **A3** |
| Potential incidence of disease due to PM emissions (PM) | Disease incidence | 1,91E-06 | 1,54E-06 | 4,70E-08 |
| Potential human exposure efficiency relative to U235 (IRP) | kBq U235 eq. | 3,31E+00 | 2,10E+00 | 1,41E-01 |
| Potential comparative toxic unit for ecosystems (ETP-fw) | CTUe | 7,71E+02 | 2,93E+02 | 5,36E+01 |
| Potential comparative toxic unit for humans (HTP-c) | CTUh | 4,52E-08 | 9,11E-09 | 1,23E-09 |
| Potential comparative toxic unit for humans (HTP-nc) | CTUh | 7,27E-07 | 2,87E-07 | 5,76E-08 |
| Potential soil quality index (SQP) | - | 2,28E+02 | 2,66E+02 | 9,44E+00 |

**PARAMETERS DESCRIBING RESOURCE USE (1 ton, LCC III 905 C30/37)**

| | | Life Cycle Stage | | |
|---|---|---|---|---|
| **Indicator** | **Unit** | **A1** | **A2** | **A3** |
| Use of renewable primary energy resources excluding renewable primary energy resources used as raw materials (PERE) | MJ, net calorific value | INA | INA | INA |
| Use of renewable primary energy resources used as raw materials (PERM) | MJ, net calorific value | INA | INA | INA |

| | | | | |
|---|---|---|---|---|
| Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials) (PERT) | MJ, net calorific value | INA | INA | INA |
| Use of non-renewable primary energy resources excluding non-renewable primary energy resources used as raw materials (PEN-RE) | MJ, net calorific value | 3,68E+02 | 3,56E+02 | 5,77E+01 |
| Use of non-renewable primary energy resources used as raw materials (RE) | MJ, net calorific value | 0,00 | 0,00 | 0,00 |
| Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials) (PENRT) | MJ, net calorific value | 3,68E+02 | 3,56E+02 | 5,77E+01 |
| Use of secondary material (SM) | kg | INA | INA | INA |
| Use of renewable secondary fuels (RSF) | MJ, net calorific value | 1,60E+01 | INA | INA |
| Use of non-renewable secondary fuels (NRSF) | MJ, net calorific value | 8,41E+01 | INA | INA |
| Net use of fresh water | $m^3$ | 1,01E+02 | 2,75E+01 | 6,21E+00 |

**PARAMETERS DESCRIBING WASTE AND OUTPUT FLOWS (1 ton, LCC III 905 C30/37)**

| | | Life Cycle Stage | | |
|---|---|---|---|---|
| **Indicator** | **Unit (expressed pre functional unit or per declared unit)** | **A1** | **A2** | **A3** |
| Hazardous waste disposed | kg | INA | INA | 3,72E-05 |
| Non-hazardous waste disposed | kg | INA | INA | 6,82E-06 |
| Radioactive waste disposed | kg | INA | INA | 0,00 |
| Components for re-use | kg | INA | INA | 0,00 |
| Materials for recycling | kg | INA | INA | 7,69E-07 |
| Materials for energy recovery | kg | INA | INA | 0,00 |
| Exported energy | MJ, net calorific value per energy carrier | INA | INA | 0,00 |

## Low Carbon Concrete III (LCC III 905 C30/37)
## 1 m³ of concrete mix, concrete grade C30/37 (ρ = 2328 kg/m³)

**CORE ENVIRONMENTAL IMPACT INDICATORS (1 m³, LCC III 905 C30/37)**

| | | Life Cycle Stage | | |
|---|---|---|---|---|
| **Indicator** | **Unit** | **A1** | **A2** | **A3** |
| Global Warming Potential total (GWP-total) | kg $CO_2$ eq. | 1,30E+02 | 5,66E+01 | 8,92E+00 |
| Global Warming Potential fossil fuels (GWP-fossil) | kg $CO_2$ eq. | 1,23E+02 | 5,64E+01 | 8,74E+00 |
| Global Warming Potential biogenic (GWP-biogenic) | kg $CO_2$ eq. | 7,35E+00 | 2,47E-01 | 1,82E-01 |
| Global Warming Potential land use and land change (GWP-luluc) | kg $CO_2$ eq. | 1,74E-01 | 2,40E-02 | 2,61E-03 |
| Depletion potential of the stratospheric ozone layer (ODP) | kg CFC11 eq. | 6,56E-06 | 1,28E-05 | 3,46E-07 |
| Acidification potential, Accumulated Exceedance (AP) | mol H+ eq. | 4,75E-01 | 1,66E-01 | 6,49E-02 |
| Eutrophication potential, fraction of nutritients reaching freshwater end compartment (EP-freshwater) | kg $PO_4$ eq. | 2,51E-02 | 4,75E-03 | 1,09E-02 |
| Eutrophication potential, fraction of nutritients reaching marine end compartment (EP-marine) | kg N eq. | 1,11E-01 | 3,42E-02 | 9,23E-03 |
| Eutrophication potential, Accumulated Exceedance (EP-terrestial) | mol N eq. | 1,21E+00 | 3,70E-01 | 7,94E-02 |
| Formation potential of tropospheric ozone (POCP) | kg NMVOC eq. | 3,03E-01 | 9,55E-02 | 2,13E-02 |
| Abiotic depletion potential for non-fossil resources (ADP-minerals&metals) | kg Sb eq. | 1,77E-03 | 1,87E-04 | 8,89E-06 |
| Abiotic depletion potential for fossil resources (ADP-fossil) | MJ, net calorific value | 1,03E+03 | 8,55E+02 | 1,10E+02 |
| Water (user) deprivation potential, deprivation-weighted water consumption (WDP) | WDP (m3 world eq. deprived) | 8,70E+01 | 3,08E+00 | 7,69E+00 |

**ADDITIONAL ENVIRONMENTAL IMPACT INDICATORS (1 m³, LCC III 905 C30/37)**

| | | Life Cycle Stage | | |
|---|---|---|---|---|
| **Indicator** | **Unit** | **A1** | **A2** | **A3** |
| Potential incidence of disease due to PM emissions (PM) | Disease incidence | 4,44E-06 | 3,57E-06 | 1,09E-07 |
| Potential human exposure efficiency relative to U235 (IRP) | kBq U235 eq. | 7,69E+00 | 4,88E+00 | 3,29E-01 |
| Potential comparative toxic unit for ecosystems (ETP-fw) | CTUe | 1,79E+03 | 6,82E+02 | 1,25E+02 |
| Potential comparative toxic unit for humans (HTP-c) | CTUh | 1,05E-07 | 2,12E-08 | 2,86E-09 |
| Potential comparative toxic unit for humans (HTP-nc) | CTUh | 1,68E-06 | 6,69E-07 | 1,34E-07 |
| Potential soil quality index (SQP) | - | 5,27E+02 | 6,20E+02 | 2,20E+01 |

**PARAMETERS DESCRIBING RESOURCE USE (1 m³, LCC III 905 C30/37)**

| | | Life Cycle Stage | | |
|---|---|---|---|---|
| **Indicator** | **Unit** | **A1** | **A2** | **A3** |
| Use of renewable primary energy resources excluding renewable primary energy resources used as raw materials (PERE) | MJ, net calorific value | INA | INA | INA |
| Use of renewable primary energy resources used as raw materials (PERM) | MJ, net calorific value | INA | INA | INA |

| | | | | |
|---|---|---|---|---|
| Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials) (PERT) | MJ, net calorific value | INA | INA | INA |
| Use of non-renewable primary energy resources excluding non-renewable primary energy resources used as raw materials (PEN-RE) | MJ, net calorific value | 8,59E+02 | 8,28E+02 | 1,34E+02 |
| Use of non-renewable primary energy resources used as raw materials (RE) | MJ, net calorific value | 0,00 | 0,00 | 0,00 |
| Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials) (PENRT) | MJ, net calorific value | 8,59E+02 | 8,28E+02 | 1,34E+02 |
| Use of secondary material (SM) | kg | INA | INA | INA |
| Use of renewable secondary fuels (RSF) | MJ, net calorific value | 3,73E+01 | INA | INA |
| Use of non-renewable secondary fuels (NRSF) | MJ, net calorific value | 1,96E+02 | INA | INA |
| Net use of fresh water | $m^3$ | 2,34E+02 | 6,40E+01 | 1,44E+01 |

**PARAMETERS DESCRIBING WASTE AND OUTPUT FLOWS (1 $m^3$, LCC III 905 C30/37)**

| | | Life Cycle Stage | | |
|---|---|---|---|---|
| **Indicator** | **Unit (expressed pre functional unit or per declared unit)** | **A1** | **A2** | **A3** |
| Hazardous waste disposed | kg | INA | INA | 8,65E-05 |
| Non-hazardous waste disposed | kg | INA | INA | 1,59E-05 |
| Radioactive waste disposed | kg | INA | INA | 0,00 |
| Components for re-use | kg | INA | INA | 0,00 |
| Materials for recycling | kg | INA | INA | 1,79E-06 |
| Materials for energy recovery | kg | INA | INA | 0,00 |
| Exported energy | MJ, net calorific value per energy carrier | INA | INA | 0,00 |

## 6. INTERPRETATION OF RESULTS

he LCA analysis proved that the processes related to the acquisition of raw materials and semi-finished products (A1) have the greatest impact on the value of the environmental impact indicators. The process with the greatest impact on the values of the impact category is the production of cement, and in particular the clinker component of cement. Due to the fact that LCC II and LCC III concrete use different types of cement (LCC II - CEM II / B with 21-35% addition of fly ash, which are treated as environmentally neutral, and LCC III - CEM III / A with 36- 65% addition of blast furnace slag, which is also considered environmentally neutral). The amounts of the remaining concrete components are at a very similar level, which in combination with the same production technology gives similar values of the impact category in module A1.

The impact of transport to the plant (A2) is different for different types of concrete. This is due to the different allocation of the material supplied to the plant for individual types of analyzed concrete. The materials are delivered to the plant from Poland, so the delivery distances are relatively small, which results in a relatively small impact on the values of the impact category.

Due to the nature of the production process, which mainly consists in mixing ingredients, the impact indicators in the A3 module are the lowest in all analyzed products. The client himself has no major influence on the values of the environmental impact indicators, as it depends on external entities.

## 7. REFERENCES


- ✓ PN-EN ISO 14025: 2014-04, Environmental labels and declarations - Type III environmental declarations - Rules and procedures.
- ✓ PN-EN 15804 + A2: 2020, Sustainability of construction works - Environmental product declarations - Basic rules for categorizing construction products.
- ✓ PN-EN 16757: 2017, Sustainable nature of construction works. Environmental product declarations. Product Categorization Rules for concrete and concrete products.
- ✓ PN-EN ISO 14040: 2009 Environmental management. Life Cycle Assessment. Principles and structure.
- ✓ PN-EN ISO 14044: 2009, Environmental management. Life Cycle Assessment. Requirements and guidelines.
- ✓ EN 15942: 2012, Sustainability of construction works - Environmental product declarations - Communication format business-to-business.
- ✓ Data from company website: www.warbud-beton.pl


Explanatory materials can be acquired by contacting a Warbud Beton representative directly.

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of Ceramics
and Building
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PROCESS ENGINEERING RESEARCH GROUP

# TYPE III ENVIRONMENTAL DECLARATION CERTIFICATE

## No. 01-08/2022

**Product:**

**Concrete mixes**
**LOW CARBON CONCRETE II**
**LOW CARBON CONCRETE III**

**Owner:**

**Warbud Beton Sp. z.o.o.**
**Gniewkowska 44 Str.**
**01-253 Warsaw**

The declaration was developed in accordance with the requirements of the standard:

**PN-EN 15804+A2: 2020-03**

Sustainability of construction works
Environmental product declarations
Core rules for the product category of construction products

The declaration was verified in accordance with the requirements of the standard:

**PN-EN ISO 14025:2010**

Environmental labels and declarations
Type III environmental declarations. Principles and procedures

The certificate was issued for the first time on **August 10, 2022** and is valid for 5 years or until the said EPD is amended.

**Process Engineering Research Group Leader**

Ewa Głodek-Bucyk, PhD Eng.

**Director of Center Of Environmental Engineering**

Joanna Poluszyńska, PhD

**Opole,** August 2022