ENVIRONMENTAL PRODUCT DECLARATION

in accordance with *ISO 14025* and *EN 15804+A2*

Declaration owner	**BAUER Spezialtiefbau GmbH**
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BAUER MIP® Class I

BAUER Spezialtiefbau GmbH

Institut Bauen und Umwelt e.V.

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1. General information

BAUER Spezialtiefbau GmbH

Program operator
IBU - Institut Bauen und Umwelt e.V.
Hegelplatz 1
10117 Berlin
Germany

Declaration number
EPD-BAU-20220299-ICC1-DE

This declaration is based on the product category rules:
Concrete construction components made of in-situ concrete or ready-mixed concrete, 03/2022 (PCR tested and approved by the *Sachverständigenrat (Independent Council of Experts*) (SVR).

Issue date
December 15, 2022

Valid until
December 14, 2027

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BAUER MIP® Class I

Declaration owner
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Germany

Declared product/declared unit 1 m^3 Mixed-in-Place- (MIP-) construction material. Class I

Scope of application:
The environmental product declaration refers to the average composition of an MIP (Mixed-in-Place) construction material manufactured by BAUER Spezialtiefbau GmbH.

Mixed-in-Place construction materials are mainly used in the manufacture of retaining structures (e.g. retaining walls). foundations or flood protection facilities. as well as for the construction of retaining structures for landfills or cut-off walls.

The environmental product declaration is based on data, which were collected for the year 2020 by BAUER Spezialtiefbau GmbH.

The declaration owner is liable for the information and evidence on which this declaration is based; liability of the IBU regarding manufacturer's information, life cycle assessment data and evidence is excluded. The EPD has been created in accordance with the specifications of *EN 15804+A2*. In the following, the name of the standard is simplified as *EN 15804*.

Verification
The European standard *EN 15804* is the key PCR

Independent verification of the declaration and information in accordance with *ISO 14025:2011*

☐ internal ☐ external

Angela Schindler,
Independent verifier

2. Product

2.1 Product description/Product definition The Mixed-in-Place construction material (MIP construction material) is created directly in the construction soil. The MIP method involves breaking open the existing ground with a single or triple auger, moving it and filling the pores with binder slurry (Figure 1). The binder slurry, consisting of concrete, water, as well as bentonite and concrete additives where appropriate, is manufactured in-situ on the MIP construction site. When manufacturing MIP walls, the individual cuts in the construction soil, which were already created using the MIP equipment and are still fresh, are combined into walls using the pilgrim step method. The declared product is therefore produced in the construction soil and consists of the binder slurry and the ground which has been incorporated, where auger(s) determine the dimensions of the construction component.

The MIP construction material which has been produced cures in the specified form by hydrating the cement, creating solid, artificial stone.

The declared product is the unreinforced MIP construction material or does not contain steel beams or other built-in components. In case of reinforced construction components, structural built-in components or non-structural built-in components, the respective share must be considered separately.

The determination of the life cycle assessment of the average MIP construction material with a cement content of 60 kg/m^3 to 100 kg/m^3 was based on

the production data.

For the use of the product in construction components which are relevant for national technical approvals, *DIN 4093* as well as the "BAUER Mixed-In-Place (MIP)" type approval with approval number Z-34.26-200 apply at the place of use (general type approval (*GTA*)).

For construction components outside the scope relevant for building authorities, reference is made to the DWA set of rules DWA-M 512-1 "Sealing Systems in Hydraulic Engineering - Part 1: Earthwork Structures" (*DWA*).

2.2 Application

The MIP construction material has many applications in the construction soil.

Typical applications of MIP construction materials are:

- Retaining walls for retaining structures or height differences in the terrain
- Cut-off walls for flood protection facilities, groundwater barriers or for dike or dam rehabilitation
- Encompassment of abandoned polluted areas
- Foundation elements (as pile-like elements).

2.3 Technical data

The BAUER MIP® Class I construction material (cement content of 60 kg/m^3 to < 100 kg/m^3) has the following technical properties:

Construction data

The properties that can be achieved are influenced by the conditions of the construction soil.

Values for 60 – < 100 kg/m^3

Description	Value	Unit
Thermal conductivity	–	W/(mK)
Design value of thermal conductivity	1.15 - 1.65	W/(mK)
Water vapor diffusion resistance coefficient	10 - 80	–
Degree of noise absorption	–	%
Bulk density	1500 - 2600	kg/m^3
Compressive strength f_m,i acc. to DIN EN ISO 17892-7 or DIN EN 12390- 3 after 28 days	0.1 - 2	N/mm^2
Modulus of elasticity	10 - 10000	N/mm^2
Equilibrium moisture content approx.	3	%
Compressive strength f_m,i acc. to DIN EN ISO 17892-7 or DIN EN 12390-3	0.1 - 2	N/mm^2
Water permeability coefficient	1E-07 - 1E-12	m/s
Spec. thermal capacity cp approx.	300 - 500	J/kg K
Tensile strength approx.	8 - 15	% of f_m,i
Flexural strength approx.	15 - 30	% of f_m,i

Decisive test standards are /*DIN EN ISO 17892-7*/ and /*DIN EN 12390-3*/.

Performance data of the MIP construction material regarding its characteristics in accordance with the decisive technical regulation (no CE marking).

2.4 Delivery status

The MIP construction material is produced directly on the construction site and at the point of application in the construction soil. The required binder slurry is mixed on-site on the construction site ready for application and fed to the MIP equipment. The MIP equipment processes the binder slurry with the existing ground in the planned dimensions of the construction component to be produced.

2.5 Base materials/Ancillary materials

- Cement, CEM III/B*: 2.7 – 5.6 m%
  (* special binding agent with same composition is possible)
- Mixing water: 10.5 – 24.9 m%
- Bentonite: 0 – 1.7 m%
- Additive: 0 – 0.6 m%
- Ground, moist (solids + inherent moisture): 67.3 – 86.8 m%

The total mass of the MIP construction material depends to a significant extent on the existing ground, which is a component of the MIP construction material. The density of the ground itself can differ from site to site. For this reason, the percentage by mass refers to 2,000 kg/m^3 ready-to-use MIP construction material to illustrate the product composition.

The product/at least one partial product contains substances on the ECHA List of Candidate Substances of Very High Concern (SVHC) (dated June 10, 2022) exceeding 0.1% by mass: No

The product/at least one partial product contains additional CMR substances in category 1A or 1B, which are not on the List of Candidates, exceeding 0.1% by mass in at least one partial product: No

Biocide products were added to this construction product or it has been treated with biocide products (this then concerns a treated product as defined by the (EU) Ordinance on Biocide Products No. 528/2012): No

2.6 Manufacture

First, the binder slurry is manufactured directly on the construction site using the base materials (cement, mixing water, bentonite, additives) (see 2.5 Base materials).

The MIP construction material is created directly in the construction soil by breaking open the existing ground with a single or triple auger, moving it and filling the pores with binder slurry that has been produced (Figure 1).

In accordance with Figure 1, cement-based binder slurries are generally incorporated in the construction soil. As an alternative to standard cement in accordance with *EN 197-1,*

special cement-based binding agents can also be used, whose composition corresponds to a CEM III/B, i.e. a mixture of Portland cement and granulated slag.

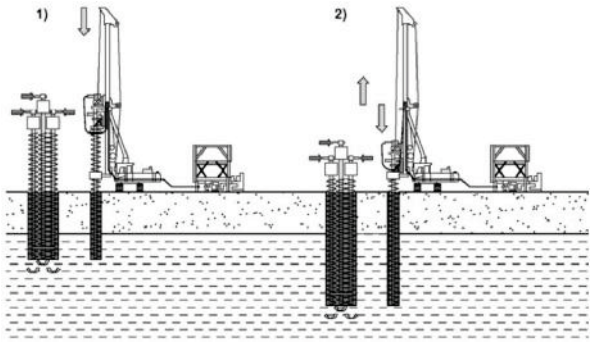


Figure 1: MIP method with triple auger [DWA-M 512-1], left: Drilling and concreting process; right: Homogenization process

To ensure the required quality of the MIP elements or walls, the manufacturing process is monitored in accordance with the decisive parameters for the properties.

2.7 Environment and health during manufacturing

The mixing and processing of binder slurries is common practice on many specialist foundation engineering construction sites. Uncured slurry residues in mixers, as well as reservoirs, pumps and delivery hoses, where appropriate, are disposed of properly (see Section 2.15).

The fresh binder slurry as well as the finished MIP construction material contain a strongly alkaline solution, which is created when mixing cement with water and can cause irritation to skin and eyes.

Due to the water-soluble chromate contained in cements other than low-chromate cements, sustained contact with binder slurries or MIP construction materials made of such cements can lead to the development of allergic chromate dermatitis. In accordance with the REACH Regulation (*REACH*), low-chromate cements are therefore used if there is a danger of skin contact.

Additional information is provided in the safety data sheets of the cement manufacturer.

2.8 Product processing/Installation

The binder slurry is manufactured on the construction site, stored for a short period of time if necessary and then transported to the MIP equipment, which mixes the binder slurry with the ground during and after the drilling process.

2.9 Packaging

The base materials of the binder slurry are delivered without packaging.

2.10 Condition of use

As a rule, the composition of the MIP construction material does not change its condition during use.

2.11 Environment and health during use

The naturally ionizing radiation of the MIP construction material is low and does not pose a health hazard [see Section 7]. Construction components in contact with the ground which are made from the MIP construction material can significantly reduce the influx of radon from the ground (*ZEM*).

The environmental compatibility of the MIP construction material is ensured by using only base materials which are considered to be harmless or whose environmental compatibility has been verified through a National Technical Approval.

The existing ground becomes part of the MIP construction material and therefore does not require verification of its environmental compatibility.

The base materials of the MIP construction material which are mixed in via the binder slurry are predominantly standardized materials which a priori do not require further verification (*DAfStb1).* Instead of standard cement, a special binding agent can be used in the binder slurry, whose composition is similar to standard cement. In addition, bentonite can be used.

Bentonite can be used on the basis of the product-specific water hazard class in combination with the administrative regulations of the German Federal Environmental Agency *(VwVWS* May 17, 1999 and July 27, 2005*).* Bentonite is also listed in the list for substances for
"Safe Construction Products for Health and the Environment" of the German Federal Environmental Agency (*Umwelt1*).

2.12 Reference service life

The MIP construction material is designed for an intended service life of at least 50 years for permanent structures, taking into account the existing exposure classes/environmental conditions (general type approval (*GTA*)). The MIP construction material can also be used for temporary purposes. A calculation of the reference service life in accordance with *ISO 15686-8* is not possible for temporary applications.

2.13 Accidental actions

Fire

MIP construction materials meet the requirements of construction material class A1, "non-flammable" in accordance with *DIN 4102-1* and *EN 13501-1.* No toxic gases and fumes can occur in case of fire, and burning construction material components do not drop or fall off.

Fire protection

Description	Value
Construction material class	A1 "non-flammable"

Water

When exposed to water (e.g. floods), the MIP construction material remains mostly inert. Substances are not washed out in quantities which could be hazardous to water.

Mechanical destruction

Not relevant for MIP construction material.

2.14 Re-use phase

Construction components made of MIP construction material can be dismantled. In order to recycle reinforced construction components, the demolished material is separated from the structural steel or reinforcing steel and is processed. For this purpose, the MIP construction material is first crushed and separated into individual grain fractions. In small amounts, they can then be used as recycled rock gravel, e.g. for the construction of earth concrete walls. The reinforcing steel or structural steel is recycled as scrap steel.

If separate base elements are used in the MIP construction material, they can consist of steel or other construction materials (such as glass-reinforced plastic, carbon fiber-reinforced plastic, wood, composite reinforcement). When using pre-fabricated elements or structural elements, it is generally possible to re-use them in their entirety.

2.15 Disposal

In Germany, disposal is generally ensured in accordance with Z1.1/Z1.2 according to the Working Group of the Federal States on Waste - Ground (*LAGA Ground)* or "Framework paper Bavaria" („*Eckpunktepapier-Bayern*"). In individual cases, the Landfill Regulation (*DepV2009*) may become relevant for disposal.

For MIP waste made of cement-bound material, waste codes 17 01 01, 17 01 07 and 17 05 04 (*AVV*) apply in accordance with the waste recycling list. For steel which may be contained in the MIP construction material (not included in the EPD), waste code 17 04 05 applies (*AVV*).

2.16 Additional information

https://www.bauer.de/bst/

3. LCA: Calculation rules

3.1 Declared unit

The declared unit is one cubic meter (1 m^3) of Mixed-in-Place construction material.

If MIP construction components contain steel beams, lattice girders or other built-in components, a separate life cycle assessment must be carried out for them.

Declared unit

Description	Value	Unit
Declared unit	1	m^3
Density (mean value)	1900	kg/m^3

The cement content in the composition of the construction material can be 60 to < 100 kg/m^3 MIP construction material in this class. For the life cycle assessment, a cement content of 80 kg/m^3 was assumed.

3.2 System boundary

Type of EPD: "From cradle to plant gate, with options." Declared are the production phase as well as other selected life cycle phases.

Module A1:
Production of cement and bentonite as well as the provision of water.

Module A2:
Transport of the base materials and the required equipment to the construction site.

Module A3:
Mixing of the binder slurry on the construction site.

Module A4:
As the production site and the construction site are identical, no environmental impacts are specified in this module.

Module A5:
Insertion of the slurry which has been produced, incl. the drilling process and the mixing process with the ground (diesel consumption).

Module B1:
No environmental impacts arise from the use of the MIP construction material. In this module, the CO_2 absorption due to carbonation during the service life is listed as having negative global warming potential.

Module B2 and B3:
For Mixed-in-Place construction components, there are generally no environmental impacts during their reference service life.

Module C1:
Dismantling/demolition of Mixed-in-Place construction components.

Module C2:
Transport of Mixed-in-Place demolition material to the processing facility.

Module C3:
Breaking and treatment of Mixed-in-Place demolition material (until the "end of being characterized as waste" is reached).

Module C4:
As only a very small amount of the demolished construction debris is disposed of in landfill and the "Treatment and use" scenario was selected for end-of-life, no environmental impacts are specified for the landfill disposal of MIP construction material.

Module D:
Benefit for use of MIP demolition material in earthworks and road construction.

3.3 Estimates and assumptions

There were no estimates and assumptions.

3.4 Cut-off criteria

All base materials and processes used were taken into account. The small amounts of waste arising from cement production (e.g. packaging material) are ignored in the life cycle assessment and are therefore not listed under "Other environmental information describing different waste categories".

3.5 Background data

The production data for the manufacture of Mixed-in-Place construction material was determined by BAUER Spezialtiefbau GmbH. Data from the year 2020 were used for the life cycle assessment of the cement production, which were determined by VDZ gGmbH as part of the life cycle assessment of cements. The life cycle assessment was carried out with *GaBi ts* 10.6.1.35 software (Sphera Solutions GmbH). Generic records from the *GaBi ts*-database (CUP 2021.1) were used for the life cycle assessment.

3.6 Data quality

The following applies for the foreground data: The geographical, technological and temporal representativeness of the data can be assessed as "very good". The following applies for the generic background data: The geographical and technological representativeness of the data can be assessed as "very good", the temporal representativeness as "good".

3.7 Period under review

The data used relate to the production of MIP construction material in 2020.

3.8 Allocation

An economical allocation was carried out for granulated slag and fly ash, which are used for cement production.

3.9 Comparability

As a matter of principle, a comparison or the assessment of EPD data is only possible if all the records to be compared were created in accordance with *EN 15804* and the building context or the product-specific performance characteristics are taken into account.

Database used: *GaBi ts*-database (CUP 2021.1)

4. LCA: Scenarios and additional technical information

Characteristic product properties of biogenic carbon

Information on the description of the biogenic carbon content at the plant gate

Description	Value	Unit
Biogenic carbon in the product	0	kg C
Biogenic carbon in the associated packaging	0	kg C

The following technical information forms the basis for the declared modules.

Module B1:
Due to carbonation, cement-bound construction materials absorb carbon dioxide from the environment during their service life. This can be expressed as negative global warming potential in module B1. Assumption: Carbonation on one side in contact with the ground, thickness of MIP construction component 55 cm.

C1: Dismantling:
No experience has yet been gained with the dismantling of MIP construction components. For life cycle assessment, it is assumed that the environmental impacts correspond to the dismantling of concrete construction components. The assumptions that form the basis of the *EPDs* for concrete issued by the InformationsZentrum Beton GmbH (September 2018) have been adopted. Typically, the dismantling of concrete structures is predominantly carried out with long reach excavators, which are equipped with demolition shears. The concrete structures are dismantled using so-called "pressure-cutting", i.e. the crushing of concrete by applying compressive force.

C2: Transport from MIP demolition material to the crushing plant:
The assumptions that form the basis of the EPDs for concrete issued by the InformationsZentrum Beton GmbH (September 2018) have been adopted. In this EPD, the average transport distance for the transport of concrete waste to the treatment process is estimated at approx. 50 km.

C3: Waste treatment:
No experience has yet been gained with the waste treatment of MIP construction components. For life cycle assessment, it is assumed that the environmental impacts correspond to the waste treatment of concrete construction components. The assumptions that form the basis of the EPDs for concrete issued by the InformationsZentrum Beton GmbH (September 2018) have been adopted. Treatment generally takes place using jaw crushers or impact crushers. In addition to crushing, pre-screening and metal separation is also carried out.

End of life (C1-C4)

Description	Value	Unit
Separately collected mineral construction waste	1900	kg
Collected as mixed construction waste	0	kg
For reuse	0	kg
For recycling	1900	kg
For energy recovery	0	kg
For landfill disposal	0	kg

D: Benefits and loads after end-of-life: In the crushing plant, the MIP construction material reaches the end of being characterized as waste. The output at the end of the crushing process is a secondary material that can replace the primary materials sand and gravel. Life cycle assessment benefits are specified for this in module D.

Additional information on carbonation: *EN 16757* specifies 75% of the maximum possible CO_2 absorption as the average guide value for the long-term absorption of CO_2 by cement-bound construction materials. This value results in 8.6 kg/m^3 MIP construction material for a MIP construction material of class 60-100. However, this value should only be understood as a reference value, as it is subject to many influencing factors.

5. LCA: Results

DESCRIPTION OF THE SYSTEM BOUNDARY (X = INCLUDED IN LIFE CYCLE ASSESSMENT; ND = MODULE OR INDICATOR NOT DECLARED; MNR = MODULE NOT RELEVANT)

Production stage			Construction process stage		Use stage							End of life stage				Benefits and loads beyond the system boundaries
Raw materials supply	Transport	Manufacture	Transport from the gate to the site	Installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Dismantling/ demolition	Transport	Waste treatment	Disposal	Reuse, Recovery or Recycling potential
A1	**A2**	**A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
X	X	X	X	X	X	ND	MNR	MNR	MNR	ND	ND	X	X	X	ND	X

RESULTS OF LIFE CYCLE ASSESSMENT – ENVIRONMENTAL IMPACTS in accordance with EN 15804+A2: 1 m^3 Mixed-in-Place (MIP) construction material, BAUER MIP® Class I, cement contents from 60 kg/m^3 to < 100 kg/m^3

Core indicator	Unit	A1-A3	A4	A5	B1	C1	C2	C3	D
GWP-total	[kg CO_2-eq.]	33.10	0.00	20.60	-0.20	3.15	7.94	4.15	-4.45
GWP-fossil	[kg CO_2-eq.]	33.00	0.00	20.50	-0.20	3.13	7.88	4.10	-4.41
GWP-biogenic	[kg CO_2-eq.]	9.00E-2	0.00E+0	7.10E-2	0.00E+0	1.00E-2	2.90E-2	3.90E-2	-3.00E-2
GWP-luluc	[kg CO_2-eq.]	1.00E-2	0.00E+0	6.43E-2	0.00E+0	1.00E-2	3.00E-2	9.20E-3	-1.00E-2
ODP	[kg CFC11-eq.]	6.25E-9	0.00E+0	2.04E-11	0.00E+0	6.47E-13	1.61E-12	5.34E-11	-3.51E-11
AP	[mol H^+-eq.]	6.98E-2	0.00E+0	2.20E-1	0.00E+0	4.22E-2	2.70E-2	3.21E-2	-1.47E-2
EP-freshwater	[kg P-eq.]	5.27E-5	0.00E+0	3.89E-5	0.00E+0	6.30E-6	1.57E-5	1.49E-5	-1.25E-5
EP-marine	[kg N-eq.]	2.12E-2	0.00E+0	8.97E-2	0.00E+0	1.92E-2	1.27E-2	1.42E-2	-5.74E-3
EP-terrestrial	[mol N-eq.]	2.39E-1	0.00E+0	9.86E-1	0.00E+0	2.11E-1	1.42E-1	1.56E-1	-6.32E-2
POCP	[kg NMVOC-	6.12E-2	0.00E+0	2.67E-1	0.00E+0	5.74E-2	2.46E-2	4.20E-2	-1.35E-2
ADPE	[kg Sb-eq.]	4.55E-6	0.00E+0	2.09E-6	0.00E+0	3.17E-7	7.89E-7	1.35E-6	-1.00E-6
ADPF	[MJ]	210.00	0.00	272.00	0.00	41.90	104.00	54.60	-58.20
WDP	[m^3 world-eq. extracted]	1.62E+1	0.00E+0	8.72E-1	0.00E+0	1.00E-2	3.40E-2	6.00E-2	-1.10E-1

Key	GWP = Global Warming Potential; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential of land and water; EP = Eutrophication potential; POCP = Formation potential of tropospheric ozone; ADPE = Abiotic depletion potential for non-fossil resources (ADP – substances); ADPF = Abiotic depletion potential for fossil resources (ADP – fossil energy resources); WDP = Water deprivation potential (user)

RESULTS OF LIFE CYCLE ASSESSMENT – INDICATORS FOR THE DESCRIPTION OF RESOURCE USE in accordance with EN 15804+A2: 1 m^3 Mixed-in-Place (MIP) construction material, BAUER MIP® Class I, cement contents from 60 kg/m^3 to < 100 kg/m^3

Indicator	Unit	A1-A3	A4	A5	B1	C1	C2	C3	D
PERE	[MJ]	70.40	0.00	26.20	0.00	2.75	6.85	27.10	-18.40
PERM	[MJ]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PERT	[MJ]	70.40	0.00	26.20	0.00	2.75	6.85	27.10	-18.40
PENRE	[MJ]	210.00	0.00	272.00	0.00	41.90	104.00	54.60	-53.80
PENRM	[MJ]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PENRT	[MJ]	210.00	0.00	272.00	0.00	41.90	104.00	54.60	-53.80
SM	[kg]	0.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RSF	[MJ]	18.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NRSF	[MJ]	42.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FW	[m^3]	0.54	0.00	0.73	0.00	0.04	0.11	0.08	-0.11

Key	PERE = Renewable primary energy as energy source; PERM = Renewable primary energy for material utilization; PERT = Total use of renewable primary energy; PENRE = Non-renewable primary energy as energy source; PENRM = Non-renewable primary energy for material utilization; PENRT = Total use of non-renewable primary energy; SM = Use of secondary materials; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels; FW = Net use of fresh water

RESULTS OF LIFE CYCLE ASSESSMENT – WASTE CATEGORIES AND OUTPUT FLOWS in accordance with EN 15804+A2: 1 m^3 Mixed-in-Place (MIP) construction material, BAUER MIP® Class I, cement contents from 60 kg/m^3 to < 100 kg/m^3

Indicator	Unit	A1-A3	A4	A5	B1	C1	C2	C3	D
HWD	[kg]	2.98E-3	0.00E+0	5.79E-9	0.00E+0	1.83E-10	4.54E-10	3.24E-9	-2.58E-9
NHWD	[kg]	3.90E-1	0.00E+0	5.01E+2	0.00E+0	6.80E-3	1.69E-2	3.30E-2	-3.96E+1
RWD	[kg]	8.89E-3	0.00E+0	1.29E-3	0.00E+0	5.26E-5	1.31E-4	2.56E-3	-1.83E-3
CRU	[kg]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MFR	[kg]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MER	[kg]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EEE	[MJ]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EET	[MJ]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Key	HWD = Hazardous waste disposed; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed; CRU = Components for re-use; MFR = Materials for recycling; MER = Materials for energy recovery; EEE = Exported electrical energy; EEE = Exported thermal energy

RESULTS OF LIFE CYCLE ASSESSMENT – additional impact categories in accordance with EN 15804+A2 optional: 1 m³ Mixed-in-Place (MIP) construction material, BAUER MIP® Class I, cement contents from 60 kg/m³ to < 100 kg/m³

Indicator	Unit	A1-A3	A4	A5	B1	C1	C2	C3	D
PM	[Cases of illness]	5.09E-7	0.00E+0	9.44E-6	0.00E+0	2.25E-6	1.51E-7	1.58E-6	-9.31E-7
IRP	[kBq U235-eq.]	2.03E+0	0.00E+0	1.39E-1	0.00E+0	5.35E-3	1.33E-2	2.34E-1	-1.82E-1
ETP-fw	[CTUe]	1.97E+2	0.00E+0	1.88E+2	0.00E+0	3.29E-1	7.97E+1	3.31E+1	-3.65E+1
HTP-c	[CTUh]	4.78E-9	0.00E+0	1.10E-8	0.00E+0	6.42E-10	1.60E-9	9.31E-10	-1.87E-9
HTP-nc	[CTUh]	4.60E-7	0.00E+0	1.12E-6	0.00E+0	4.84E-8	9.28E-8	4.94E-8	-1.64E-7
SQP	[-]	64.70	0.00	73.40	0.00	12.60	31.20	24.90	-22.60

Key	PM = Potential incidence of disease due to particulate matter emissions; IRP = Potential effect from human exposure to U235; ETP-fw = Potential toxicity comparison unit for ecosystems; HTP-c = Potential toxicity comparison unit for humans (carcinogenic effect); HTP-nc = Potential toxicity comparison unit for humans (non-carcinogenic effect); SQP = Potential soil quality index

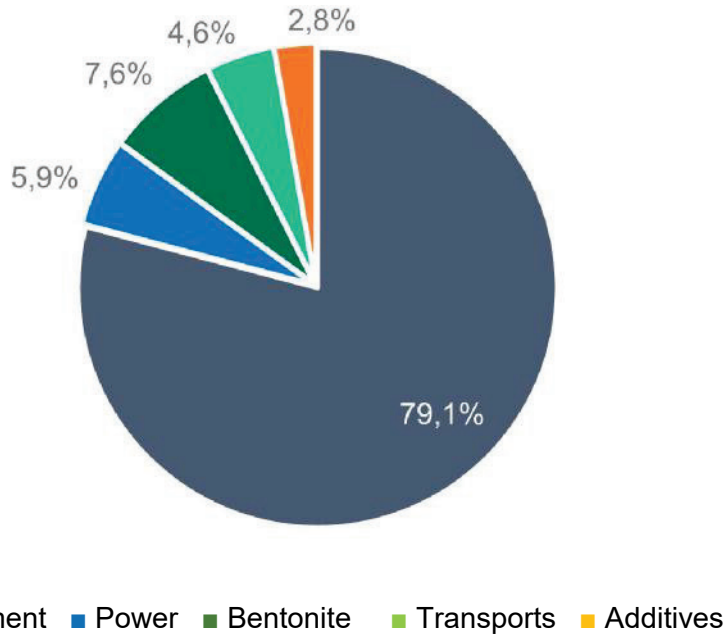
Net values are declared in A1–A3 for all GWP (global warming potential) indicators. The waste status of the (waste-based) energy sources has been verified. The gross emissions (i.e. including CO_2 from the combustion of waste) are:
37.3 kg CO_2-eq/m3 (GWP-total)
35.5 kg CO_2-eq/m^3 (GWP-fossil)
1.8 kg CO_2-eq/m^3 (GWP-biogenic)
with these values representing the corresponding sums from the net values and the emissions resulting from the incineration of verified waste materials.

Disclaimer 1 — applies for the indicator "Potential effect from human exposure to U235". This impact category deals mainly with the possible impact of low dose ionizing radiation on human health in the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents or occupational exposure, nor due to radioactive waste disposal in underground facilities. Potential ionizing radiation from the ground, from radon and from some construction materials is also not measured by this indicator.

Disclaimer 2 — applies for the indicators: "Abiotic depletion potential - non-fossil resources", "Abiotic depletion potential - fossil resources", "Water deprivation potential (user)", "Potential toxicity comparison unit for ecosystems", "Potential toxicity comparison unit for humans - carcinogenic effect"; "Potential toxicity comparison unit for humans - non-carcinogenic effect"; "Potential soil quality index".
The results of these environmental indicators must be used with caution, as there is a high level of uncertainty regarding these results or there is only limited experience in relation to the indicator.

6. LCA: Interpretation

The following diagram indicates the most important influencing factors for the global warming potential (Module A1–A3):



The range of the MIP construction materials used to generate the average values encompasses

- MIP construction materials where the environmental impact parameters listed in Section 5 and the resource use (Module A1–A3) are exceeded by up to 20%

up to

- MIP construction materials where the environmental impact parameters listed in Section 5 and the resource use (Module A1–A3) fall short by up to 20%

7. Requisite evidence

7.1 Radioactivity
Measurement of nuclide contents in Bq/kg for Ra-226, Th-232, K-40. In Germany, there are currently no legally specified limit values for assessing the radioactivity of construction materials. Assessment can be carried out in accordance with:
- Document of the European Commission 'Radiation Protection 112'
- OENORM 5200
- Nordic Countries' Recommendation 2000.

7.2 Leaching
To test the leaching of construction materials, test procedures such as *CEN/TS 16637-2* (monolithic test specimens) as well as *CEN/TS 16637-3* (permeable construction materials, e.g. rock gravel) are used. Tests are not required for most of the base materials of MIP construction materials and fields of application (e.g. natural rock gravel or cements in accordance with *EN 197-1*).

Requirements for leaching may arise for MIP construction materials containing cement additives in the relevant fields of application. If the construction materials are not covered by harmonized standards, their compliance with requirements is verified as part of the technical approval of the materials.

8. Literature references

Standards

CEN/TS 16637-2
DIN CEN/TS 16637-2:2014-11; DIN SPEC 18046-2:2014-11, Construction products - Assessment of release of dangerous substances - Part 2: Horizontal dynamic surface leaching test; German version CEN/TS 16637-2:2014.

CEN/TS 16637-3
DIN CEN/TS 16637-3:2016-12; DIN SPEC 18046-3:2016-12 Construction products - Assessment of release of dangerous substances - Part 3: Horizontal Horizontal up-flow percolation test; German version CEN/TS 16637-3:2016.

DIN 4093
DIN 4093:2015-11 Design of strengthened soil - Set up by means of jet grouting, deep mixing or grouting.

DIN 4102-1
DIN 4102-1:1998-05 Fire behaviour of building materials and building components - Part 1: Building materials; concepts, requirements and tests.

EN 197-1
DIN EN 197-1:2011-11 Cement - Part 1: Composition, specifications and conformity criteria for common cements.

EN 12390-3
DIN EN 12390-3:2019-10 Testing hardened concrete -Part 3: Compressive strength of test specimens.

EN 13501-1
DIN EN 13501-1:2010 Fire Classification Of Construction Products And Building Elements - Part 1: Classification Using Data From Reaction To Fire Tests.

EN 15804
DIN EN 15804:2022-03, Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products; German version EN 15804:2012+A2:2019 + AC:2021.

EN 16757
DIN EN 16757:2017-10 Sustainability Of Construction Works - Environmental Product Declarations - Product Category Rules For Concrete And Concrete Elements.

ISO 14025
DIN EN ISO 14025:2011-10 Environmental labels and declarations - Type III environmental declarations - Principles and procedures (ISO 14025:2006); German and English version EN ISO 14025:2011.

ISO 15686-8
ISO 15686-8:2008-06 Buildings and constructed assets - Service-life planning - Part 8: Reference service life and service-life estimation.

ISO 17892-7
ISO 17892-7:2017-11 Geotechnical Investigation And Testing - Laboratory Testing Of Soil - Part 7: Unconfined Compression Test.

Laws, rules and regulations

AVV
Directive on the European Waste List: Waste List Directive (AVV) dated December 10, 2001 (Federal Law Gazette I p. 3379), last amended by Article 2 of the directive dated July 17, 2017 (Federal Law Gazette p. 2644).

DepV2009
Landfill regulation - regulation concerning landfills and long-term storage, Berlin: Bundesministerium der Justiz und für Verbraucherschutz (*Federal Ministry of Justice and Consumer Protection*).

DWA
Data sheet DWA-M 512-1, February 2012. Sealing Systems in Hydraulic Engineering. Part: 1: Earthwork Structures. Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall e. V. (*German Association for Water, Wastewater and Waste*) (DWA) (Publisher).

"Framework paper Bavaria"
Requirements for fill materials for pits and quarries as well as open-cast mines, version dated July 15, 2021.

LAGA-ground
Notification of the Ländergemeinschaft (LAGA) (*German Association of Federal Government and Federal States*) M20, Requirements for the recycling of mineral-based residual materials/waste - Technical Regulations - Status November 6, 2003.

REACH
REGULATION (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/E.

VwVWS
Administrative Regulation on Substances Hazardous to Water dated 17/05/1999 (Federal Gazette No. 98a dated 29/05/1999), amended by Administrative Regulation dated 27/07/2005 (Federal Gazette No. 142a dated 30/07/2005).

Other sources

General type approval
National technical approval "BAUER Mixed-In-Place (MIP)" Z-34.26-200, Deutsches Institut für Bautechnik (*German Institute of Construction Technology*), Berlin

DAfStb1
Commentary of the Deutscher Ausschuss für Stahlbeton e.V. (German Committee for Reinforced Concrete) (DAfStb) on the current regulatory status of the environmental impact of concrete (December 2010).

GaBi ts
Software and database for life cycle assessment, version 10.6.1.35, Sphera Solutions GmbH.

EPDs
EPDs (declaration owner: InformationsZentrum Beton GmbH)

- Environmental Product Declaration Concrete of compressive strength class C 20/25, EPD-IZB-20180097-IBG1-DE
  Environmental Product Declaration Concrete of compressive strength class C 25/30, EPD-IZB-20180101-IBG1-DE
- Environmental Product Declaration Concrete of compressive strength class C 30/37, EPD-IZB-20180102-IBG1-DE
- Environmental Product Declaration Concrete of compressive strength class C 35/45, EPD-IZB-20180098-IBG1-DE
- Environmental Product Declaration Concrete of compressive strength class C 45/55, EPD-IZB-20180099-IBG1-DE
- Environmental Product Declaration Concrete of compressive strength class C 50/60, EPD-IZB-20180100-IBG1-DE

IBU 2021
IBU (2021): General program information of the Institut Bauen und Umwelt e.V. (IBU). Version 2.0, Institut Bauen und Umwelt e.V., Berlin.

PCR part A
Product category rules for building-related products and services. Part A: Calculation rules

for the life cycle assessment and requirements for the project report in accordance with EN 15804+A2:2021 (v1.2). Berlin: Institut Bauen und Umwelt e.V. (Publisher), 2021-09.

PCR cement
Product category rules for building-related products and services. Part B: Requirements for the EPD for cement, Version 1.7. Berlin: Institut Bauen und Umwelt e.V. (Publisher), 2022-05. www.ibu-epd.com

Umwelt1
Rheinberger, Ulrike, Dirk Bunke and Outi Ilvonen. 2007. Safe Construction Products for Health and the Environment: How much inspection effort is required to implement the EU Construction Products Directive? Dessau: German Federal Environmental Agency. http://d-nb.info/990406695/34.

ZEM
Zement Taschenbuch (cement paperback). Verein Deutscher Zementwerke e.V.
(German Cement Works Association) (2008)

Published by
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ENVIRONMENTAL PRODUCT DECLARATION

in accordance with *ISO 14025* and *EN 15804+A2*

Declaration owner	**BAUER Spezialtiefbau GmbH**
Published by	Institut Bauen und Umwelt e.V. (IBU)
Program operator	Institut Bauen und Umwelt e.V. (IBU)
Declaration number	EPD-BAU-20230029-ICC1-DE
Issue date	February 7, 2023
Valid until	February 6, 2028

BAUER MIP® Class II

BAUER Spezialtiefbau GmbH

Institut Bauen und Umwelt e.V.

www.ibu-epd.com | https://epd-online.com

ECO PLATFORM EPD VERIFIED

1. General information

BAUER Spezialtiefbau GmbH

Program operator
IBU - Institut Bauen und Umwelt e.V.
Hegelplatz 1
10117 Berlin
Germany

Declaration number
EPD-BAU-20230029-ICC1-DE

This declaration is based on the product category rules:
Concrete construction components made of in-situ concrete or ready-mixed concrete, 03/2022 (PCR tested and approved by the *Sachverständigenrat (Independent Council of Experts*) (SVR).

Issue date
February 7, 2023

Valid until
February 6, 2028

Dipl. Ing. Hans Peters
(CEO of Institut Bauen und Umwelt e.V.)

Dr. Alexander Röder
(Managing Director Institut Bauen und Umwelt e.V)

BAUER MIP® Class II

Declaration owner
BAUER Spezialtiefbau GmbH
BAUER-Str. 1
86529 Schrobenhausen
Germany

Declared product/declared unit
1 m^3 Mixed-in-Place- (MIP-) construction material, Class II

Scope of application:
The environmental product declaration refers to the average composition of an MIP (Mixed-in-Place) construction material manufactured by BAUER Spezialtiefbau GmbH.

Mixed-in-Place construction materials are mainly used in the manufacture of retaining structures (e.g. retaining walls). foundations or flood protection facilities. as well as for the construction of retaining structures for landfills or cut-off walls.

The environmental product declaration is based on data, which were collected for the year 2020 by BAUER Spezialtiefbau GmbH.

The declaration owner is liable for the information and evidence on which this declaration is based; liability of the IBU regarding manufacturer's information, life cycle assessment data and evidence is excluded. The EPD has been created in accordance with the specifications of *EN 15804+A2*. In the following, the name of the standard is simplified as *EN 15804*.

Verification
The European standard *EN 15804* is the key PCR
Independent verification of the declaration and information in accordance with *ISO 14025:2011*

☐ internal ☐ external

Angela Schindler,
Independent verifier

2. Product

2.1 Product description/Product definition The Mixed-in-Place construction material (MIP construction material) is created directly in the construction soil. The MIP method involves breaking open the existing ground with a single or triple auger, moving it and filling the pores with binder slurry (Figure 1). The binder slurry, consisting of concrete, water, as well as bentonite and concrete additives where appropriate, is manufactured in-situ on the MIP construction site. When manufacturing MIP walls, the individual cuts in the construction soil, which were already created using the MIP equipment and are still fresh, are combined into walls using the pilgrim step method. The declared product is therefore produced in the construction soil and consists of the binder slurry and the ground which has been incorporated, where the dimensions of the auger(s) determine the dimensions of the construction component.

The MIP construction material which has been produced cures in the specified form by hydrating the cement, creating solid, artificial stone.

The declared product is the unreinforced MIP construction material or does not contain steel beams or other built-in components. In case of reinforced construction components, structural built-in components or non-structural built-in components, the respective share must be considered separately.

The determination of the life cycle assessment of the average MIP construction material with a cement content of 100 kg/m^3

to < 150 kg/m^3 was based on the production data.

For the use of the product in construction components which are relevant for national technical approvals, *DIN 4093* as well as the "BAUER Mixed-In-Place (MIP)" type approval with approval number Z-34.26-200 apply at the place of use (general type approval (*GTA*)).

For construction components outside the scope relevant for building authorities, reference is made to the DWA set of rules DWA-M 512-1 "Sealing Systems in Hydraulic Engineering - Part 1: Earthwork Structures" (*DWA*).

2.2 Application

The MIP construction material has many applications in the construction soil.

Typical applications of MIP construction materials are:

- Retaining walls for retaining structures or height differences in the terrain
- Cut-off walls for flood protection facilities, groundwater barriers or for dike or dam rehabilitation
- Encompassment of abandoned polluted areas
- Foundation elements (as pile-like elements).

2.3 Technical data

The BAUER MIP® Class II construction material (cement content of 100 kg/m^3 to < 150 kg/m^3) has the following technical properties:

Construction data

The properties that can be achieved are influenced by the conditions of the construction soil.

Values for class II

Description	Value	Unit
Thermal conductivity	–	W/(mK)
Design value of thermal conductivity	1.15 - 1.65	W/(mK)
Water vapor diffusion resistance coefficient	10 - 80	–
Degree of noise absorption	–	%
Bulk density	1500 - 2600	kg/m^3
Compressive strength f_m,i acc. to DIN EN ISO 17892-7 or DIN EN 12390- 3 after 28 days	0.5 – 5	N/mm^2
Modulus of elasticity	50 - 12000	N/mm^2
Equilibrium moisture content approx.	3	%
Compressive strength f_m,i acc. to DIN EN ISO 17892-7 or DIN EN 12390-3	0.1 – 2	N/mm^2
Water permeability coefficient	1E-07 – 1E-12	m/s
Spec. thermal capacity cp approx.	300 – 500	J/kg K
Tensile strength approx.	8 – 15	% of f_m,i
Flexural strength approx.	15 – 30	% of f_m,i

Decisive test standards are /*DIN EN ISO 17892-7*/ and /*DIN EN 12390-3*/.

Performance data of the MIP construction material regarding its characteristics in accordance with the decisive technical regulation (no CE marking).

2.4 Delivery status

The MIP construction material is produced directly on the construction site and at the point of application in the construction soil. The required binder slurry is mixed on-site on the construction site ready for application and fed to the MIP equipment. The MIP equipment processes the binder slurry with the existing ground in the planned dimensions of the construction component to be produced.

2.5 Base materials/Ancillary materials

- Cement, CEM III/B*: 4.5 – 8.3 m%
  (* special binding agent with same composition is possible)
- Mixing water: 8.3 – 22.3 m%
- Bentonite: 0 – 1.7 m%
- Additive: 0 – 0.6 m%
- Ground, moist (solids + inherent moisture): 67.2 – 87.1 m%

The total mass of the MIP construction material depends to a significant extent on the existing ground, which is a component of the MIP construction material. The density of the ground itself can differ from site to site. For this reason, the percentage by mass refers to 2,000 kg/m^3 ready-to-use MIP construction material to illustrate the product composition.

The product/at least one partial product contains substances on the ECHA List of Candidate Substances of Very High Concern (SVHC) (dated June 10, 2022) exceeding 0.1% by mass: No

The product/at least one partial product contains additional CMR substances in category 1A or 1B, which are not on the List of Candidates, exceeding 0.1% by mass in at least one partial product: No

Biocide products were added to this construction product or it has been treated with biocide products (this then concerns a treated product as defined by the (EU) Ordinance on Biocide Products No. 528/2012): No

2.6 Manufacture

First, the binder slurry is manufactured directly on the construction site using the base materials (cement, mixing water, bentonite, additives) (see 2.5 Base materials).

The MIP construction material is created directly in the construction soil by breaking open the existing ground with a single or triple auger, moving it and filling the pores with the binder slurry that has been produced (Figure 1).

In accordance with Figure 1, cement-based binder slurries are generally incorporated in the construction soil. As an alternative to standard cement in accordance with *EN 197-1,*

special cement-based binding agents can also be used, whose composition corresponds to a CEM III/B, i.e. a mixture of Portland cement and granulated slag.

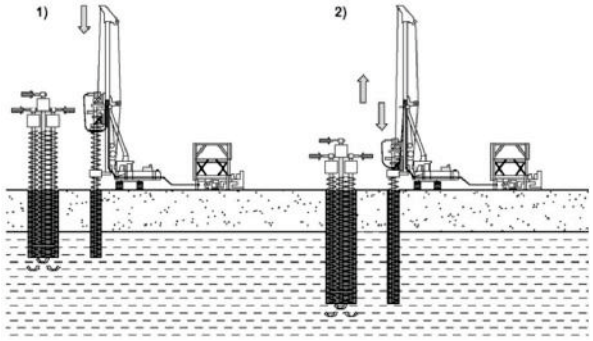


Figure 1: MIP method with triple auger [DWA-M 512-1], left: Drilling and concreting process; right: Homogenization process

To ensure the required quality of the MIP elements or walls, the manufacturing process is monitored in accordance with the decisive parameters for the properties.

2.7 Environment and health during manufacturing

The mixing and processing of binder slurries is common practice on many specialist foundation engineering construction sites. Uncured slurry residues in mixers, as well as reservoirs, pumps and delivery hoses, where appropriate, are disposed of properly (see Section 2.15).

The fresh binder slurry as well as the finished MIP construction material contain a strongly alkaline solution, which is created when mixing cement with water and can cause irritation to skin and eyes.

Due to the water-soluble chromate contained in cements other than low-chromate cements, sustained contact with binder slurries or MIP construction materials made of such cements can lead to the development of allergic chromate dermatitis. In accordance with the REACH Regulation (*REACH*), low-chromate cements are therefore used if there is a danger of skin contact.

Additional information is provided in the safety data sheets of the cement manufacturer.

2.8 Product processing/Installation

The binder slurry is manufactured on the construction site, stored for a short period of time if necessary and then transported to the MIP equipment, which mixes the binder slurry with the ground during and after the drilling process.

2.9 Packaging

The base materials of the binder slurry are delivered without packaging.

2.10 Condition of use

As a rule, the composition of the MIP construction material does not change its condition of use.

2.11 Environment and health during use

The naturally ionizing radiation of the MIP construction material is low and does not pose a health hazard [see Section 7]. Construction components in contact with the ground which are made from the MIP construction material can significantly reduce the influx of radon from the ground (*ZEM*).

The environmental compatibility of the MIP construction material is ensured by using only base materials which are considered to be harmless or whose environmental compatibility has been verified through a National Technical Approval.

The existing ground becomes part of the MIP construction material and therefore does not require verification of its environmental compatibility.

The base materials of the MIP construction material which are mixed in via the binder slurry are predominantly standardized materials which a priori do not require further verification (*DAfStb1).* Instead of standard cement, a special binding agent can be used in the binder slurry, whose composition is similar to standard cement. In addition, bentonite can be used.

Bentonite can be used on the basis of the product-specific water hazard class in combination with the administrative regulations of the German Federal Environmental Agency *(VwVWS* May 17, 1999 and July 27, 2005*).* Bentonite is also listed in the list for substances for "Safe Construction Products for Health and the Environment" of the German Federal Environmental Agency (*Umwelt1*).

2.12 Reference service life

The MIP construction material is designed for an intended service life of at least 50 years for permanent structures, taking into account the existing exposure classes/environmental conditions (general type approval (*GTA*)). The MIP construction material can also be used for temporary purposes. A calculation of the reference service life in accordance with *ISO 15686-8* is not possible for temporary applications.

2.13 Accidental actions

Fire

MIP construction materials meet the requirements of construction material class A1, "non-flammable" in accordance with *DIN 4102-1* and *EN 13501-1*. No toxic gases and fumes can occur in case of fire, and burning construction material components do not drop or fall off.

Fire protection

Description	Value
Construction material class	A1 "non-flammable"

Water

When exposed to water (e.g. floods), the MIP construction material remains mostly inert. Substances are not washed out in quantities which could be hazardous to water.

Mechanical destruction

Not relevant for MIP construction material.

2.14 Re-use phase

Construction components made of MIP construction material can be dismantled. In order to recycle reinforced construction components, the demolished material is separated from the structural steel or reinforcing steel and is processed. For this purpose, the MIP construction material is first crushed and separated into individual grain fractions. In small amounts, they can then be used as recycled rock gravel, e.g. for the construction of earth concrete walls. The reinforcing steel or structural steel is recycled as scrap steel.

If separate base elements are used in the MIP construction material, they can consist of steel or other construction materials (such as glass-reinforced plastic, carbon fiber-reinforced plastic, wood, composite reinforcement). When using pre-fabricated elements or structural elements, it is generally possible to re-use them in their entirety.

2.15 Disposal

In Germany, disposal is generally ensured in accordance with Z1.1/Z1.2 according to the Working Group of the Federal States on Waste - Ground (*LAGA Ground)* or "Framework paper Bavaria" („*Eckpunktepapier-Bayern*"). In individual cases, the Landfill Regulation (*DepV2009*) may become relevant for disposal.

For MIP waste made of cement-bound material, waste codes 17 01 01, 17 01 07 and 17 05 04 (*AVV*) apply in accordance with the waste recycling list. For steel which may be contained in the MIP construction material (not included in the EPD), waste code 17 04 05 applies (*AVV*).

2.16 Additional information

https://www.bauer.de/bst/

3. LCA: Calculation rules

3.1 Declared unit

The declared unit is one cubic meter (1 m^3) of Mixed-in-Place construction material.

If MIP construction components contain steel beams, lattice girders or other built-in components, a separate life cycle assessment must be carried out for them.

Declared unit

Description	Value	Unit
Declared unit	1	m^3
Density (mean value)	1900	kg/m^3

The cement content in the composition of the construction material can be 100 to < 150 kg/m^3 MIP construction material in this class. For the life cycle assessment, a cement content of 125 kg/m^3 was assumed.

3.2 System boundary

Type of EPD: "From cradle to plant gate, with options." Declared are the production phase as well as other selected life cycle phases.

Module A1:
Production of cement and bentonite as well as the provision of water.

Module A2:
Transport of the base materials and the required equipment to the construction site.

Module A3:
Mixing of the binder slurry on the construction site.

Module A4:
As the production site and the construction site are identical, no environmental impacts are specified in this module.

Module A5:
Insertion of the slurry which has been produced, incl. the drilling process and the mixing process with the ground (diesel consumption).

Module B1:
No environmental impacts arise from the use of the MIP construction material. In this module, the CO_2 absorption due to carbonation during the service life is listed as having negative global warming potential.

Module B2 and B3:
For Mixed-in-Place construction components, there are generally no environmental impacts during their reference service life.

Module C1:
Dismantling/demolition of Mixed-in-Place construction components.

Module C2:
Transport of Mixed-in-Place demolition material to the processing facility.

Module C3:
Breaking and treatment of Mixed-in-Place demolition material (until the "end of being characterized as waste" is reached).

Module C4:
As only a very small amount of the demolished construction debris is disposed of in landfill and the "Treatment and use" scenario was selected for end-of-life, no environmental impacts are specified for the landfill disposal of MIP construction material.

Module D:
Benefit for use of MIP demolition material in earthworks and road construction.

3.3 Estimates and assumptions

There were no estimates and assumptions.

3.4 Cut-off criteria

All base materials and processes used were taken into account. The small amounts of waste arising from cement production (e.g. packaging material) are ignored in the life cycle assessment and are therefore not listed under "Other environmental information describing different waste categories".

3.5 Background data

The production data for the manufacture of Mixed-in-Place construction material was determined by BAUER Spezialtiefbau GmbH. Data from the year 2020 were used for the life cycle assessment of the cement production, which were determined by VDZ gGmbH as part of the life cycle assessment of cements. The life cycle assessment was carried out with *GaBi ts* 10.6.1.35 software (Sphera Solutions GmbH). Generic records from the *GaBi ts*-database (CUP 2021.1) were used for the life cycle assessment.

3.6 Data quality

The following applies for the foreground data: The geographical, technological and temporal representativeness of the data can be assessed as "very good". The following applies for the generic background data: The geographical and technological representativeness of the data can be assessed as "very good", the temporal representativeness as "good".

3.7 Period under review

The data used relate to the production of MIP construction material in 2020.

3.8 Allocation

An economical allocation was carried out for granulated slag and fly ash, which are used for cement production.

3.9 Comparability

As a matter of principle, a comparison or the assessment of EPD data is only possible if all the records to be compared were created in accordance with *EN 15804* and the building context or the product-specific performance characteristics are taken into account.

Database used: *GaBi ts*-database (CUP 2021.1)

4. LCA: Scenarios and additional technical information

Characteristic product properties of biogenic carbon

Information on the description of the biogenic carbon content at the plant gate

Description	Value	Unit
Biogenic carbon in the product	0	kg C
Biogenic carbon in the associated packaging	0	kg C

The following technical information forms the basis for the declared modules.

Module B1:
Due to carbonation, cement-bound construction materials absorb carbon dioxide from the environment during their service life. This can be expressed as negative global warming potential in module B1. Assumption: Carbonation on one side in contact with the ground, thickness of MIP construction component 55 cm.

C1: Dismantling:
No experience has yet been gained with the dismantling of MIP construction components. For life cycle assessment, it is assumed that the environmental impacts correspond to the dismantling of concrete construction components. The assumptions that form the basis of the *EPDs* for concrete issued by the InformationsZentrum Beton GmbH (September 2018) have been adopted. Typically, the dismantling of concrete structures is predominantly carried out with long reach excavators, which are equipped with demolition shears. The concrete structures are dismantled using so-called "pressure-cutting", i.e. the crushing of concrete by applying compressive force.

C2: Transport from MIP demolition material to the crushing plant:
The assumptions that form the basis of the EPDs for concrete issued by the InformationsZentrum Beton GmbH (September 2018) have been adopted. In this EPD, the average transport distance for the transport of concrete waste to the treatment process is estimated at approx. 50 km.

C3: Waste treatment:
No experience has yet been gained with the waste treatment of MIP construction components. For life cycle assessment, it is assumed that the environmental impacts correspond to the waste treatment of concrete construction components. The assumptions that form the basis of the EPDs for concrete issued by the InformationsZentrum Beton GmbH (September 2018) have been adopted. Treatment generally takes place using jaw crushers or impact crushers. In addition to crushing, pre-screening and metal separation is also carried out.

End of life (C1-C4)

Description	Value	Unit
Separately collected mineral construction waste	1900	kg
Collected as mixed construction waste	0	kg
For reuse	0	kg
For recycling	1900	kg
For energy recovery	0	kg
For landfill disposal	0	kg

D: Benefits and loads after end-of-life: In the crushing plant, the MIP construction material reaches the end of being characterized as waste. The output at the end of the crushing process is a secondary material that can replace the primary materials sand and gravel. Life cycle assessment benefits are specified for this in module D.
Additional information on carbonation: *EN 16757* specifies 75% of the maximum possible CO_2 absorption as the average guide value for the long-term absorption of CO_2 by cement-bound construction materials. This value results in 13.4 kg/m^3 MIP construction material for a MIP construction material of class II. However, this value should only be understood as a reference value, as it is subject to many influencing factors.

5. LCA: Results

DESCRIPTION OF THE SYSTEM BOUNDARY (X = INCLUDED IN LIFE CYCLE ASSESSMENT; ND = MODULE OR INDICATOR NOT DECLARED; MNR = MODULE NOT RELEVANT)

Production stage			Construction process stage		Use stage							End of life stage				Benefits and loads beyond the system boundaries
Raw materials supply	Transport	Manufacture	Transport from the gate to the site	Installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Dismantling/ demolition	Transport	Waste treatment	Disposal	Reuse, Recovery or Recycling potential
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
X	X	X	X	X	X	ND	MNR	MNR	MNR	ND	ND	X	X	X	ND	X

RESULTS OF LIFE CYCLE ASSESSMENT – ENVIRONMENTAL IMPACTS acc. to EN 15804+A2: 1 m^3 Mixed-in-Place (MIP) construction material, BAUER MIP® Class II, cement contents from 100 kg/m^3 to < 150 kg/m^3

Core indicator	Unit	A1-A3	A4	A5	B1	C1	C2	C3	D
GWP-total	[kg CO_2-eq.]	50.40	0.00	23.30	-0.30	3.15	7.94	4.15	-4.45
GWP-fossil	[kg CO_2-eq.]	50.30	0.00	23.10	-0.30	3.13	7.88	4.10	-4.41
GWP-biogenic	[kg CO_2-eq.]	1.40E-1	0.00E+0	8.07E-2	0.00E+0	1.00E-2	2.90E-2	3.90E-2	-3.00E-2
GWP-luluc	[kg CO_2-eq.]	2.00E-2	0.00E+0	7.45E-2	0.00E+0	1.00E-2	3.00E-2	9.20E-3	-1.00E-2
ODP	[kg CFC11-eq.]	9.49E-9	0.00E+0	2.10E-11	0.00E+0	6.47E-13	1.61E-12	5.34E-11	-3.51E-11
AP	[mol H^+-eq.]	1.01E-1	0.00E+0	2.55E-1	0.00E+0	4.22E-2	2.70E-2	3.21E-2	-1.47E-2
EP-freshwater	[kg P-eq.]	8.02E-5	0.00E+0	4.41E-5	0.00E+0	6.30E-6	1.57E-5	1.49E-5	-1.25E-5
EP-marine	[kg N-eq.]	3.11E-2	0.00E+0	1.06E-1	0.00E+0	1.92E-2	1.27E-2	1.42E-2	-5.74E-3
EP-terrestrial	[mol N-eq.]	3.54E-1	0.00E+0	1.16E+0	0.00E+0	2.11E-1	1.42E-1	1.56E-1	-6.32E-2
POCP	[kg NMVOC-eq.]	9.07E-2	0.00E+0	3.15E-1	0.00E+0	5.74E-2	2.46E-2	4.20E-2	-1.35E-2
ADPE	[kg Sb-eq.]	6.94E-6	0.00E+0	2.35E-6	0.00E+0	3.17E-7	7.89E-7	1.35E-6	-1.00E-6
ADPF	[MJ]	308.00	0.00	307.00	0.00	41.90	104.00	54.60	-58.20
WDP	[m^3 world-eq. extracted]	1.46E+1	0.00E+0	8.83E-1	0.00E+0	1.00E-2	3.40E-2	6.00E-2	-1.10E-1

Key	GWP = Global Warming Potential; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential of land and water; EP = Eutrophication potential; POCP = Formation potential of tropospheric ozone; ADPE = Abiotic depletion potential for non-fossil resources (ADP – substances); ADPF = Abiotic depletion potential for fossil resources (ADP – fossil energy resources); WDP = Water deprivation potential (user)

RESULTS OF LIFE CYCLE ASSESSMENT – INDICATORS FOR THE DESCRIPTION OF RESOURCE USE in accordance with EN 15804+A2: 1 m^3 Mixed-in-Place (MIP) construction material, BAUER MIP® Class II, cement contents from 100 kg/m^3 to < 150 kg/m^3

Indicator	Unit	A1-A3	A4	A5	B1	C1	C2	C3	D
PERE	[MJ]	106.00	0.00	28.50	0.00	2.75	6.85	27.10	-18.40
PERM	[MJ]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PERT	[MJ]	106.00	0.00	28.50	0.00	2.75	6.85	27.10	-18.40
PENRE	[MJ]	308.00	0.00	307.00	0.00	41.90	104.00	54.60	-53.80
PENRM	[MJ]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PENRT	[MJ]	308.00	0.00	307.00	0.00	41.90	104.00	54.60	-53.80
SM	[kg]	0.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RSF	[MJ]	28.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NRSF	[MJ]	66.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FW	[m^3]	0.60	0.00	0.77	0.00	0.04	0.11	0.08	-0.11

Key	PERE = Renewable primary energy as energy source; PERM = Renewable primary energy for material utilization; PERT = Total use of renewable primary energy; PENRE = Non-renewable primary energy as energy source; PENRM = Non-renewable primary energy for material utilization; PENRT = Total use of non-renewable primary energy; SM = Use of secondary materials; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels; FW = Net use of fresh water

RESULTS OF LIFE CYCLE ASSESSMENT – WASTE CATEGORIES AND OUTPUT FLOWS in accordance with EN 15804+A2: 1 m^3 Mixed-in-Place (MIP) construction material, BAUER MIP® Class II, cement contents from 100 kg/m^3 to < 150 kg/m^3

Indicator	Unit	A1-A3	A4	A5	B1	C1	C2	C3	D
HWD	[kg]	3.10E-3	0.00E+0	5.94E-9	0.00E+0	1.83E-10	4.54E-10	3.24E-9	-2.58E-9
NHWD	[kg]	4.87E-1	0.00E+0	5.01E+2	0.00E+0	6.80E-3	1.69E-2	3.30E-2	-3.96E+1
RWD	[kg]	1.27E-2	0.00E+0	1.33E-3	0.00E+0	5.26E-5	1.31E-4	2.56E-3	-1.83E-3
CRU	[kg]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MFR	[kg]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MER	[kg]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EEE	[MJ]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EET	[MJ]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Key	HWD = Hazardous waste disposed; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed; CRU = Components for re-use; MFR = Materials for recycling; MER = Materials for energy recovery; EEE = Exported electrical energy; EEE = Exported thermal energy

RESULTS OF LIFE CYCLE ASSESSMENT – additional impact categories in accordance with EN 15804+A2 optional: 1 m³ Mixed-in-Place (MIP) construction material, BAUER MIP® Class II, cement contents from 100 kg/m³ to < 150 kg/m³

Indicator	Unit	A1-A3	A4	A5	B1	C1	C2	C3	D
PM	[Cases of illness]	7.07E-7	0.00E+0	1.13E-5	0.00E+0	2.25E-6	1.51E-7	1.58E-6	-9.31E-7
IRP	[kBq U235-eq.]	2.49E+0	0.00E+0	1.43E-1	0.00E+0	5.35E-3	1.33E-2	2.34E-1	-1.82E-1
ETP-fw	[CTUe]	2.50E+2	0.00E+0	2.15E+2	0.00E+0	3.29E-1	7.97E+1	3.31E+1	-3.65E+1
HTP-c	[CTUh]	7.39E-9	0.00E+0	1.16E-8	0.00E+0	6.42E-10	1.60E-9	9.31E-10	-1.87E-9
HTP-nc	[CTUh]	7.08E-7	0.00E+0	1.16E-6	0.00E+0	4.84E-8	9.28E-8	4.94E-8	-1.64E-7
SQP	[-]	151.30	0.00	83.90	0.00	12.60	31.20	24.90	-22.60

Key	PM = Potential incidence of disease due to particulate matter emissions; IRP = Potential effect from human exposure to U235; ETP-fw = Potential toxicity comparison unit for ecosystems; HTP-c = Potential toxicity comparison unit for humans (carcinogenic effect); HTP-nc = Potential toxicity comparison unit for humans (non-carcinogenic effect); SQP = Potential soil quality index

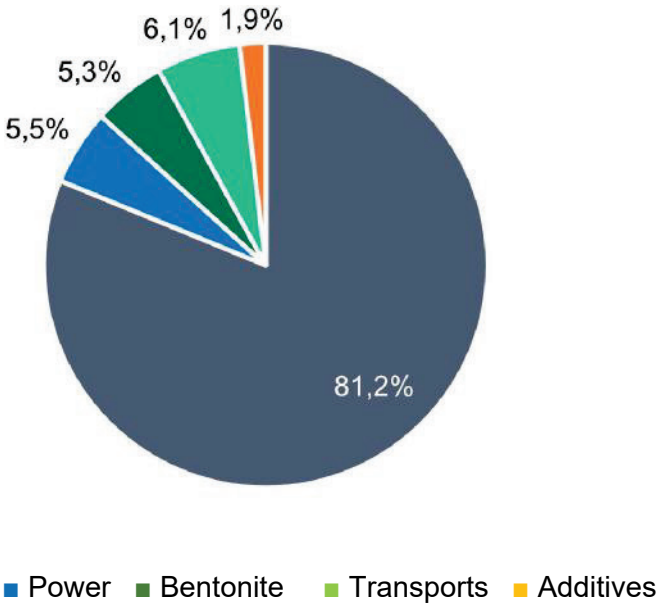
Net values are declared in A1–A3 for all GWP (global warming potential) indicators. The waste status of the (waste-based) energy sources has been verified. The gross emissions (i.e. including CO_2 from the combustion of waste) are:
58.7 kg CO_2-eq/m³ (GWP-total)
55.9 kg CO_2-eq/m³ (GWP-fossil)
2.7 kg CO_2-eq/m³ (GWP-biogenic)
with these values representing the corresponding sums from the net values and the emissions resulting from the incineration of verified waste materials.

Disclaimer 1 — applies for the indicator "Potential effect from human exposure to U235". This impact category deals mainly with the possible impact of low dose ionizing radiation on human health in the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents or occupational exposure, nor due to radioactive waste disposal in underground facilities. Potential ionizing radiation from the ground, from radon and from some construction materials is also not measured by this indicator.

Disclaimer 2 — applies for the indicators: "Abiotic depletion potential - non-fossil resources", "Abiotic depletion potential - fossil resources", "Water deprivation potential (user)", "Potential toxicity comparison unit for ecosystems", "Potential toxicity comparison unit for humans - carcinogenic effect"; "Potential toxicity comparison unit for humans - non-carcinogenic effect"; "Potential soil quality index".
The results of these environmental indicators must be used with caution, as there is a high level of uncertainty regarding these results or there is only limited experience in relation to the indicator.

6. LCA: Interpretation

The following diagram indicates the most important influencing factors for the global warming potential (Module A1–A3):



The range of the MIP construction materials used to generate the average values encompasses

- MIP construction materials where the environmental impact parameters listed in Section 5 and the resource use (Module A1–A3) are exceeded by up to 20%

up to

- MIP construction materials where the environmental impact parameters listed in Section 5 and the resource use (Module A1–A3) fall short by up to 20%

7. Requisite evidence

7.1 Radioactivity

Measurement of nuclide contents in Bq/kg for Ra-226, Th-232, K-40. In Germany, there are currently no legally specified limit values for assessing the radioactivity of construction materials. Assessment can be carried out in accordance with:
- Document of the European Commission 'Radiation Protection 112'
- OENORM 5200
- Nordic Countries' Recommendation 2000.

7.2 Leaching

To test the leaching of construction materials, test procedures such as *CEN/TS 16637-2* (monolithic test specimens) as well as *CEN/TS 16637-3* (permeable construction materials, e.g. rock gravel) are used. Tests are not required for most of the base materials of MIP construction materials and fields of application (e.g. natural rock gravel or cements in accordance with *EN 197-1*).

Requirements for leaching may arise for MIP construction materials containing cement additives in the relevant fields of application. If the construction materials are not covered by harmonized standards, their compliance with requirements is verified as part of the technical approval of the materials.

8. Literature references

Standards

CEN/TS 16637-2
DIN CEN/TS 16637-2:2014-11; DIN SPEC 18046-2:2014-11, Construction products - Assessment of release of dangerous substances - Part 2: Horizontal dynamic surface leaching test; German version CEN/TS 16637-2:2014.

CEN/TS 16637-3
DIN CEN/TS 16637-3:2016-12; DIN SPEC 18046-3:2016-12 Construction products - Assessment of release of dangerous substances - Part 3: Horizontal up-flow percolation test; German version CEN/TS 16637-3:2016.

DIN 4093
DIN 4093:2015-11 Design of strengthened soil - Set up by means of jet grouting, deep mixing or grouting.

DIN 4102-1
DIN 4102-1:1998-05 Fire behaviour of building materials and building components - Part 1: Building materials; concepts, requirements and tests.

EN 197-1
DIN EN 197-1:2011-11 Cement - Part 1: Composition, specifications and conformity criteria for common cements.

EN 12390-3
DIN EN 12390-3:2019-10 Testing hardened concrete - Part 3: Compressive strength of test specimens.

EN 13501-1
DIN EN 13501-1:2010 Fire Classification Of Construction Products And Building Elements - Part 1: Classification Using Data From Reaction To Fire Tests.

EN 15804
DIN EN 15804:2022-03, Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products; German version EN 15804:2012+A2:2019 + AC:2021.

EN 16757
DIN EN 16757:2017-10 Sustainability Of Construction Works - Environmental Product Declarations - Product Category Rules For Concrete And Concrete Elements.

ISO 14025
DIN EN ISO 14025:2011-10 Environmental labels and declarations - Type III environmental declarations - Principles and procedures (ISO 14025:2006); German and English version EN ISO 14025:2011.

ISO 15686-8
ISO 15686-8:2008-06 Buildings and constructed assets - Service-life planning - Part 8: Reference service life and service-life estimation.

ISO 17892-7
ISO 17892-7:2017-11 Geotechnical Investigation And Testing - Laboratory Testing Of Soil - Part 7: Unconfined Compression Test.

Laws, rules and regulations

AVV
Directive on the European Waste List: Waste List Directive (AVV) dated December 10, 2001 (Federal Law Gazette I p. 3379), last amended by Article 2 of the directive dated July 17, 2017 (Federal Law Gazette p. 2644).

DepV2009
Landfill regulation - regulation concerning landfills and long-term storage, Berlin: Federal Ministry of Justice and Consumer Protection.

DWA
Data sheet DWA-M 512-1, February 2012. Sealing Systems in Hydraulic Engineering. Part: 1: Earthwork Structures. Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall e. V. (*German Association for Water, Wastewater and Waste*) (DWA) (Publisher).

"Framework paper Bavaria"
Requirements for fill materials for pits and quarries as well as open-cast mines, version dated July 15, 2021.

LAGA-ground
Notification of the Ländergemeinschaft (LAGA) (*German Association of Federal Government and Federal States*) M20, Requirements for the recycling of mineral-based residual materials/waste - Technical Regulations - Status November 6, 2003.

REACH
REGULATION (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/E.

VwVWS
Administrative Regulation on Substances Hazardous to Water dated 17/05/1999 (Federal Gazette No. 98a dated 29/05/1999), amended by Administrative Regulation dated 27/07/2005 (Federal Gazette No. 142a dated 30/07/2005).

Other sources

General type approval
National technical approval "BAUER Mixed-In-Place (MIP)" Z-34.26-200, Deutsches Institut für Bautechnik (*German Institute of Construction Technology*), Berlin

DAfStb1
Commentary of the Deutscher Ausschuss für Stahlbeton e.V. (*German Committee for Reinforced Concrete*) (DAfStb) on the current regulatory status of the environmental impact of concrete (December 2010).

GaBi ts
Software and database for life cycle assessment, version 10.6.1.35, Sphera Solutions GmbH.

EPDs
EPDs (declaration owner: InformationsZentrum Beton GmbH)

- Environmental Product Declaration Concrete of compressive strength class C 20/25, EPD-IZB-20180097-IBG1-DE
- Environmental Product Declaration Concrete of compressive strength class C 25/30, EPD-IZB-20180101-IBG1-DE
- Environmental Product Declaration Concrete of compressive strength class C 30/37, EPD-IZB-20180102-IBG1-DE
- Environmental Product Declaration Concrete of compressive strength class C 35/45, EPD-IZB-20180098-IBG1-DE
- Environmental Product Declaration Concrete of compressive strength class C 45/55, EPD-IZB-20180099-IBG1-DE
- Environmental Product Declaration Concrete of compressive strength class C 50/60, EPD-IZB-20180100-IBG1-DE

IBU 2021
IBU (2021): General program information of the Institut Bauen und Umwelt e.V. (IBU). Version 2.0, Institut Bauen und Umwelt e.V., Berlin.

PCR part A
Product category rules for building-related products and services. Part A: Calculation rules for the life cycle assessment and requirements for the project report in accordance with EN 15804+A2:2021 (v1.2). Berlin: Institut Bauen und Umwelt e.V. (Publisher), 2021-09.

PCR cement
Product category rules for building-related products and services. Part B: Requirements for the EPD for cement, Version 1.7. Berlin: Institut Bauen und Umwelt e.V. (Publisher), 2022-05. www.ibu-epd.com

Umwelt1
Rheinberger, Ulrike, Dirk Bunke and Outi Ilvonen. 2007. Safe Construction Products for Health and the Environment: How much inspection effort is required to implement the EU Construction Products Directive? Dessau: German Federal Environmental Agency. http://d-nb.info/990406695/34.

ZEM
Zement Taschenbuch (cement paperback). Verein Deutscher Zementwerke
e.V. *(German Cement Works Association*) (2008)

Published by
Institut Bauen und Umwelt e.V.
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ENVIRONMENTAL PRODUCT DECLARATION

in accordance with *ISO 14025* and *EN 15804+A2*

Declaration owner	**BAUER Spezialtiefbau GmbH**
Published by	Institut Bauen und Umwelt e.V. (IBU)
Program operator	Institut Bauen und Umwelt e.V. (IBU)
Declaration number	EPD-BAU-20230030-ICC1-DE
Issue date	February 7, 2023
Valid until	February 6, 2028

BAUER MIP® Class III

BAUER Spezialtiefbau GmbH

Institut Bauen und Umwelt e.V.

www.ibu-epd.com | https://epd-online.com

ECO PLATFORM EPD VERIFIED

1. General information

BAUER Spezialtiefbau GmbH

Program operator
IBU - Institut Bauen und Umwelt e.V.
Hegelplatz 1
10117 Berlin
Germany

Declaration number
EPD-BAU-20230030-ICC1-DE

This declaration is based on the product category rules:
Concrete construction components made of in-situ concrete or ready-mixed concrete, 03/2022 (PCR tested and approved by the *Sachverständigenrat (Independent Council of Experts*) (SVR).

Issue date
February 7, 2023

Valid until
February 6, 2028

Dipl. Ing. Hans Peters
(CEO of Institut Bauen und Umwelt e.V.)

Dr. Alexander Röder
(Managing Director Institut Bauen und Umwelt e.V)

BAUER MIP® Class III

Declaration owner
BAUER Spezialtiefbau GmbH
BAUER-Str. 1
86529 Schrobenhausen
Germany

Declared product/declared unit
1 m^3 Mixed-in-Place- (MIP-) construction material, Class III

Scope of application:
The environmental product declaration refers to the average composition of an MIP (Mixed-in-Place) construction material manufactured by BAUER Spezialtiefbau GmbH.

Mixed-in-Place construction materials are mainly used in the manufacture of retaining structures (e.g. retaining walls). foundations or flood protection facilities. as well as for the construction of retaining structures for landfills or cut-off walls.

The environmental product declaration is based on data, which were collected for the year 2020 by BAUER Spezialtiefbau GmbH.

The declaration owner is liable for the information and evidence on which this declaration is based; liability of the IBU regarding manufacturer's information, life cycle assessment data and evidence is excluded. The EPD has been created in accordance with the specifications of *EN 15804+A2*. In the following, the name of the standard is simplified as *EN 15804*.

Verification
The European standard *EN 15804* is the key PCR
Independent verification of the declaration and information in accordance with *ISO 14025:2011*

☐ internal ☐ external

Angela Schindler,
Independent verifier

2. Product

2.1 Product description/Product definition The Mixed-in-Place construction material (MIP construction material) is created directly in the construction soil. The MIP method involves breaking open the existing ground with a single or triple auger, moving it and filling the pores with binder slurry (Figure 1). The binder slurry, consisting of concrete, water, as well as bentonite and concrete additives where appropriate, is manufactured in-situ on the MIP construction site. When manufacturing MIP walls, the individual cuts in the construction soil, which were already created using the MIP equipment and are still fresh, are combined into walls using the pilgrim step method. The declared product is therefore produced in the construction soil and consists of the binder slurry and the ground which has been incorporated, where the dimensions of the auger(s) determine the dimensions of the construction component.

The MIP construction material which has been produced cures in the specified form by hydrating the cement, creating solid, artificial stone.

The declared product is the unreinforced MIP construction material or does not contain steel beams or other built-in components. In case of reinforced construction components, structural built-in components or non-structural built-in components, the respective share must be considered separately.

The determination of the life cycle assessment of the average MIP construction material with a cement content of 150 kg/m^3 to < 230 kg/m^3 was based on

the production data.

For the use of the product in construction components which are relevant for national technical approvals, *DIN 4093* as well as the "BAUER Mixed-In-Place (MIP)" type approval with approval number Z-34.26-200 apply at the place of use (general type approval (*GTA*)).

For construction components outside the scope relevant for building authorities, reference is made to the DWA set of rules DWA-M 512-1 "Sealing Systems in Hydraulic Engineering - Part 1: Earthwork Structures" (*DWA*).

2.2 Application

The MIP construction material has many applications in the construction soil.

Typical applications of MIP construction materials are:

- Retaining walls for retaining structures or height differences in the terrain
- Cut-off walls for flood protection facilities, groundwater barriers or for dike or dam rehabilitation
- Encompassment of abandoned polluted areas
- Foundation elements (as pile-like elements).

2.3 Technical data

The BAUER MIP® Class III construction material (cement content of 150 kg/m^3 to < 230 kg/m^3) has the following technical properties:

Construction data

The properties that can be achieved are influenced by the conditions of the construction soil.

Values for class III

Description	Value	Unit
Thermal conductivity	–	W/(mK)
Design value of thermal conductivity	1.15 - 1.65	W/(mK)
Water vapor diffusion resistance coefficient	10 - 80	–
Degree of noise absorption	–	%
Bulk density	1500 - 2600	kg/m^3
Compressive strength f_m,i acc. to DIN EN ISO 17892-7 or DIN EN 12390- 3 after 28 days	1 - 10	N/mm^2
Modulus of elasticity	200 - 15000	N/mm2
Equilibrium moisture content	3	%
Compressive strength f_m,i in accordance with DIN EN ISO 17892-7 or DIN EN	0.1 - 2	N/mm^2
Water permeability coefficient	1E-07 - 1E-12	m/s
Spec. thermal capacity cp	300 - 500	J/kg K
Tensile strength approx.	8 - 15	% of f_m,i
Flexural strength approx.	15 - 30	% of f_m,i

Decisive test standards are /*DIN EN ISO 17892-7*/ and /*DIN EN 12390-3*/.

Performance data of the MIP construction material regarding its characteristics in accordance with the decisive technical regulation (no CE marking).

2.4 Delivery status

The MIP construction material is produced directly on the construction site and at the point of application in the construction soil. The required binder slurry is mixed on-site on the construction site ready for application and fed to the MIP equipment. The MIP equipment processes the binder slurry with the existing ground in the planned dimensions of the construction component to be produced.

2.5 Base materials/Ancillary materials

- Cement, CEM III/B*: 6.8 – 12.8 m% (* special binding agent with same composition is possible)
- Mixing water: 8.3 – 22.3 m%
- Bentonite: 0 – 1.7 m%
- Additive: 0 – 0.6 m%
- Ground, moist (solids + inherent moisture): 62.7 – 84.9 m%

The total mass of the MIP construction material depends to a significant extent on the existing ground, which is a component of the MIP construction material. The density of the ground itself can differ from site to site. For this reason, the percentage by mass refers to 2,000 kg/m^3 ready-to-use MIP construction material to illustrate the product composition.

The product/at least one partial product contains substances on the ECHA List of Candidate Substances of Very High Concern (SVHC) (dated June 10, 2022) exceeding 0.1% by mass: No

The product/at least one partial product contains additional CMR substances in category 1A or 1B, which are not on the List of Candidates, exceeding 0.1% by mass in at least one partial product: No

Biocide products were added to this construction product or it has been treated with biocide products (this then concerns a treated product as defined by the (EU) Ordinance on Biocide Products No. 528/2012): No

2.6 Manufacture

First, the binder slurry is manufactured directly on the construction site using the base materials (cement, mixing water, bentonite, additives) (see 2.5 Base materials).

The MIP construction material is created directly in the construction soil by breaking open the existing ground with a single or triple auger, moving it and filling the pores with binder slurry that has been produced (Figure 1).

In accordance with Figure 1, cement-based binder slurries are generally incorporated in the construction

soil. As an alternative to standard cement in accordance with EN 197-1, special cement-based binding agents can also be used, whose composition corresponds to a CEM III/B, i.e. a mixture of Portland cement and granulated slag.

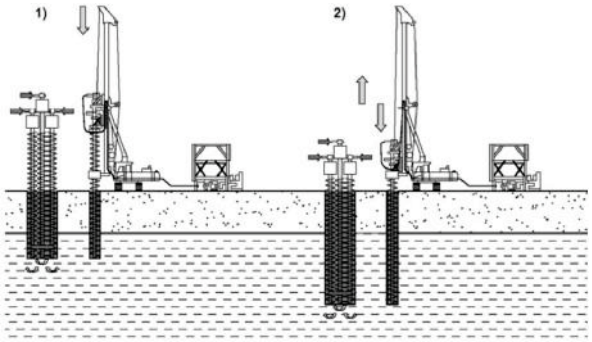


Figure 1: MIP method with triple auger [DWA-M 512-1], left: Drilling and concreting process; right: Homogenization process

To ensure the required quality of the MIP elements or walls, the manufacturing process is monitored in accordance with the decisive parameters for the properties.

2.7 Environment and health during manufacturing

The mixing and processing of binder slurries is common practice on many specialist foundation engineering construction sites. Uncured slurry residues in mixers, as well as reservoirs, pumps and delivery hoses, where appropriate, are disposed of properly (see Section 2.15).

The fresh binder slurry as well as the finished MIP construction material contain a strongly alkaline solution, which is created when mixing cement with water and can cause irritation to skin and eyes.

Due to the water-soluble chromate contained in cements other than low-chromate cements, sustained contact with binder slurries or MIP construction materials made of such cements can lead to the development of allergic chromate dermatitis. In accordance with the REACH Regulation (*REACH*), low-chromate cements are therefore used if there is a danger of skin contact.

Additional information is provided in the safety data sheets of the cement manufacturer.

2.8 Product processing/Installation

The binder slurry is manufactured on the construction site, stored for a short period of time if necessary and then transported to the MIP equipment, which mixes the binder slurry with the ground during and after the drilling process.

2.9 Packaging

The base materials of the binder slurry are delivered without packaging.

2.10 Condition of use

As a rule, the composition of the MIP construction material-does not change its condition during use.

2.11 Environment and health during use

The naturally ionizing radiation of the MIP construction material is low and does not pose a health hazard [see Section 7]. Construction components in contact with the ground which are made from the MIP construction material can significantly reduce the influx of radon from the ground (*ZEM*).

The environmental compatibility of the MIP construction material is ensured by using only base materials which are considered to be harmless or whose environmental compatibility has been verified through a National Technical Approval.

The existing ground becomes part of the MIP construction material and therefore does not require verification of its environmental compatibility.

The base materials of the MIP construction material which are mixed in via the binder slurry are predominantly standardized materials which a priori do not require further verification (*DAfStb1).* Instead of standard cement, a special binding agent can be used in the binder slurry, whose composition is similar to standard cement. In addition, bentonite can be used.

Bentonite can be used on the basis of the product-specific water hazard class in combination with the administrative regulations of the German Federal Environmental Agency *(VwVWS* May 17, 1999 and July 27, 2005*).* Bentonite is also listed in the list for substances for "Safe Construction Products for Health and the Environment" of the German Federal Environmental Agency (*Umwelt1*).

2.12 Reference service life

The MIP construction material is designed for an intended service life of at least 50 years for permanent structures, taking into account the existing exposure classes/environmental conditions (general type approval (*GTA*)). The MIP construction material can also be used for temporary purposes. A calculation of the reference service life in accordance with *ISO 15686-8* is not possible for temporary applications.

2.13 Accidental actions

Fire

MIP construction materials meet the requirements of construction material class A1, "non-flammable" in accordance with *DIN 4102-1* and *EN 13501-1*. No toxic gases and fumes can occur in case of fire, and burning construction material components do not drop or fall off.

Fire protection

Description	Value
Construction material class	A1 "non-flammable"

Water

When exposed to water (e.g. floods), the MIP construction material remains mostly inert. Substances are not washed out in quantities which could be hazardous to water.

Mechanical destruction

Not relevant for MIP construction material.

2.14 Re-use phase
Construction components made of MIP construction material can be dismantled. In order to recycle reinforced construction components, the demolished material is separated from the structural steel or reinforcing steel and is processed. For this purpose, the MIP construction material is first crushed and separated into individual grain fractions. In small amounts, they can then be used as recycled rock gravel, e.g. for the construction of earth concrete walls. The reinforcing steel or structural steel is recycled as scrap steel.

If separate base elements are used in the MIP construction material, they can consist of steel or other construction materials (such as glass-reinforced plastic, carbon fiber-reinforced plastic, wood, composite reinforcement). When using pre-fabricated elements or structural elements, it is generally possible to re-use them in their entirety.

2.15 Disposal
In Germany, disposal is generally ensured in accordance with Z1.1/Z1.2 according to the Working Group of the Federal States on Waste - Ground (*LAGA Ground)* or "Framework paper Bavaria" („*Eckpunktepapier-Bayern*"). In individual cases, the Landfill Regulation (*DepV2009*) may become relevant for disposal.

For MIP waste made of cement-bound material, waste codes 17 01 01, 17 01 07 and 17 05 04 (*AVV*) apply in accordance with the waste recycling list. For steel which may be contained in the MIP construction material (not included in the EPD), waste code 17 04 05 applies (*AVV*).

2.16 Additional information
https://www.bauer.de/bst/

3. LCA: Calculation rules

3.1 Declared unit
The declared unit is one cubic meter (1 m^3) of Mixed-in-Place construction material.

If MIP construction components contain steel beams, lattice girders or other built-in components, a separate life cycle assessment must be carried out for them.

Declared unit

Description	Value	Unit
Declared unit	1	m^3
Density (mean value)	1900	kg/m^3

The cement content in the composition of the construction material can be 150 to < 230 kg/m^3 MIP construction material in this class. For the life cycle assessment, a cement content of 190 kg/m^3 was assumed.

3.2 System boundary
Type of EPD: "From cradle to plant gate, with options." Declared are the production phase as well as other selected life cycle phases.

Module A1:
Production of cement and bentonite as well as the provision of water.

Module A2:
Transport of the base materials and the required equipment to the construction site.

Module A3:
Mixing of the binder slurry on the construction site.

Module A4:
As the production site and the construction site are identical, no environmental impacts are specified in this module.

Module A5:
Insertion of the slurry which has been produced, incl. the drilling process and the mixing process with the ground (diesel consumption).

Module B1:
No environmental impacts arise from the use of the MIP construction material. In this module, the CO_2 absorption due to carbonation during the service life is listed as having negative global warming potential.

Module B2 and B3:
For Mixed-in-Place construction components, there are generally no environmental impacts during their reference service life.

Module C1:
Dismantling/demolition of Mixed-in-Place construction components.

Module C2:
Transport of Mixed-in-Place demolition material to the processing facility.

Module C3:
Breaking and treatment of Mixed-in-Place demolition material (until the "end of being characterized as waste" is reached).

Module C4:
As only a very small amount of the demolished construction debris is disposed of in landfill and the "Treatment and use" scenario was selected for end-of-life, no environmental impacts are specified for the landfill disposal of MIP construction material.

Module D:
Benefit for use of MIP demolition material in earthworks and road construction.

3.3 Estimates and assumptions
There were no estimates and assumptions.

3.4 Cut-off criteria
All base materials and processes used were taken into account. The small amounts of waste arising from cement production (e.g. packaging material) are ignored in the life cycle assessment and are therefore not listed under "Other environmental information describing different waste categories".

3.5 Background data

The production data for the manufacture of Mixed-in-Place construction material was determined by BAUER Spezialtiefbau GmbH. Data from the year 2020 were used for the life cycle assessment of the cement production, which were determined by VDZ gGmbH as part of the life cycle assessment of cements. The life cycle assessment was carried out with *GaBi ts* 10.6.1.35 software (Sphera Solutions GmbH). Generic records from the *GaBi ts*-database (CUP 2021.1) were used for the life cycle assessment.

3.6 Data quality

The following applies for the foreground data: The geographical, technological and temporal representativeness of the data can be assessed as "very good". The following applies for the generic background data: The geographical and technological representativeness of the data can be assessed as "very good", the temporal representativeness as "good".

3.7 Period under review

The data used relate to the production of MIP construction material in 2020.

3.8 Allocation

An economical allocation was carried out for granulated slag and fly ash, which are used for cement production.

3.9 Comparability

As a matter of principle, a comparison or the assessment of EPD data is only possible if all the records to be compared were created in accordance with *EN 15804* and the building context or the product-specific performance characteristics are taken into account.

Database used: *GaBi ts*-database (CUP 2021.1)

4. LCA: Scenarios and additional technical information

Characteristic product properties of biogenic carbon

Information on the description of the biogenic carbon content at the plant gate

Description	Value	Unit
Biogenic carbon in the product	0	kg C
Biogenic carbon in the associated packaging	0	kg C

The following technical information forms the basis for the declared modules.

Module B1:
Due to carbonation, cement-bound construction materials absorb carbon dioxide from the environment during their service life. This can be expressed as negative global warming potential in module B1. Assumption: Carbonation on one side in contact with the ground, thickness of MIP construction component 55 cm.

C1: Dismantling:
No experience has yet been gained with the dismantling of MIP construction components. For life cycle assessment, it is assumed that the environmental impacts correspond to the dismantling of concrete construction components. The assumptions that form the basis of the *EPDs* for concrete issued by the InformationsZentrum Beton GmbH (September 2018) have been adopted. Typically, the dismantling of concrete structures is predominantly carried out with long reach excavators, which are equipped with demolition shears. The concrete structures are dismantled using so-called "pressure-cutting", i.e. the crushing of concrete by applying compressive force.

C2: Transport from MIP demolition material to the crushing plant:
The assumptions that form the basis of the EPDs for concrete issued by the InformationsZentrum Beton GmbH (September 2018) have been adopted. In this EPD, the average transport distance for the transport of concrete waste to the treatment process is estimated at approx. 50 km.

C3: Waste treatment:
No experience has yet been gained with the waste treatment of MIP construction components. For life cycle assessment, it is assumed that the environmental impacts correspond to the waste treatment of concrete construction components. The assumptions that form the basis of the EPDs for concrete issued by the InformationsZentrum Beton GmbH (September 2018) have been adopted. Treatment generally takes place using jaw crushers or impact crushers. In addition to crushing, pre-screening and metal separation is also carried out.

End of life (C1-C4)

Description	Value	Unit
Separately collected mineral construction waste	1900	kg
Collected as mixed construction waste	0	kg
For reuse	0	kg
For recycling	1900	kg
For energy recovery	0	kg
For landfill disposal	0	kg

D: Benefits and loads after end-of-life: In the crushing plant, the MIP construction material reaches the end of being characterized as waste. The output at the end of the crushing process is a secondary material that can replace the primary materials sand and gravel. Life cycle assessment benefits are specified for this in module D.
Additional information on carbonation: *EN 16757* specifies 75% of the maximum possible CO_2 absorption as the average guide value for the long-term absorption of CO_2 by cement-bound construction materials. This value results in 20.4 kg/m^3 MIP construction material for a MIP construction material of class III. However, this value should only be understood as a reference value, as it is subject to many influencing factors.

5. LCA: Results

DESCRIPTION OF THE SYSTEM BOUNDARY (X = INCLUDED IN LIFE CYCLE ASSESSMENT; ND = MODULE OR INDICATOR NOT DECLARED; MNR = MODULE NOT RELEVANT)

Production stage			Construction process stage		Use stage							End of life stage				Benefits and loads beyond the system boundaries
Raw materials supply	Transport	Manufacture	Transport from the gate to the site	Installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Dismantling/ demolition	Transport	Waste treatment	Disposal	Reuse, Recovery or Recycling potential
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
X	X	X	X	X	X	ND	MNR	MNR	MNR	ND	ND	X	X	X	ND	X

RESULTS OF LIFE CYCLE ASSESSMENT – ENVIRONMENTAL IMPACTS in accordance with EN 15804+A2: 1 m³ Mixed-in-Place (MIP) construction material, BAUER MIP® Class III, cement contents from 150 kg/m³ to < 230 kg/m³

Core indicator	Unit	A1-A3	A4	A5	B1	C1	C2	C3	D
GWP-total	[kg CO_2-eq.]	72.50	0.00	23.30	-0.40	3.15	7.94	4.15	-4.45
GWP-fossil	[kg CO_2-eq.]	72.30	0.00	23.10	-0.40	3.13	7.88	4.10	-4.41
GWP-biogenic	[kg CO_2-eq.]	1.90E-1	0.00E+0	8.07E-2	0.00E+0	1.00E-2	2.90E-2	3.90E-2	-3.00E-2
GWP-luluc	[kg CO_2-eq.]	2.00E-2	0.00E+0	7.45E-2	0.00E+0	1.00E-2	3.00E-2	9.20E-3	-1.00E-2
ODP	[kg CFC11-eq.]	1.41E-8	0.00E+0	2.10E-11	0.00E+0	6.47E-13	1.61E-12	5.34E-11	-3.51E-11
AP	[mol H^+-eq.]	1.37E-1	0.00E+0	2.55E-1	0.00E+0	4.22E-2	2.70E-2	3.21E-2	-1.47E-2
EP-freshwater	[kg P-eq.]	1.10E-4	0.00E+0	4.41E-5	0.00E+0	6.30E-6	1.57E-5	1.49E-5	-1.25E-5
EP-marine	[kg N-eq.]	4.21E-2	0.00E+0	1.06E-1	0.00E+0	1.92E-2	1.27E-2	1.42E-2	-5.74E-3
EP-terrestrial	[mol N-eq.]	4.83E-1	0.00E+0	1.16E+0	0.00E+0	2.11E-1	1.42E-1	1.56E-1	-6.32E-2
POCP	[kg NMVOC-	1.26E-1	0.00E+0	3.15E-1	0.00E+0	5.74E-2	2.46E-2	4.20E-2	-1.35E-2
ADPE	[kg Sb-eq.]	9.53E-6	0.00E+0	2.35E-6	0.00E+0	3.17E-7	7.89E-7	1.35E-6	-1.00E-6
ADPF	[MJ]	410.00	0.00	307.00	0.00	41.90	104.00	54.60	-58.20
WDP	[m^3 world-eq. extracted]	1.51E+1	0.00E+0	8.83E-1	0.00E+0	1.00E-2	3.40E-2	6.00E-2	-1.10E-1

Key	GWP = Global Warming Potential; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential of land and water; EP = Eutrophication potential; POCP = Formation potential of tropospheric ozone; ADPE = Abiotic depletion potential for non-fossil resources (ADP – substances); ADPF = Abiotic depletion potential for fossil resources (ADP – fossil energy resources); WDP = Water deprivation potential (user)

RESULTS OF LIFE CYCLE ASSESSMENT – INDICATORS FOR THE DESCRIPTION OF RESOURCE USE in accordance with EN 15804+A2: 1 m³ Mixed-in-Place (MIP) construction material, BAUER MIP® Class III, cement contents from 150 kg/m³ to < 230 kg/m³

Indicator	Unit	A1-A3	A4	A5	B1	C1	C2	C3	D
PERE	[MJ]	141.00	0.00	28.50	0.00	2.75	6.85	27.10	-18.40
PERM	[MJ]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PERT	[MJ]	141.00	0.00	28.50	0.00	2.75	6.85	27.10	-18.40
PENRE	[MJ]	410.00	0.00	307.00	0.00	41.90	104.00	54.60	-53.80
PENRM	[MJ]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PENRT	[MJ]	410.00	0.00	307.00	0.00	41.90	104.00	54.60	-53.80
SM	[kg]	0.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RSF	[MJ]	42.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NRSF	[MJ]	100.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FW	[m^3]	0.69	0.00	0.77	0.00	0.04	0.11	0.08	-0.11

Key	PERE = Renewable primary energy as energy source; PERM = Renewable primary energy for material utilization; PERT = Total use of renewable primary energy; PENRE = Non-renewable primary energy as energy source; PENRM = Non-renewable primary energy for material utilization; PENRT = Total use of non-renewable primary energy; SM = Use of secondary materials; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels; FW = Net use of fresh water

RESULTS OF LIFE CYCLE ASSESSMENT – WASTE CATEGORIES AND OUTPUT FLOWS in accordance with EN 15804+A2: 1 m³ Mixed-in-Place (MIP) construction material, BAUER MIP® Class III, cement contents from 150 kg/m³ to < 230 kg/m³

Indicator	Unit	A1-A3	A4	A5	B1	C1	C2	C3	D
HWD	[kg]	3.10E-3	0.00E+0	5.94E-9	0.00E+0	1.83E-10	4.54E-10	3.24E-9	-2.58E-9
NHWD	[kg]	5.83E-1	0.00E+0	5.01E+2	0.00E+0	6.80E-3	1.69E-2	3.30E-2	-3.96E+1
RWD	[kg]	1.65E-2	0.00E+0	1.33E-3	0.00E+0	5.26E-5	1.31E-4	2.56E-3	-1.83E-3
CRU	[kg]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MFR	[kg]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MER	[kg]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EEE	[MJ]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EET	[MJ]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Key	HWD = Hazardous waste disposed; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed; CRU = Components for re-use; MFR = Materials for recycling; MER = Materials for energy recovery; EEE = Exported electrical energy; EEE = Exported thermal energy

RESULTS OF LIFE CYCLE ASSESSMENT – additional impact categories in accordance with EN 15804+A2 optional: 1 m³ Mixed-in-Place (MIP) construction material, BAUER MIP® Class III, cement contents from 150 kg/m³ to < 230 kg/m³

Indicator	Unit	A1-A3	A4	A5	B1	C1	C2	C3	D
PM	[Cases of illness]	9.33E-7	0.00E+0	1.13E-5	0.00E+0	2.25E-6	1.51E-7	1.58E-6	-9.31E-7
IRP	[kBq U235-eq.]	2.87E+0	0.00E+0	1.43E-1	0.00E+0	5.35E-3	1.33E-2	2.34E-1	-1.82E-1
ETP-fw	[CTUe]	2.92E+2	0.00E+0	2.15E+2	0.00E+0	3.29E-1	7.97E+1	3.31E+1	-3.65E+1
HTP-c	[CTUh]	1.05E-8	0.00E+0	1.16E-8	0.00E+0	6.42E-10	1.60E-9	9.31E-10	-1.87E-9
HTP-nc	[CTUh]	1.04E-6	0.00E+0	1.16E-6	0.00E+0	4.84E-8	9.28E-8	4.94E-8	-1.64E-7
SQP	[-]	214.90	0.00	83.90	0.00	12.60	31.20	24.90	-22.60

Key	PM = Potential incidence of disease due to particulate matter emissions; IRP = Potential effect from human exposure to U235; ETP-fw = Potential toxicity comparison unit for ecosystems; HTP-c = Potential toxicity comparison unit for humans (carcinogenic effect); HTP-nc = Potential toxicity comparison unit for humans (non-carcinogenic effect); SQP = Potential soil quality index

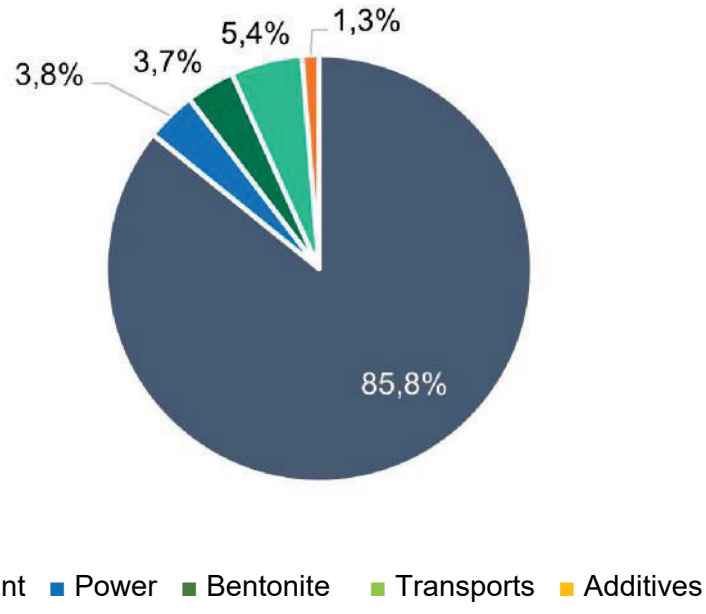
Net values are declared in A1–A3 for all GWP (global warming potential) indicators. The waste status of the (waste-based) energy sources has been verified. The gross emissions (i.e. including CO_2 from the combustion of waste) are:
84.9 kg CO_2-eq/m³ (GWP-total)
80.8 kg CO_2-eq/m³ (GWP-fossil)
4.1 kg CO_2-eq/m³ (GWP-biogenic)
with these values representing the corresponding sums from the net values and the emissions resulting from the incineration of verified waste materials.

Disclaimer 1 — applies for the indicator "Potential effect from human exposure to U235". This impact category deals mainly with the possible impact of low dose ionizing radiation on human health in the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents or occupational exposure, nor due to radioactive waste disposal in underground facilities. Potential ionizing radiation from the ground, from radon and from some construction materials is also not measured by this indicator.

Disclaimer 2 — applies for the indicators: "Abiotic depletion potential - non-fossil resources", "Abiotic depletion potential - fossil resources", "Water deprivation potential (user)", "Potential toxicity comparison unit for ecosystems", "Potential toxicity comparison unit for humans - carcinogenic effect"; "Potential toxicity comparison unit for humans - non-carcinogenic effect"; "Potential soil quality index".
The results of these environmental indicators must be used with caution, as there is a high level of uncertainty regarding these results or there is only limited experience in relation to the indicator.

6. LCA: Interpretation

The following diagram indicates the most important influencing factors for the global warming potential (Module A1–A3):



The range of the MIP construction materials used to generate the average values encompasses

- MIP construction materials where the environmental impact parameters listed in Section 5 and the resource use (Module A1–A3) are exceeded by up to 20%

up to

- MIP construction materials where the environmental impact parameters listed in Section 5 and the resource use (Module A1–A3) fall short by up to 20%

7. Requisite evidence

7.1 Radioactivity
Measurement of nuclide contents in Bq/kg for Ra-226, Th-232, K-40. In Germany, there are currently no legally specified limit values for assessing the radioactivity of construction materials. Assessment can be carried out in accordance with:
- Document of the European Commission 'Radiation Protection 112'
- OENORM 5200
- Nordic Countries' Recommendation 2000.

7.2 Leaching
To test the leaching of construction materials, test procedures such as *CEN/TS 16637-2* (monolithic test specimens) as well as *CEN/TS 16637-3* (permeable construction materials, e.g. rock gravel) are used. Tests are not required for most of the base materials of MIP construction materials and fields of application (e.g. natural rock gravel or cements in accordance with *EN 197-1*).

Requirements for leaching may arise for MIP construction materials containing cement additives in the relevant fields of application. If the construction materials are not covered by harmonized standards, their compliance with requirements is verified as part of the technical approval of the materials.

8. Literature references

Standards

CEN/TS 16637-2
DIN CEN/TS 16637-2:2014-11; DIN SPEC 18046-2:2014-11, Construction products - Assessment of release of dangerous substances - Part 2: Horizontal dynamic surface leaching test; German version CEN/TS 16637-2:2014.

CEN/TS 16637-3
DIN CEN/TS 16637-3:2016-12; DIN SPEC 18046-3:2016-12 Construction products - Assessment of release of dangerous substances - Part 3: Horizontal up-flow percolation test; German version CEN/TS 16637-3:2016.

DIN 4093
DIN 4093:2015-11 Design of strengthened soil - Set up by means of jet grouting, deep mixing or grouting.

DIN 4102-1
DIN 4102-1:1998-05 Fire behaviour of building materials and building components - Part 1: Building materials; concepts, requirements and tests.

EN 197-1
DIN EN 197-1:2011-11 Cement - Part 1: Composition, specifications and conformity criteria for common cements.

EN 12390-3
DIN EN 12390-3:2019-10 Testing hardened concrete - Part 3: Compressive strength of test specimens.

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Published by
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ENVIRONMENTAL PRODUCT DECLARATION

in accordance with *ISO 14025* and *EN 15804+A2*

Declaration owner	**BAUER Spezialtiefbau GmbH**
Published by	Institut Bauen und Umwelt e.V. (IBU)
Program operator	Institut Bauen und Umwelt e.V. (IBU)
Declaration number	EPD-BAU-20230031-ICC1-DE
Issue date	February 7, 2023
Valid until	February 6, 2028

BAUER MIP® Class IV

BAUER Spezialtiefbau GmbH

Institut Bauen und Umwelt e.V.

www.ibu-epd.com | https://epd-online.com

ECO PLATFORM EPD VERIFIED

1. General information

BAUER Spezialtiefbau GmbH

Program operator
IBU - Institut Bauen und Umwelt e.V.
Hegelplatz 1
10117 Berlin
Germany

Declaration number
EPD-BAU-20230031-ICC1-DE

This declaration is based on the product category rules:
Concrete construction components made of in-situ concrete or ready-mixed concrete, 03/2022 (PCR tested and approved by the *Sachverständigenrat (Independent Council of Experts*) (SVR).

Issue date
February 7, 2023

Valid until
February 6, 2028

Dipl. Ing. Hans Peters
(CEO of Institut Bauen und Umwelt e.V.)

Dr. Alexander Röder
(Managing Director Institut Bauen und Umwelt e.V)

BAUER MIP® Class IV

Declaration owner
BAUER Spezialtiefbau GmbH
BAUER-Str. 1
86529 Schrobenhausen
Germany

Declared product/declared unit
1 m^3 Mixed-in-Place- (MIP-) construction material, Class IV

Scope of application:
The environmental product declaration refers to the average composition of an MIP (Mixed-in-Place) construction material manufactured by BAUER Spezialtiefbau GmbH.

Mixed-in-Place construction materials are mainly used in the manufacture of retaining structures (e.g. retaining walls). foundations or flood protection facilities. as well as for the construction of retaining structures for landfills or cut-off walls.

The environmental product declaration is based on data, which were collected for the year 2020 by BAUER Spezialtiefbau GmbH.

The declaration owner is liable for the information and evidence on which this declaration is based; liability of the IBU regarding manufacturer's information, life cycle assessment data and evidence is excluded. The EPD has been created in accordance with the specifications of *EN 15804+A2*. In the following, the name of the standard is simplified as *EN 15804*.

Verification
The European standard *EN 15804* is the key PCR
Independent verification of the declaration and information in accordance with *ISO 14025:2011*

☐ internal ☐ external

Angela Schindler,
Independent verifier

2. Product

2.1 Product description/Product definition The Mixed-in-Place construction material (MIP construction material) is created directly in the construction soil. The MIP method involves breaking open the existing ground with a single or triple auger, moving it and filling the pores with binder slurry (Figure 1). The binder slurry, consisting of concrete, water, as well as bentonite and concrete additives where appropriate, is manufactured in-situ on the MIP construction site. When manufacturing MIP walls, the individual cuts in the construction soil, which were already created using the MIP equipment and are still fresh, are combined into walls using the pilgrim step method. The declared product is therefore produced in the construction soil and consists of the binder slurry and the ground which has been incorporated, where the dimensions of the auger(s) determine the dimensions of the construction component.

The MIP construction material which has been produced cures in the specified form by hydrating the cement, creating solid, artificial stone.

The declared product is the unreinforced MIP construction material or does not contain steel beams or other built-in components. In case of reinforced construction components, structural built-in components or non-structural built-in components, the respective share must be considered separately.

The determination of the life cycle assessment of the average MIP construction material with a cement content of 230 kg/m^3 to < 360 kg/m^3 was based on

the production data.

For the use of the product in construction components which are relevant for national technical approvals, *DIN 4093* as well as the "BAUER Mixed-In-Place (MIP)" type approval with approval number Z-34.26-200 apply at the place of use (general type approval (*GTA*)).

For construction components outside the scope relevant for building authorities, reference is made to the DWA set of rules DWA-M 512-1 "Sealing Systems in Hydraulic Engineering - Part 1: Earthwork Structures" (*DWA*).

2.2 Application

The MIP construction material has many applications in the construction soil.

Typical applications of MIP construction materials are:

- Retaining walls for retaining structures or height differences in the terrain
- Cut-off walls for flood protection facilities, groundwater barriers or for dike or dam rehabilitation
- Encompassment of abandoned polluted areas
- Foundation elements (as pile-like elements).

2.3 Technical data

The BAUER MIP® Class IV construction material (cement content of 230 kg/m^3 to < 360 kg/m^3) has the following technical properties:

Construction data

The properties that can be achieved are influenced by the conditions of the construction soil.

Values for class IV

Description	Value	Unit
Thermal conductivity	–	W/(mK)
Design value of thermal conductivity	1.15 - 1.65	W/(mK)
Water vapor diffusion resistance coefficient	10 - 80	–
Degree of noise absorption	–	%
Bulk density	1500 - 2600	kg/m^3
Compressive strength f_m,i acc. to DIN EN ISO 17892-7 or DIN EN 12390- 3 after 28 days	2 - 15	N/mm^2
Modulus of elasticity	550 - 18000	N/mm2
Equilibrium moisture content approx.	3	%
Compressive strength f_m,i in accordance with DIN EN ISO 17892-7 or DIN EN 12390-3	0.1 – 2	N/mm^2
Water permeability coefficient	1E-07 - 1E-12	m/s
Spec. thermal capacity cp approx.	300 - 500	J/kg K
Tensile strength approx.	8 - 15	% of f_m,i
Flexural strength approx.	15 - 30	% of f_m,i

Decisive test standards are /*DIN EN ISO 17892-7*/ and /*DIN EN 12390-3*/.

Performance data of the MIP construction material regarding its characteristics in accordance with the decisive technical regulation (no CE marking).

2.4 Delivery status

The MIP construction material is produced directly on the construction site and at the point of application in the construction soil. The required binder slurry is mixed on-site on the construction site ready for application and fed to the MIP equipment. The MIP equipment processes the binder slurry with the existing ground in the planned dimensions of the construction component to be produced.

2.5 Base materials/Ancillary materials

- Cement, CEM III/B*: 10.5 – 20.0 m% (* special binding agent with same composition is possible)
- Mixing water: 8.3 – 22.3 m%
- Bentonite: 0 – 1.7 m%
- Additive: 0 – 0.6 m%
- Ground, moist (solids + inherent moisture): 55.5 – 81.2 m%

The total mass of the MIP construction material depends to a significant extent on the existing ground, which is a component of the MIP construction material. The density of the ground itself can differ from site to site. For this reason, the percentage by mass refers to 2,000 kg/m^3 ready-to-use MIP construction material to illustrate the product composition.

The product/at least one partial product contains substances on the ECHA List of Candidate Substances of Very High Concern (SVHC) (dated June 10, 2022) exceeding 0.1% by mass: No

The product/at least one partial product contains additional CMR substances in category 1A or 1B, which are not on the List of Candidates, exceeding 0.1% by mass in at least one partial product: No

Biocide products were added to this construction product or it has been treated with biocide products (this then concerns a treated product as defined by the (EU) Ordinance on Biocide Products No. 528/2012): No

2.6 Manufacture

First, the binder slurry is manufactured directly on the construction site using the base materials (cement, mixing water, bentonite, additives) (see 2.5 Base materials).

The MIP construction material is created directly in the construction soil by breaking open the existing ground with a single or triple auger, moving it and filling the pores with binder slurry that has been produced (Figure 1).

In accordance with Figure 1, cement-based binder slurries are generally incorporated in the construction

soil. As an alternative to standard cement in accordance with EN 197-1, special cement-based binding agents can also be used, whose composition corresponds to a CEM III/B, i.e. a mixture of Portland cement and granulated slag.

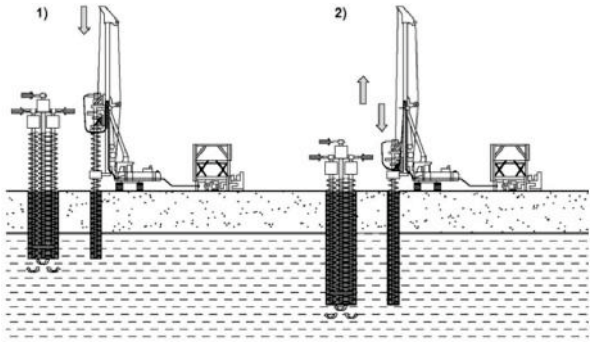


Figure 1: MIP method with triple auger [DWA-M 512-1], left: Drilling and concreting process; right: Homogenization process

To ensure the required quality of the MIP elements or walls, the manufacturing process is monitored in accordance with the decisive parameters for the properties.

2.7 Environment and health during manufacturing

The mixing and processing of binder slurries is common practice on many specialist foundation engineering construction sites. Uncured slurry residues in mixers, as well as reservoirs, pumps and delivery hoses, where appropriate, are disposed of properly (see Section 2.15).

The fresh binder slurry as well as the finished MIP construction material contain a strongly alkaline solution, which is created when mixing cement with water and can cause irritation to skin and eyes.

Due to the water-soluble chromate contained in cements other than low-chromate cements, sustained contact with binder slurries or MIP construction materials made of such cements can lead to the development of allergic chromate dermatitis. In accordance with the REACH Regulation (*REACH*), low-chromate cements are therefore used if there is a danger of skin contact.

Additional information is provided in the safety data sheets of the cement manufacturer.

2.8 Product processing/Installation

The binder slurry is manufactured on the construction site, stored for a short period of time if necessary and then transported to the MIP equipment, which mixes the binder slurry with the ground during and after the drilling process.

2.9 Packaging

The base materials of the binder slurry are delivered without packaging.

2.10 Condition of use

As a rule, the composition of the MIP construction material does not change its condition during use.

2.11 Environment and health during use

The naturally ionizing radiation of the MIP construction material is low and does not pose a health hazard [see Section 7]. Construction components in contact with the ground which are made from the MIP construction material can significantly reduce the influx of radon from the ground (*ZEM*).

The environmental compatibility of the MIP construction material is ensured by using only base materials which are considered to be harmless or whose environmental compatibility has been verified through a National Technical Approval.

The existing ground becomes part of the MIP construction material and therefore does not require verification of its environmental compatibility.

The base materials of the MIP construction material which are mixed in via the binder slurry are predominantly standardized materials which a priori do not require further verification (*DAfStb1).* Instead of standard cement, a special binding agent can be used in the binder slurry, whose composition is similar to standard cement. In addition, bentonite can be used.

Bentonite can be used on the basis of the product-specific water hazard class in combination with the administrative regulations of the German Federal Environmental Agency *(VwVWS* May 17, 1999 and July 27, 2005*).* Bentonite is also listed in the list for substances for "Safe Construction Products for Health and the Environment" of the German Federal Environmental Agency (*Umwelt1*).

2.12 Reference service life

The MIP construction material is designed for an intended service life of at least 50 years for permanent structures, taking into account the existing exposure classes/environmental conditions (general type approval (*GTA*)). The MIP construction material can also be used for temporary purposes. A calculation of the reference service life in accordance with *ISO 15686-8* is not possible for temporary applications.

2.13 Accidental actions

Fire

MIP construction materials meet the requirements of construction material class A1, "non-flammable" in accordance with *DIN 4102-1* and *EN 13501-1*. No toxic gases and fumes can occur in case of fire, and burning construction material components do not drop or fall off.

Fire protection

Description	Value
Construction material class	A1 "non-flammable"

Water

When exposed to water (e.g. floods), the MIP construction material remains mostly inert. Substances are not washed out in quantities which could be hazardous to water.

Mechanical destruction

Not relevant for MIP construction material.

2.14 Re-use phase
Construction components made of MIP construction material can be dismantled. In order to recycle reinforced construction components, the demolished material is separated from the structural steel or reinforcing steel and is processed. For this purpose, the MIP construction material is first crushed and separated into individual grain fractions. In small amounts, they can then be used as recycled rock gravel, e.g. for the construction of earth concrete walls. The reinforcing steel or structural steel is recycled as scrap steel.

If separate base elements are used in the MIP construction material, they can consist of steel or other construction materials (such as glass-reinforced plastic, carbon fiber-reinforced plastic, wood, composite reinforcement). When using pre-fabricated elements or structural elements, it is generally possible to re-use them in their entirety.

2.15 Disposal
In Germany, disposal is generally ensured in accordance with Z1.1/Z1.2 according to the Working Group of the Federal States on Waste - Ground (*LAGA Ground)* or "Framework paper Bavaria" („*Eckpunktepapier-Bayern*"). In individual cases, the Landfill Regulation (*DepV2009*) may become relevant for disposal.

For MIP waste made of cement-bound material, waste codes 17 01 01, 17 01 07 and 17 05 04 (*AVV*) apply in accordance with the waste recycling list. For steel which may be contained in the MIP construction material (not included in the EPD), waste code 17 04 05 applies (*AVV*).

2.16 Additional information
https://www.bauer.de/bst/

3. LCA: Calculation rules

3.1 Declared unit
The declared unit is one cubic meter (1 m^3) of Mixed-in-Place construction material.

If MIP construction components contain steel beams, lattice girders or other built-in components, a separate life cycle assessment must be carried out for them.

Declared unit

Description	Value	Unit
Declared unit	1	m^3
Density (mean value)	1900	kg/m^3

The cement content in the composition of the construction material can be 230 to < 360 kg/m^3 MIP construction material in this class. For the life cycle assessment, a cement content of 295 kg/m^3 was assumed.

3.2 System boundary
Type of EPD: "From cradle to plant gate, with options." Declared are the production phase as well as other selected life cycle phases.

Module A1:
Production of cement and bentonite as well as the provision of water.

Module A2:
Transport of the base materials and the required equipment to the construction site.

Module A3:
Mixing of the binder slurry on the construction site.

Module A4:
As the production site and the construction site are identical, no environmental impacts are specified in this module.

Module A5:
Insertion of the slurry which has been produced, incl. the drilling process and the mixing process with the ground (diesel consumption).

Module B1:
No environmental impacts arise from the use of the MIP construction material. In this module, the CO_2 absorption due to carbonation during the service life is listed as having negative global warming potential.

Module B2 and B3:
For Mixed-in-Place construction components, there are generally no environmental impacts during their reference service life.

Module C1:
Dismantling/demolition of Mixed-in-Place construction components.

Module C2:
Transport of Mixed-in-Place demolition material to the processing facility.

Module C3:
Breaking and treatment of Mixed-in-Place demolition material (until the "end of being characterized as waste" is reached).

Module C4:
As only a very small amount of the demolished construction debris is disposed of in landfill and the "Treatment and use" scenario was selected for end-of-life, no environmental impacts are specified for the landfill disposal of MIP construction material.

Module D:
Benefit for use of MIP demolition material in earthworks and road construction.

3.3 Estimates and assumptions
There were no estimates and assumptions.

3.4 Cut-off criteria
All base materials and processes used were taken into account. The small amounts of waste arising from cement production (e.g. packaging material) are ignored in the life cycle assessment and are therefore not listed under "Other environmental information describing different waste categories".

3.5 Background data

The production data for the manufacture of Mixed-in-Place construction material was determined by BAUER Spezialtiefbau GmbH. Data from the year 2020 were used for the life cycle assessment of the cement production, which were determined by VDZ gGmbH as part of the life cycle assessment of cements. The life cycle assessment was carried out with *GaBi ts* 10.6.1.35 software (Sphera Solutions GmbH). Generic records from the *GaBi ts*-database (CUP 2021.1) were used for the life cycle assessment.

3.6 Data quality

The following applies for the foreground data: The geographical, technological and temporal representativeness of the data can be assessed as "very good". The following applies for the generic background data: The geographical and technological representativeness of the data can be assessed as "very good", the temporal representativeness as "good".

3.7 Period under review

The data used relate to the production of MIP construction material in 2020.

3.8 Allocation

An economical allocation was carried out for granulated slag and fly ash, which are used for cement production.

3.9 Comparability

As a matter of principle, a comparison or the assessment of EPD data is only possible if all the records to be compared were created in accordance with *EN 15804* and the building context or the product-specific performance characteristics are taken into account.

Database used: *GaBi ts*-database (CUP 2021.1)

4. LCA: Scenarios and additional technical information

Characteristic product properties of biogenic carbon

Information on the description of the biogenic carbon content at the plant gate

Description	Value	Unit
Biogenic carbon in the product	0	kg C
Biogenic carbon in the associated packaging	0	kg C

The following technical information forms the basis for the declared modules.

Module B1:
Due to carbonation, cement-bound construction materials absorb carbon dioxide from the environment during their service life. This can be expressed as negative global warming potential in module B1. Assumption: Carbonation on one side in contact with the ground, thickness of MIP construction component 55 cm.

C1: Dismantling:
No experience has yet been gained with the dismantling of MIP construction components. For life cycle assessment, it is assumed that the environmental impacts correspond to the dismantling of concrete construction components. The assumptions that form the basis of the *EPDs* for concrete issued by the InformationsZentrum Beton GmbH (September 2018) have been adopted. Typically, the dismantling of concrete structures is predominantly carried out with long reach excavators, which are equipped with demolition shears. The concrete structures are dismantled using so-called "pressure-cutting", i.e. the crushing of concrete by applying compressive force.

C2: Transport from MIP demolition material to the crushing plant:
The assumptions that form the basis of the EPDs for concrete issued by the InformationsZentrum Beton GmbH (September 2018) have been adopted. In this EPD, the average transport distance for the transport of concrete waste to the treatment process is estimated at approx. 50 km.

C3: Waste treatment:
No experience has yet been gained with the waste treatment of MIP construction components. For life cycle assessment, it is assumed that the environmental impacts correspond to the waste treatment of concrete construction components. The assumptions that form the basis of the EPDs for concrete issued by the InformationsZentrum Beton GmbH (September 2018) have been adopted. Treatment generally takes place using jaw crushers or impact crushers. In addition to crushing, pre-screening and metal separation is also carried out.

End of life (C1-C4)

Description	Value	Unit
Separately collected mineral construction waste	1900	kg
Collected as mixed construction waste	0	kg
For reuse	0	kg
For recycling	1900	kg
For energy recovery	0	kg
For landfill disposal	0	kg

D: Benefits and loads after end-of-life: In the crushing plant, the MIP construction material reaches the end of being characterized as waste. The output at the end of the crushing process is a secondary material that can replace the primary materials sand and gravel. Life cycle assessment benefits are specified for this in module D.
Additional information on carbonation: *EN 16757* specifies 75% of the maximum possible CO_2 absorption as the average guide value for the long-term absorption of CO_2 by cement-bound construction materials. This value results in 31.7 kg/m^3 MIP construction material for a MIP construction material of class IV. However, this value should only be understood as a reference value, as it is subject to many influencing factors.

5. LCA: Results

DESCRIPTION OF THE SYSTEM BOUNDARY (X = INCLUDED IN LIFE CYCLE ASSESSMENT; ND = MODULE OR INDICATOR NOT DECLARED; MNR = MODULE NOT RELEVANT)

Production stage			Construction process stage		Use stage							End of life stage				Benefits and loads beyond the system boundaries
Raw materials supply	Transport	Manufacture	Transport from the gate to the site	Installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Dismantling/ demolition	Transport	Waste treatment	Disposal	Reuse, Recovery or Recycling potential
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
X	X	X	X	X	X	ND	MNR	MNR	MNR	ND	ND	X	X	X	ND	X

RESULTS OF LIFE CYCLE ASSESSMENT – ENVIRONMENTAL IMPACTS in accordance with EN 15804+A2: 1 m^3 Mixed-in-Place (MIP) construction material, BAUER MIP® Class IV, cement contents from 230 kg/m^3 to < 360 kg/m^3

Core indicator	Unit	A1-A3	A4	A5	B1	C1	C2	C3	D
GWP-total	[kg CO_2-eq.]	108.00	0.00	23.30	-0.70	3.15	7.94	4.15	-4.45
GWP-fossil	[kg CO_2-eq.]	108.00	0.00	23.10	-0.70	3.13	7.88	4.10	-4.41
GWP-biogenic	[kg CO_2-eq.]	2.70E-1	0.00E+0	8.07E-2	0.00E+0	1.00E-2	2.90E-2	3.90E-2	-3.00E-2
GWP-luluc	[kg CO_2-eq.]	3.00E-2	0.00E+0	7.45E-2	0.00E+0	1.00E-2	3.00E-2	9.20E-3	-1.00E-2
ODP	[kg CFC11-eq.]	2.16E-8	0.00E+0	2.10E-11	0.00E+0	6.47E-13	1.61E-12	5.34E-11	-3.51E-11
AP	[mol H^+-eq.]	1.96E-1	0.00E+0	2.55E-1	0.00E+0	4.22E-2	2.70E-2	3.21E-2	-1.47E-2
EP-freshwater	[kg P-eq.]	1.58E-4	0.00E+0	4.41E-5	0.00E+0	6.30E-6	1.57E-5	1.49E-5	-1.25E-5
EP-marine	[kg N-eq.]	5.98E-2	0.00E+0	1.06E-1	0.00E+0	1.92E-2	1.27E-2	1.42E-2	-5.74E-3
EP-terrestrial	[mol N-eq.]	6.92E-1	0.00E+0	1.16E+0	0.00E+0	2.11E-1	1.42E-1	1.56E-1	-6.32E-2
POCP	[kg NMVOC-	1.84E-1	0.00E+0	3.15E-1	0.00E+0	5.74E-2	2.46E-2	4.20E-2	-1.35E-2
ADPE	[kg Sb-eq.]	1.37E-5	0.00E+0	2.35E-6	0.00E+0	3.17E-7	7.89E-7	1.35E-6	-1.00E-6
ADPF	[MJ]	575.00	0.00	307.00	0.00	41.90	104.00	54.60	-58.20
WDP	[m^3 world-eq. extracted]	1.60E+1	0.00E+0	8.83E-1	0.00E+0	1.00E-2	3.40E-2	6.00E-2	-1.10E-1

Key	GWP = Global Warming Potential; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential of land and water; EP = Eutrophication potential; POCP = Formation potential of tropospheric ozone; ADPE = Abiotic depletion potential for non-fossil resources (ADP – substances); ADPF = Abiotic depletion potential for fossil resources (ADP – fossil energy resources); WDP = Water deprivation potential (user)

RESULTS OF LIFE CYCLE ASSESSMENT – INDICATORS FOR THE DESCRIPTION OF RESOURCE USE in accordance with EN 15804+A2: 1 m^3 Mixed-in-Place (MIP) construction material, BAUER MIP® Class IV, cement contents from 230 kg/m^3 to < 360 kg/m^3

Indicator	Unit	A1-A3	A4	A5	B1	C1	C2	C3	D
PERE	[MJ]	196.00	0.00	28.50	0.00	2.75	6.85	27.10	-18.40
PERM	[MJ]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PERT	[MJ]	196.00	0.00	28.50	0.00	2.75	6.85	27.10	-18.40
PENRE	[MJ]	575.00	0.00	307.00	0.00	41.90	104.00	54.60	-53.80
PENRM	[MJ]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PENRT	[MJ]	575.00	0.00	307.00	0.00	41.90	104.00	54.60	-53.80
SM	[kg]	1.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RSF	[MJ]	66.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NRSF	[MJ]	155.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FW	[m^3]	0.85	0.00	0.77	0.00	0.04	0.11	0.08	-0.11

Key	PERE = Renewable primary energy as energy source; PERM = Renewable primary energy for material utilization; PERT = Total use of renewable primary energy; PENRE = Non-renewable primary energy as energy source; PENRM = Non-renewable primary energy for material utilization; PENRT = Total use of non-renewable primary energy; SM = Use of secondary materials; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels; FW = Net use of fresh water

RESULTS OF LIFE CYCLE ASSESSMENT – WASTE CATEGORIES AND OUTPUT FLOWS in accordance with EN 15804+A2: 1 m^3 Mixed-in-Place (MIP) construction material, BAUER MIP® Class IV, cement contents from 230 kg/m^3 to < 360 kg/m^3

Indicator	Unit	A1-A3	A4	A5	B1	C1	C2	C3	D
HWD	[kg]	3.10E-3	0.00E+0	5.94E-9	0.00E+0	1.83E-10	4.54E-10	3.24E-9	-2.58E-9
NHWD	[kg]	7.38E-1	0.00E+0	5.01E+2	0.00E+0	6.80E-3	1.69E-2	3.30E-2	-3.96E+1
RWD	[kg]	2.26E-2	0.00E+0	1.33E-3	0.00E+0	5.26E-5	1.31E-4	2.56E-3	-1.83E-3
CRU	[kg]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MFR	[kg]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MER	[kg]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EEE	[MJ]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EET	[MJ]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Key	HWD = Hazardous waste disposed; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed; CRU = Components for re-use; MFR = Materials for recycling; MER = Materials for energy recovery; EEE = Exported electrical energy; EEE = Exported thermal energy

RESULTS OF LIFE CYCLE ASSESSMENT – additional impact categories in accordance with EN 15804+A2 optional: 1 m³ Mixed-in-Place (MIP) construction material, BAUER MIP® Class IV, cement contents from 230 kg/m³ to < 360 kg/m³

Indicator	Unit	A1-A3	A4	A5	B1	C1	C2	C3	D
PM	[Cases of illness]	1.30E-6	0.00E+0	1.13E-5	0.00E+0	2.25E-6	1.51E-7	1.58E-6	-9.31E-7
IRP	[kBq U235-eq.]	3.49E+0	0.00E+0	1.43E-1	0.00E+0	5.35E-3	1.33E-2	2.34E-1	-1.82E-1
ETP-fw	[CTUe]	3.61E+2	0.00E+0	2.15E+2	0.00E+0	3.29E-1	7.97E+1	3.31E+1	-3.65E+1
HTP-c	[CTUh]	1.56E-8	0.00E+0	1.16E-8	0.00E+0	6.42E-10	1.60E-9	9.31E-10	-1.87E-9
HTP-nc	[CTUh]	1.57E-6	0.00E+0	1.16E-6	0.00E+0	4.84E-8	9.28E-8	4.94E-8	-1.64E-7
SQP	[-]	317.40	0.00	83.90	0.00	12.60	31.20	24.90	-22.60

Key	PM = Potential incidence of disease due to particulate matter emissions; IRP = Potential effect from human exposure to U235; ETP-fw = Potential toxicity comparison unit for ecosystems; HTP-c = Potential toxicity comparison unit for humans (carcinogenic effect); HTP-nc = Potential toxicity comparison unit for humans (non-carcinogenic effect); SQP = Potential soil quality index

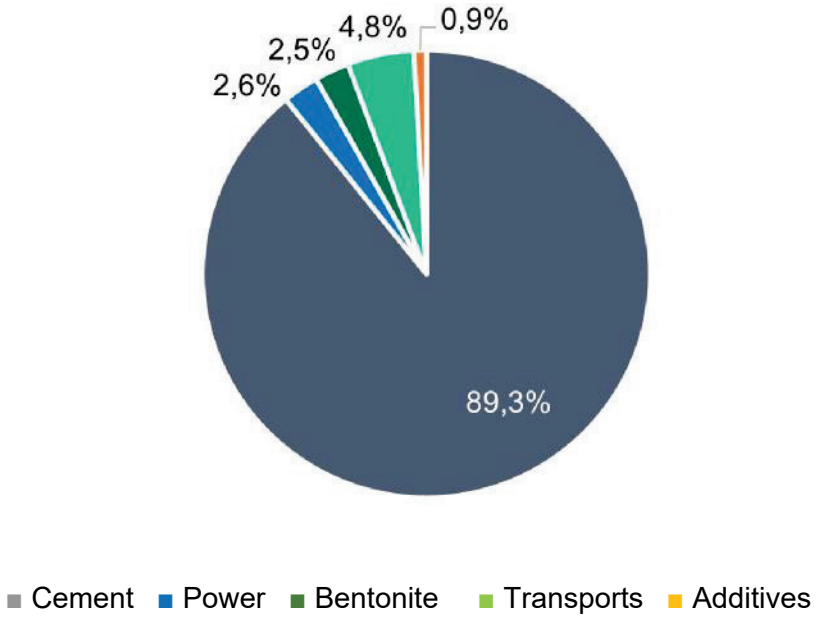
Net values are declared in A1–A3 for all GWP (global warming potential) indicators. The waste status of the (waste-based) energy sources has been verified. The gross emissions (i.e. including CO_2 from the combustion of waste) are:
127.5 kg CO_2-eq/m³ (GWP-total)
121.2 kg CO_2-eq/m³ (GWP-fossil)
6.3 kg CO_2-eq/m³ (GWP-biogenic)
with these values representing the corresponding sums from the net values and the emissions resulting from the incineration of verified waste materials.

Disclaimer 1 — applies for the indicator "Potential effect from human exposure to U235". This impact category deals mainly with the possible impact of low dose ionizing radiation on human health in the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents or occupational exposure, nor due to radioactive waste disposal in underground facilities. Potential ionizing radiation from the ground, from radon and from some construction materials is also not measured by this indicator.

Disclaimer 2 — applies for the indicators: "Abiotic depletion potential - non-fossil resources", "Abiotic depletion potential - fossil resources", "Water deprivation potential (user)", "Potential toxicity comparison unit for ecosystems", "Potential toxicity comparison unit for humans - carcinogenic effect"; "Potential toxicity comparison unit for humans - non-carcinogenic effect"; "Potential soil quality index".
The results of these environmental indicators must be used with caution, as there is a high level of uncertainty regarding these results or there is only limited experience in relation to the indicator.

6. LCA: Interpretation

The following diagram indicates the most important influencing factors for the global warming potential (Module A1–A3):



The range of the MIP construction materials used to generate the average values encompasses

- MIP construction materials where the environmental impact parameters listed in Section 5 and the resource use (Module A1–A3) are exceeded by up to 20%

up to

- MIP construction materials where the environmental impact parameters listed in Section 5 and the resource use (Module A1–A3) fall short by up to 20%

7. Requisite evidence

7.1 Radioactivity
Measurement of nuclide contents in Bq/kg for Ra-226, Th-232, K-40. In Germany, there are currently no legally specified limit values for assessing the radioactivity of construction materials. Assessment can be carried out in accordance with:
- Document of the European Commission 'Radiation Protection 112'
- OENORM 5200
- Nordic Countries' Recommendation 2000.

7.2 Leaching
To test the leaching of construction materials, test procedures such as *CEN/TS 16637-2* (monolithic test specimens) as well as *CEN/TS 16637-3* (permeable construction materials, e.g. rock gravel) are used. Tests are not required for most of the base materials of MIP construction materials and fields of application (e.g. natural rock gravel or cements in accordance with *EN 197-1*).

Requirements for leaching may arise for MIP construction materials containing cement additives in the relevant fields of application. If the construction materials are not covered by harmonized standards, their compliance with requirements is verified as part of the technical approval of the materials.

8. Literature references

Standards

CEN/TS 16637-2
DIN CEN/TS 16637-2:2014-11; DIN SPEC 18046-2:2014-11, Construction products - Assessment of release of dangerous substances - Part 2: Horizontal dynamic surface leaching test; German version CEN/TS 16637-2:2014.

CEN/TS 16637-3
DIN CEN/TS 16637-3:2016-12; DIN SPEC 18046-3:2016-12 Construction products - Assessment of release of dangerous substances - Part 3: Horizontal up-flow percolation test; German version CEN/TS 16637-3:2016.

DIN 4093
DIN 4093:2015-11 Design of strengthened soil - Set up by means of jet grouting, deep mixing or grouting.

DIN 4102-1
DIN 4102-1:1998-05 Fire behaviour of building materials and building components - Part 1: Building materials; concepts, requirements and tests.

EN 197-1
DIN EN 197-1:2011-11 Cement - Part 1: Composition, specifications and conformity criteria for common cements.

EN 12390-3
DIN EN 12390-3:2019-10 Testing hardened concrete - Part 3: Compressive strength of test specimens.

EN 13501-1
DIN EN 13501-1:2010 Fire Classification Of Construction Products And Building Elements - Part 1: Classification Using Data From Reaction To Fire Tests.

EN 15804
DIN EN 15804:2022-03, Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products; German version EN 15804:2012+A2:2019 + AC:2021.

EN 16757
DIN EN 16757:2017-10 Sustainability Of Construction Works - Environmental Product Declarations - Product Category Rules For Concrete And Concrete Elements.

ISO 14025
DIN EN ISO 14025:2011-10 Environmental labels and declarations - Type III environmental declarations - Principles and procedures (ISO 14025:2006); German and English version EN ISO 14025:2011.

ISO 15686-8
ISO 15686-8:2008-06 Buildings and constructed assets - Service-life planning - Part 8: Reference service life and service-life estimation.

ISO 17892-7
ISO 17892-7:2017-11 Geotechnical Investigation And Testing - Laboratory Testing Of Soil - Part 7: Unconfined Compression Test.

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AVV
Directive on the European Waste List: Waste List Directive (AVV) dated December 10, 2001 (Federal Law Gazette I p. 3379), last amended by Article 2 of the directive dated July 17, 2017 (Federal Law Gazette p. 2644).

DepV2009
Landfill regulation - regulation concerning landfills and long-term storage, Berlin: Federal Ministry of Justice and Consumer Protection.

DWA
Data sheet DWA-M 512-1, February 2012. Sealing Systems in Hydraulic Engineering. Part: 1: Earthwork Structures. Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall e. V. (*German Association for Water, Wastewater and Waste*) (DWA) (Publisher).

"Framework paper Bavaria"
Requirements for fill materials for pits and quarries as well as open-cast mines, version dated July 15, 2021.

LAGA-ground
Notification of the Ländergemeinschaft (LAGA) (*German Association of Federal Government and Federal States*) M20, Requirements for the recycling of mineral-based residual materials/waste - Technical Regulations - Status November 6, 2003.

REACH
REGULATION (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/E.

VwVWS
Administrative Regulation on Substances Hazardous to Water dated 17/05/1999 (Federal Gazette No. 98a dated 29/05/1999), amended by Administrative Regulation dated 27/07/2005 (Federal Gazette No. 142a dated 30/07/2005).

Other sources

General type approval
National technical approval "BAUER Mixed-In-Place (MIP)" Z-34.26-200, Deutsches Institut für Bautechnik (*German Institute of Construction Technology*), Berlin

DAfStb1
Commentary of the Deutscher Ausschuss für Stahlbeton e.V. (German Committee for Reinforced Concrete) (DAfStb) on the current regulatory status of the environmental impact of concrete (December 2010).

GaBi ts
Software and database for life cycle assessment, version
10.6.1.35, Sphera Solutions GmbH.

EPDs
EPDs (declaration owner: InformationsZentrum Beton GmbH)

- Environmental Product Declaration Concrete of compressive strength class C 20/25, EPD-IZB-20180097-IBG1-DE
- Environmental Product Declaration Concrete of compressive strength class C 25/30, EPD-IZB-20180101-IBG1-DE
- Environmental Product Declaration Concrete of compressive strength class C 30/37, EPD-IZB-20180102-IBG1-DE
- Environmental Product Declaration Concrete of compressive strength class C 35/45, EPD-IZB-20180098-IBG1-DE
- Environmental Product Declaration Concrete of compressive strength class C 45/55, EPD-IZB-20180099-IBG1-DE
- Environmental Product Declaration Concrete of compressive strength class C 50/60, EPD-IZB-20180100-IBG1-DE

IBU 2021
IBU (2021): General program information of the Institut Bauen und Umwelt e.V. (IBU). Version 2.0, Institut Bauen und Umwelt e.V., Berlin.

PCR part A
Product category rules for building-related products and services. Part A: Calculation rules for the life cycle assessment and requirements for the project report in accordance with EN 15804+A2:2021 (v1.2). Berlin: Institut Bauen und Umwelt e.V. (Publisher), 2021-09.

PCR cement
Product category rules for building-related products and services. Part B: Requirements for the EPD for cement, Version 1.7. Berlin: Institut Bauen und Umwelt e.V. (Publisher), 2022-05. www.ibu-epd.com

Umwelt1
Rheinberger, Ulrike, Dirk Bunke and Outi Ilvonen. 2007. Safe Construction Products for Health and the Environment: How much inspection effort is required to implement the EU Construction Products Directive? Dessau: German Federal Environmental Agency. http://d-nb.info/990406695/34.

ZEM
Zement Taschenbuch (cement paperback). Verein Deutscher Zementwerke
e.V. *(German Cement Works Association*) (2008)

Published by
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ENVIRONMENTAL PRODUCT DECLARATION

in accordance with *ISO 14025* and *EN 15804+A2*

Declaration owner	**BAUER Spezialtiefbau GmbH**
Published by	Institut Bauen und Umwelt e.V. (IBU)
Program operator	Institut Bauen und Umwelt e.V. (IBU)
Declaration number	EPD-BAU-20230032-ICC1-DE
Issue date	February 7, 2023
Valid until	February 6, 2028

BAUER MIP® Class V

BAUER Spezialtiefbau GmbH

Institut Bauen und Umwelt e.V.

www.ibu-epd.com | https://epd-online.com

ECO PLATFORM EPD VERIFIED

1. General information

BAUER Spezialtiefbau GmbH

Program operator
IBU - Institut Bauen und Umwelt e.V.
Hegelplatz 1
10117 Berlin
Germany

Declaration number
EPD-BAU-20230032-ICC1-DE

This declaration is based on the product category rules:
Concrete construction components made of in-situ concrete or ready-mixed concrete, 03/2022 (PCR tested and approved by the *Sachverständigenrat (Independent Council of Experts*) (SVR).

Issue date
February 7, 2023

Valid until
February 6, 2028

Dipl. Ing. Hans Peters
(CEO of Institut Bauen und Umwelt e.V.)

Dr. Alexander Röder
(Managing Director Institut Bauen und Umwelt e.V)

BAUER MIP® Class V

Declaration owner
BAUER Spezialtiefbau GmbH
BAUER-Str. 1
86529 Schrobenhausen
Germany

Declared product/declared unit
1 m^3 Mixed-in-Place- (MIP-) construction material, Class V

Scope of application:
The environmental product declaration refers to the average composition of an MIP (Mixed-in-Place) construction material manufactured by BAUER Spezialtiefbau GmbH.

Mixed-in-Place construction materials are mainly used in the manufacture of retaining structures (e.g. retaining walls). foundations or flood protection facilities. as well as for the construction of retaining structures for landfills or cut-off walls.

The environmental product declaration is based on data, which were collected for the year 2020 by BAUER Spezialtiefbau GmbH.

The declaration owner is liable for the information and evidence on which this declaration is based; liability of the IBU regarding manufacturer's information, life cycle assessment data and evidence is excluded. The EPD has been created in accordance with the specifications of *EN 15804+A2*. In the following, the name of the standard is simplified as *EN 15804*.

Verification
The European standard *EN 15804* is the key PCR

Independent verification of the declaration and information in accordance with *ISO 14025:2011*

☐ internal ☐ external

Angela Schindler,
Independent verifier

2. Product

2.1 Product description/Product definition The Mixed-in-Place construction material (MIP construction material) is created directly in the construction soil. The MIP method involves breaking open the existing ground with a single or triple auger, moving it and filling the pores with binder slurry (Figure 1). The binder slurry, consisting of concrete, water, as well as bentonite and concrete additives where appropriate, is manufactured in-situ on the MIP construction site. When manufacturing MIP walls, the individual cuts in the construction soil, which were already created using the MIP equipment and are still fresh, are combined into walls using the pilgrim step method. The declared product is therefore produced in the construction soil and consists of the binder slurry and the ground which has been incorporated, where the dimensions of the auger(s) determine the dimensions of the construction component.

The MIP construction material which has been produced cures in the specified form by hydrating the cement, creating solid, artificial stone.

The declared product is the unreinforced MIP construction material or does not contain steel beams or other built-in components. In case of reinforced construction components, structural built-in components or non-structural built-in components, the respective share must be considered separately.

The determination of the life cycle assessment of the average MIP construction material with a cement content of 360 kg/m^3 to < 520 kg/m^3 was based

on the production data.

For the use of the product in construction components which are relevant for national technical approvals, *DIN 4093* as well as the "BAUER Mixed-In-Place (MIP)" type approval with approval number Z-34.26-200 apply at the place of use (general type approval (*GTA*)).

For construction components outside the scope relevant for building authorities, reference is made to the DWA set of rules DWA-M 512-1 "Sealing Systems in Hydraulic Engineering - Part 1: Earthwork Structures" (*DWA*).

2.2 Application

The MIP construction material has many applications in the construction soil.

Typical applications of MIP construction materials are:

- Retaining walls for retaining structures or height differences in the terrain
- Cut-off walls for flood protection facilities, groundwater barriers or for dike or dam rehabilitation
- Encompassment of abandoned polluted areas
- Foundation elements (as pile-like elements).

2.3 Technical data

The BAUER MIP® Class V construction material (cement content of 360 kg/m^3 to < 520 kg/m^3) has the following technical properties:

Construction data

The properties that can be achieved are influenced by the conditions of the construction soil.

Values for class V

Description	Value	Unit
Thermal conductivity	–	W/(mK)
Design value of thermal conductivity	1.15 - 1.65	W/(mK)
Water vapor diffusion resistance coefficient	10 - 80	–
Degree of noise absorption	–	%
Bulk density	1500 - 2600	kg/m^3
Compressive strength f_m,i acc. to DIN EN ISO 17892-7 or DIN EN 12390- 3 after 28 days	3 - 20	N/mm^2
Modulus of elasticity	1000 - 20500	N/mm2
Equilibrium moisture content	3	%
Compressive strength f_m,i acc. to DIN EN ISO 17892-7 or DIN EN 12390-3	0.1 - 2	N/mm^2
Water permeability coefficient	1E-07 - 1E-12	m/s
Spec. thermal capacity cp approx.	300 - 500	J/kg K
Tensile strength approx.	8 - 15	% of f_m,i
Flexural strength approx.	15 - 30	% of f_m,i

Decisive test standards are /*DIN EN ISO 17892-7*/ and /*DIN EN 12390-3*/.

Performance data of the MIP construction material regarding its characteristics in accordance with the decisive technical regulation (no CE marking).

2.4 Delivery status

The MIP construction material is produced directly on the construction site and at the point of application in the construction soil. The required binder slurry is mixed on-site on the construction site ready for application and fed to the MIP equipment. The MIP equipment processes the binder slurry with the existing ground in the planned dimensions of the construction component to be produced.

2.5 Base materials/Ancillary materials

- Cement, CEM III/B*: 16.4 – 28.9 m% (* special binding agent with same composition is possible)
- Mixing water: 8.3 – 22.3 m%
- Bentonite: 0 – 1.7 m%
- Additive: 0 – 0.6 m%
- Ground, moist (solids + inherent moisture): 46.6 – 75.3 m%

The total mass of the MIP construction material depends to a significant extent on the existing ground, which is a component of the MIP construction material. The density of the ground itself can differ from site to site. For this reason, the percentage by mass refers to 2,000 kg/m^3 ready-to-use MIP construction material to illustrate the product composition.

The product/at least one partial product contains substances on the ECHA List of Candidate Substances of Very High Concern (SVHC) (dated June 10, 2022) exceeding 0.1% by mass: No

The product/at least one partial product contains additional CMR substances in category 1A or 1B, which are not on the List of Candidates, exceeding 0.1% by mass in at least one partial product: No

Biocide products were added to this construction product or it has been treated with biocide products (this then concerns a treated product as defined by the (EU) Ordinance on Biocide Products No. 528/2012): No

2.6 Manufacture

First, the binder slurry is manufactured directly on the construction site using the base materials (cement, mixing water, bentonite, additives) (see 2.5 Base materials).

The MIP construction material is created directly in the construction soil by breaking open the existing ground with a single or triple auger, moving it and filling the pores with binder slurry that has been produced (Figure 1).

In accordance with Figure 1, cement-based binder slurries are generally incorporated in the construction soil.

As an alternative to standard cement in accordance with EN 197-1, special cement-based binding agents can also be used, whose composition corresponds to a CEM III/B, i.e. a mixture of Portland cement and granulated slag.

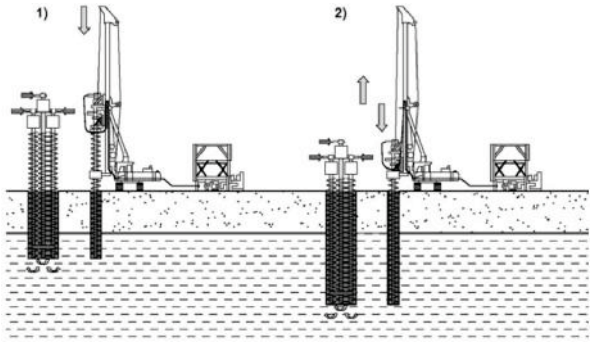


Figure 1: MIP method with triple auger [DWA-M 512-1], left: Drilling and concreting process; right: Homogenization process

To ensure the required quality of the MIP elements or walls, the manufacturing process is monitored in accordance with the decisive parameters for the properties.

2.7 Environment and health during manufacturing

The mixing and processing of binder slurries is common practice on many specialist foundation engineering construction sites. Uncured slurry residues in mixers, as well as reservoirs, pumps and delivery hoses, where appropriate, are disposed of properly (see Section 2.15).

The fresh binder slurry as well as the finished MIP construction material contain a strongly alkaline solution, which is created when mixing cement with water and can cause irritation to skin and eyes.

Due to the water-soluble chromate contained in cements other than low-chromate cements, sustained contact with binder slurries or MIP construction materials made of such cements can lead to the development of allergic chromate dermatitis. In accordance with the REACH Regulation (*REACH*), low-chromate cements are therefore used if there is a danger of skin contact.

Additional information is provided in the safety data sheets of the cement manufacturer.

2.8 Product processing/Installation

The binder slurry is manufactured on the construction site, stored for a short period of time if necessary and then transported to the MIP equipment, which mixes the binder slurry with the ground during and after the drilling process.

2.9 Packaging

The base materials of the binder slurry are delivered without packaging.

2.10 Condition of use

As a rule, the composition of the MIP construction material does not change its condition during use.

2.11 Environment and health during use

The naturally ionizing radiation of the MIP construction material is low and does not pose a health hazard [see Section 7]. Construction components in contact with the ground which are made from the MIP construction material can significantly reduce the influx of radon from the ground (*ZEM*).

The environmental compatibility of the MIP construction material is ensured by using only base materials which are considered to be harmless or whose environmental compatibility has been verified through a National Technical Approval.

The existing ground becomes part of the MIP construction material and therefore does not require verification of its environmental compatibility.

The base materials of the MIP construction material which are mixed in via the binder slurry are predominantly standardized materials which a priori do not require further verification (*DAfStb1).* Instead of standard cement, a special binding agent can be used in the binder slurry, whose composition is similar to standard cement. In addition, bentonite can be used.

Bentonite can be used on the basis of the product-specific water hazard class in combination with the administrative regulations of the German Federal Environmental Agency *(VwVWS* May 17, 1999 and July 27, 2005*).* Bentonite is also listed in the list for substances for "Safe Construction Products for Health and the Environment" of the German Federal Environmental Agency (*Umwelt1*).

2.12 Reference service life

The MIP construction material is designed for an intended service life of at least 50 years for permanent structures, taking into account the existing exposure classes/environmental conditions (general type approval (*GTA*)). The MIP construction material can also be used for temporary purposes. A calculation of the reference service life in accordance with *ISO 15686-8* is not possible for temporary applications.

2.13 Accidental actions

Fire

MIP construction materials meet the requirements of construction material class A1, "non-flammable" in accordance with *DIN 4102-1* and *EN 13501-1.* No toxic gases and fumes can occur in case of fire, and burning construction material components do not drop or fall off.

Fire protection

Description	Value
Construction material class	A1 "non-flammable"

Water

When exposed to water (e.g. floods), the MIP construction material remains mostly inert. Substances are not washed out in quantities which could be hazardous to water.

Mechanical destruction

Not relevant for MIP construction material.

2.14 Re-use phase

Construction components made of MIP construction material can be dismantled. In order to recycle reinforced construction components, the demolished material is separated from the structural steel or reinforcing steel and is processed. For this purpose, the MIP construction material is first crushed and separated into individual grain fractions. In small amounts, they can then be used as recycled rock gravel, e.g. for the construction of earth concrete walls. The reinforcing steel or structural steel is recycled as scrap steel.

If separate base elements are used in the MIP construction material, they can consist of steel or other construction materials (such as glass-reinforced plastic, carbon fiber-reinforced plastic, wood, composite reinforcement). When using pre-fabricated elements or structural elements, structural elements, it is generally possible to re-use them in their entirety.

2.15 Disposal

In Germany, disposal is generally ensured in accordance with Z1.1/Z1.2 according to the Working Group of the Federal States on Waste - Ground (*LAGA Ground)* or "Framework paper Bavaria" („*Eckpunktepapier-Bayern*"). In individual cases, the Landfill Regulation (*DepV2009*) may become relevant for disposal.

For MIP waste made of cement-bound material, waste codes 17 01 01, 17 01 07 and 17 05 04 (*AVV*) apply in accordance with the waste recycling list. For steel which may be contained in the MIP construction material (not included in the EPD), waste code 17 04 05 applies (*AVV*).

2.16 Additional information

https://www.bauer.de/bst/

3. LCA: Calculation rules

3.1 Declared unit

The declared unit is one cubic meter (1 m^3) of Mixed-in-Place construction material.

If MIP construction components contain steel beams, lattice girders or other built-in components, a separate life cycle assessment must be carried out for them.

Declared unit

Description	Value	Unit
Declared unit	1	m^3
Density (mean value)	1900	kg/m^3

The cement content in the composition of the construction material can be 360 to < 520 kg/m^3 MIP construction material in this class. For the life cycle assessment, a cement content of 440 kg/m^3 was assumed.

3.2 System boundary

Type of EPD: "From cradle to plant gate, with options." Declared are the production phase as well as other selected life cycle phases.

Module A1:
Production of cement and bentonite as well as the provision of water.

Module A2:
Transport of the base materials and the required equipment to the construction site.

Module A3:
Mixing of the binder slurry on the construction site.

Module A4:
As the production site and the construction site are identical, no environmental impacts are specified in this module.

Module A5:
Insertion of the slurry which has been produced, incl. the drilling process and the mixing process with the ground (diesel consumption).

Module B1:
No environmental impacts arise from the use of the MIP construction material. In this module, the CO_2 absorption due to carbonation during the service life is listed as having negative global warming potential.

Module B2 and B3:
For Mixed-in-Place construction components, there are generally no environmental impacts during their reference service life.

Module C1:
Dismantling/demolition of Mixed-in-Place construction components.

Module C2:
Transport of Mixed-in-Place demolition material to the processing facility.

Module C3:
Breaking and treatment of Mixed-in-Place demolition material (until the "end of being characterized as waste" is reached).

Module C4:
As only a very small amount of the demolished construction debris is disposed of in landfill and the "Treatment and use" scenario was selected for end-of-life, no environmental impacts are specified for the landfill disposal of MIP construction material.

Module D:
Benefit for use of MIP demolition material in earthworks and road construction.

3.3 Estimates and assumptions

There were no estimates and assumptions.

3.4 Cut-off criteria

All base materials and processes used were taken into account. The small amounts of waste arising from cement production (e.g. packaging material) are ignored in the life cycle assessment and are therefore not listed under "Other environmental information describing different waste categories".

3.5 Background data

The production data for the manufacture of Mixed-in-Place construction material was determined by BAUER Spezialtiefbau GmbH. Data from the year 2020 were used for the life cycle assessment of the cement production, which were determined by VDZ gGmbH as part of the life cycle assessment of cements. The life cycle assessment was carried out with *GaBi ts* 10.6.1.35 software (Sphera Solutions GmbH). Generic records from the *GaBi ts*-database (CUP 2021.1) were used for the life cycle assessment.

3.6 Data quality

The following applies for the foreground data: The geographical, technological and temporal representativeness of the data can be assessed as "very good". The following applies for the generic background data: The geographical and technological representativeness of the data can be assessed as "very good", the temporal representativeness as "good".

3.7 Period under review

The data used relate to the production of MIP construction material in 2020.

3.8 Allocation

An economical allocation was carried out for granulated slag and fly ash, which are used for cement production.

3.9 Comparability

As a matter of principle, a comparison or the assessment of EPD data is only possible if all the records to be compared were created in accordance with *EN 15804* and the building context or the product-specific performance characteristics are taken into account.

Database used: *GaBi ts*-database (CUP 2021.1)

4. LCA: Scenarios and additional technical information

Characteristic product properties of biogenic carbon

Information on the description of the biogenic carbon content at the plant gate

Description	Value	Unit
Biogenic carbon in the product	0	kg C
Biogenic carbon in the associated packaging	0	kg C

The following technical information forms the basis for the declared modules.

Module B1:
Due to carbonation, cement-bound construction materials absorb carbon dioxide from the environment during their service life. This can be expressed as negative global warming potential in module B1. Assumption: Carbonation on one side in contact with the ground, thickness of MIP construction component 55 cm.

C1: Dismantling:
No experience has yet been gained with the dismantling of MIP construction components. For life cycle assessment, it is assumed that the environmental impacts correspond to the dismantling of concrete construction components. The assumptions that form the basis of the *EPDs* for concrete issued by the InformationsZentrum Beton GmbH (September 2018) have been adopted. Typically, the dismantling of concrete structures is predominantly carried out with long reach excavators, which are equipped with demolition shears. The concrete structures are dismantled using so-called "pressure-cutting", i.e. the crushing of concrete by applying compressive force.

C2: Transport from MIP demolition material to the crushing plant:
The assumptions that form the basis of the EPDs for concrete issued by the InformationsZentrum Beton GmbH (September 2018) have been adopted. In this EPD, the average transport distance for the transport of concrete waste to the treatment process is estimated at approx. 50 km.

C3: Waste treatment:
No experience has yet been gained with the waste treatment of MIP construction components. For life cycle assessment, it is assumed that the environmental impacts correspond to the waste treatment of concrete construction components. The assumptions that form the basis of the EPDs for concrete issued by the InformationsZentrum Beton GmbH (September 2018) have been adopted. Treatment generally takes place using jaw crushers or impact crushers. In addition to crushing, pre-screening and metal separation is also carried out.

End of life (C1-C4)

Description	Value	Unit
Separately collected mineral construction waste	1900	kg
Collected as mixed construction waste	0	kg
For reuse	0	kg
For recycling	1900	kg
For energy recovery	0	kg
For landfill disposal	0	kg

D: Benefits and loads after end-of-life: In the crushing plant, the MIP construction material reaches the end of being characterized as waste. The output at the end of the crushing process is a secondary material that can replace the primary materials sand and gravel. Life cycle assessment benefits are specified for this in module D.
Additional information on carbonation: *EN 16757* specifies 75% of the maximum possible CO_2 absorption as the average guide value for the long-term absorption of CO_2 by cement-bound construction materials. This value results in 47.2 kg/m^3 MIP construction material for a MIP construction material of class V. However, this value should only be understood as a reference value, as it is subject to many influencing factors.

5. LCA: Results

DESCRIPTION OF THE SYSTEM BOUNDARY (X = INCLUDED IN LIFE CYCLE ASSESSMENT; ND = MODULE OR INDICATOR NOT DECLARED; MNR = MODULE NOT RELEVANT)

Production stage			Construction process stage		Use stage							End of life stage				Benefits and loads beyond the system boundaries
Raw materials supply	Transport	Manufacture	Transport from the gate to the site	Installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Dismantling/ demolition	Transport	Waste treatment	Disposal	Reuse, Recovery or Recycling potential
A1	**A2**	**A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
X	X	X	X	X	X	ND	MNR	MNR	MNR	ND	ND	X	X	X	ND	X

RESULTS OF LIFE CYCLE ASSESSMENT – ENVIRONMENTAL IMPACTS in accordance with EN 15804+A2: 1 m^3 Mixed-in-Place (MIP) construction material, BAUER MIP® Class V, cement contents from 360 kg/m^3 to < 520 kg/m^3

Core indicator	Unit	A1-A3	A4	A5	B1	C1	C2	C3	D
GWP-total	[kg CO_2-eq.]	157.00	0.00	23.30	-1.00	3.15	7.94	4.15	-4.45
GWP-fossil	[kg CO_2-eq.]	157.00	0.00	23.10	-1.00	3.13	7.88	4.10	-4.41
GWP-biogenic	[kg CO_2-eq.]	3.80E-1	0.00E+0	8.07E-2	0.00E+0	1.00E-2	2.90E-2	3.90E-2	-3.00E-2
GWP-luluc	[kg CO_2-eq.]	5.00E-2	0.00E+0	7.45E-2	0.00E+0	1.00E-2	3.00E-2	9.20E-3	-1.00E-2
ODP	[kg CFC11-eq.]	3.19E-8	0.00E+0	2.10E-11	0.00E+0	6.47E-13	1.61E-12	5.34E-11	-3.51E-11
AP	[mol H^+-eq.]	2.77E-1	0.00E+0	2.55E-1	0.00E+0	4.22E-2	2.70E-2	3.21E-2	-1.47E-2
EP-freshwater	[kg P-eq.]	2.25E-4	0.00E+0	4.41E-5	0.00E+0	6.30E-6	1.57E-5	1.49E-5	-1.25E-5
EP-marine	[kg N-eq.]	8.43E-2	0.00E+0	1.06E-1	0.00E+0	1.92E-2	1.27E-2	1.42E-2	-5.74E-3
EP-terrestrial	[mol N-eq.]	9.81E-1	0.00E+0	1.16E+0	0.00E+0	2.11E-1	1.42E-1	1.56E-1	-6.32E-2
POCP	[kg NMVOC-	2.63E-1	0.00E+0	3.15E-1	0.00E+0	5.74E-2	2.46E-2	4.20E-2	-1.35E-2
ADPE	[kg Sb-eq.]	1.95E-5	0.00E+0	2.35E-6	0.00E+0	3.17E-7	7.89E-7	1.35E-6	-1.00E-6
ADPF	[MJ]	803.00	0.00	307.00	0.00	41.90	104.00	54.60	-58.20
WDP	[m^3 world-eq. extracted]	1.71E+1	0.00E+0	8.83E-1	0.00E+0	1.00E-2	3.40E-2	6.00E-2	-1.10E-1

Key	GWP = Global Warming Potential; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential of land and water; EP = Eutrophication potential; POCP = Formation potential of tropospheric ozone; ADPE = Abiotic depletion potential for non-fossil resources (ADP – substances); ADPF = Abiotic depletion potential for fossil resources (ADP – fossil energy resources); WDP = Water deprivation potential (user)

RESULTS OF LIFE CYCLE ASSESSMENT – INDICATORS FOR THE DESCRIPTION OF RESOURCE USE in accordance with EN 15804+A2: 1 m^3 Mixed-in-Place (MIP) construction material, BAUER MIP® Class V, cement contents from 360 kg/m^3 to < 520 kg/m^3

Indicator	Unit	A1-A3	A4	A5	B1	C1	C2	C3	D
PERE	[MJ]	273.00	0.00	28.50	0.00	2.75	6.85	27.10	-18.40
PERM	[MJ]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PERT	[MJ]	273.00	0.00	28.50	0.00	2.75	6.85	27.10	-18.40
PENRE	[MJ]	803.00	0.00	307.00	0.00	41.90	104.00	54.60	-53.80
PENRM	[MJ]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PENRT	[MJ]	803.00	0.00	307.00	0.00	41.90	104.00	54.60	-53.80
SM	[kg]	2.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RSF	[MJ]	99.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NRSF	[MJ]	232.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FW	[m^3]	1.07	0.00	0.77	0.00	0.04	0.11	0.08	-0.11

Key	PERE = Renewable primary energy as energy source; PERM = Renewable primary energy for material utilization; PERT = Total use of renewable primary energy; PENRE = Non-renewable primary energy as energy source; PENRM = Non-renewable primary energy for material utilization; PENRT = Total use of non-renewable primary energy; SM = Use of secondary materials; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels; FW = Net use of fresh water

RESULTS OF LIFE CYCLE ASSESSMENT – WASTE CATEGORIES AND OUTPUT FLOWS in accordance with EN 15804+A2:

Indicator	Unit	A1-A3	A4	A5	B1	C1	C2	C3	D
HWD	[kg]	3.10E-3	0.00E+0	5.94E-9	0.00E+0	1.83E-10	4.54E-10	3.24E-9	-2.58E-9
NHWD	[kg]	9.53E-1	0.00E+0	5.01E+2	0.00E+0	6.80E-3	1.69E-2	3.30E-2	-3.96E+1
RWD	[kg]	3.11E-2	0.00E+0	1.33E-3	0.00E+0	5.26E-5	1.31E-4	2.56E-3	-1.83E-3
CRU	[kg]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MFR	[kg]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MER	[kg]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EEE	[MJ]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EET	[MJ]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Key	HWD = Hazardous waste disposed; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed; CRU = Components for re-use; MFR = Materials for recycling; MER = Materials for energy recovery; EEE = Exported electrical energy; EEE = Exported thermal energy

RESULTS OF LIFE CYCLE ASSESSMENT – additional impact categories in accordance with EN 15804+A2 optional: 1 m³ Mixed-in-Place (MIP) construction material, BAUER MIP® Class V, cement contents from 360 kg/m³ to < 520 kg/m³

Indicator	Unit	A1-A3	A4	A5	B1	C1	C2	C3	D
PM	[Cases of illness]	1.80E-6	0.00E+0	1.13E-5	0.00E+0	2.25E-6	1.51E-7	1.58E-6	-9.31E-7
IRP	[kBq U235-eq.]	4.34E+0	0.00E+0	1.43E-1	0.00E+0	5.35E-3	1.33E-2	2.34E-1	-1.82E-1
ETP-fw	[CTUe]	4.55E+2	0.00E+0	2.15E+2	0.00E+0	3.29E-1	7.97E+1	3.31E+1	-3.65E+1
HTP-c	[CTUh]	2.26E-8	0.00E+0	1.16E-8	0.00E+0	6.42E-10	1.60E-9	9.31E-10	-1.87E-9
HTP-nc	[CTUh]	2.30E-6	0.00E+0	1.16E-6	0.00E+0	4.84E-8	9.28E-8	4.94E-8	-1.64E-7
SQP	[-]	458.70	0.00	83.90	0.00	12.60	31.20	24.90	-22.60

Key	PM = Potential incidence of disease due to particulate matter emissions; IRP = Potential effect from human exposure to U235; ETP-fw = Potential toxicity comparison unit for ecosystems; HTP-c = Potential toxicity comparison unit for humans (carcinogenic effect); HTP-nc = Potential toxicity comparison unit for humans (non-carcinogenic effect); SQP = Potential soil quality index

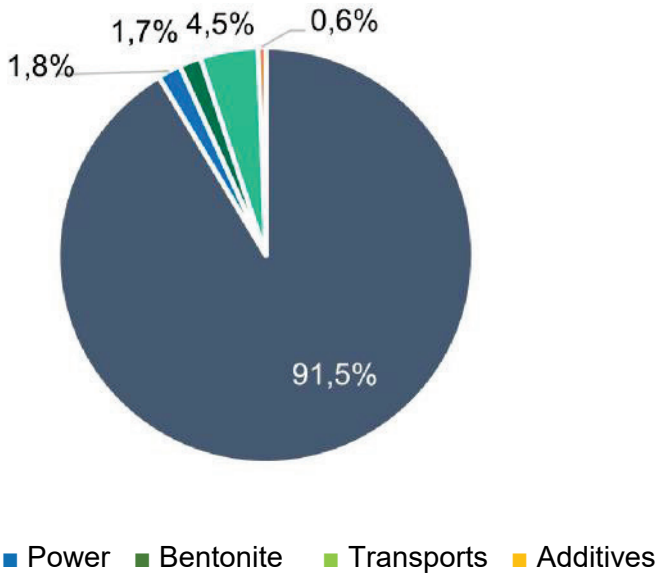
Net values are declared in A1–A3 for all GWP (global warming potential) indicators. The waste status of the (waste-based) energy sources has been verified. The gross emissions (i.e. including CO_2 from the combustion of waste) are:
186.2 kg CO_2-eq/m³ (GWP-total)
176.4 kg CO_2-eq/m³ (GWP-fossil)
9.4 kg CO_2-eq/m³ (GWP-biogenic)
with these values representing the corresponding sums from the net values and the emissions resulting from the incineration of verified waste materials.

Disclaimer 1 — applies for the indicator "Potential effect from human exposure to U235". This impact category deals mainly with the possible impact of low dose ionizing radiation on human health in the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents or occupational exposure, nor due to radioactive waste disposal in underground facilities. Potential ionizing radiation from the ground, from radon and from some construction materials is also not measured by this indicator.

Disclaimer 2 — applies for the indicators: "Abiotic depletion potential - non-fossil resources", "Abiotic depletion potential - fossil resources", "Water deprivation potential (user)", "Potential toxicity comparison unit for ecosystems", "Potential toxicity comparison unit for humans - carcinogenic effect"; "Potential toxicity comparison unit for humans - non-carcinogenic effect"; "Potential soil quality index".
The results of these environmental indicators must be used with caution, as there is a high level of uncertainty regarding these results or there is only limited experience in relation to the indicator.

6. LCA: Interpretation

The following diagram indicates the most important influencing factors for the global warming potential (Module A1–A3):



The range of the MIP construction materials used to generate the average values encompasses

- MIP construction materials where the environmental impact parameters listed in Section 5 and the resource use (Module A1–A3) are exceeded by up to 20%

up to

- MIP construction materials where the environmental impact parameters listed in Section 5 and the resource use (Module A1–A3) fall short by up to 20%

7. Requisite evidence

7.1 Radioactivity
Measurement of nuclide contents in Bq/kg for Ra-226, Th-232, K-40. In Germany, there are currently no legally specified limit values for assessing the radioactivity of construction materials. Assessment can be carried out in accordance with:
- Document of the European Commission 'Radiation Protection 112'
- OENORM 5200
- Nordic Countries' Recommendation 2000.

7.2 Leaching
To test the leaching of construction materials, test procedures such as *CEN/TS 16637-2* (monolithic test specimens) as well as *CEN/TS 16637-3* (permeable construction materials, e.g. rock gravel) are used. Tests are not required for most of the base materials of MIP construction materials and fields of application (e.g. natural rock gravel or cements in accordance with *EN 197-1*).

Requirements for leaching may arise for MIP construction materials containing cement additives in the relevant fields of application. If the construction materials are not covered by harmonized standards, their compliance with requirements is verified as part of the technical approval of the materials.

8. Literature references

Standards

CEN/TS 16637-2
DIN CEN/TS 16637-2:2014-11; DIN SPEC 18046-2:2014-11, Construction products - Assessment of release of dangerous substances - Part 2: Horizontal dynamic surface leaching test; German version CEN/TS 16637-2:2014.

CEN/TS 16637-3
DIN CEN/TS 16637-3:2016-12; DIN SPEC 18046-3:2016-12 Construction products - Assessment of release of dangerous substances - Part 3: Horizontal up-flow percolation test; German version CEN/TS 16637-3:2016.

DIN 4093
DIN 4093:2015-11 Design of strengthened soil - Set up by means of jet grouting, deep mixing or grouting.

DIN 4102-1
DIN 4102-1:1998-05 Fire behaviour of building materials and building components - Part 1: Building materials; concepts, requirements and tests.

EN 197-1
DIN EN 197-1:2011-11 Cement - Part 1: Composition, specifications and conformity criteria for common cements.

EN 12390-3
DIN EN 12390-3:2019-10 Testing hardened concrete - Part 3: Compressive strength of test specimens.

EN 13501-1
DIN EN 13501-1:2010 Fire Classification Of Construction Products And Building Elements - Part 1: Classification Using Data From Reaction To Fire Tests.

EN 15804
DIN EN 15804:2022-03, Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products; German version EN 15804:2012+A2:2019 + AC:2021.

EN 16757
DIN EN 16757:2017-10 Sustainability Of Construction Works - Environmental Product Declarations - Product Category Rules For Concrete And Concrete Elements.

ISO 14025
DIN EN ISO 14025:2011-10 Environmental labels and declarations - Type III environmental declarations - Principles and procedures (ISO 14025:2006); German and English version EN ISO 14025:2011.

ISO 15686-8
ISO 15686-8:2008-06 Buildings and constructed assets - Service-life planning - Part 8: Reference service life and service-life estimation.

ISO 17892-7
ISO 17892-7:2017-11 Geotechnical Investigation And Testing - Laboratory Testing Of Soil - Part 7: Unconfined Compression Test.

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AVV
Directive on the European Waste List: Waste List Directive (AVV) dated December 10, 2001 (Federal Law Gazette I p. 3379), last amended by Article 2 of the directive dated July 17, 2017 (Federal Law Gazette p. 2644).

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DWA
Data sheet DWA-M 512-1, February 2012. Sealing Systems in Hydraulic Engineering. Part: 1: Earthwork Structures. Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall e. V. (*German Association for Water, Wastewater and Waste*) (DWA) (Publisher).

"Framework paper Bavaria"
Requirements for fill materials for pits and quarries as well as open-cast mines, version dated July 15, 2021.

LAGA-ground
Notification of the Ländergemeinschaft (LAGA) (*German Association of Federal Government and Federal States*) M20, Requirements for the recycling of mineral-based residual materials/waste - Technical Regulations - Status November 6, 2003.

REACH
REGULATION (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/E.

VwVWS
Administrative Regulation on Substances Hazardous to Water dated 17/05/1999 (Federal Gazette No. 98a dated 29/05/1999), amended by Administrative Regulation dated 27/07/2005 (Federal Gazette No. 142a dated 30/07/2005).

Other sources

General type approval
National technical approval "BAUER Mixed-In-Place (MIP)" Z-34.26-200, Deutsches Institut für Bautechnik (*German Institute of Construction Technology*), Berlin

DAfStb1
Commentary of the Deutscher Ausschuss für Stahlbeton e.V. (*German Committee for Reinforced Concrete*) (DAfStb) on the current regulatory status of the environmental impact of concrete (December 2010).

GaBi ts
Software and database for life cycle assessment, version 10.6.1.35, Sphera Solutions GmbH.

EPDs
EPDs (declaration owner: InformationsZentrum Beton GmbH)

- Environmental Product Declaration Concrete of compressive strength class C 20/25, EPD-IZB-20180097-IBG1-DE
- Environmental Product Declaration Concrete of compressive strength class C 25/30, EPD-IZB-20180101-IBG1-DE
- Environmental Product Declaration Concrete of compressive strength class C 30/37, EPD-IZB-20180102-IBG1-DE
- Environmental Product Declaration Concrete of compressive strength class C 35/45, EPD-IZB-20180098-IBG1-DE
- Environmental Product Declaration Concrete of compressive strength class C 45/55, EPD-IZB-20180099-IBG1-DE
- Environmental Product Declaration Concrete of compressive strength class C 50/60, EPD-IZB-20180100-IBG1-DE

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ZEM
Zement Taschenbuch (cement paperback). Verein Deutscher Zementwerke
e.V. *(German Cement Works Association*) (2008)

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ENVIRONMENTAL PRODUCT DECLARATION

in accordance with *ISO 14025* and *EN 15804+A2*

Declaration owner	**BAUER Spezialtiefbau GmbH**
Published by	Institut Bauen und Umwelt e.V. (IBU)
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Declaration number	EPD-BAU-20230033-ICC1-DE
Issue date	February 7, 2023
Valid until	February 6, 2028

BAUER MIP® Class VI

BAUER Spezialtiefbau GmbH

Institut Bauen und Umwelt e.V.

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ECO PLATFORM EPD VERIFIED

1. General information

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Declaration number
EPD-BAU-20230033-ICC1-DE

This declaration is based on the product category rules:
Concrete construction components made of in-situ concrete or ready-mixed concrete, 03/2022 (PCR tested and approved by the *Sachverständigenrat (Independent Council of Experts*) (SVR).

Issue date
February 7, 2023

Valid until
February 6, 2028

Dipl. Ing. Hans Peters
(CEO of Institut Bauen und Umwelt e.V.)

Dr. Alexander Röder
(Managing Director Institut Bauen und Umwelt e.V)

BAUER MIP® Class VI

Declaration owner
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Declared product/declared unit
1 m^3 Mixed-in-Place- (MIP-) construction material, Class VI

Scope of application:
The environmental product declaration refers to the average composition of an MIP (Mixed-in-Place) construction material manufactured by BAUER Spezialtiefbau GmbH.

Mixed-in-Place construction materials are mainly used in the manufacture of retaining structures (e.g. retaining walls). foundations or flood protection facilities. as well as for the construction of retaining structures for landfills or cut-off walls.

The environmental product declaration is based on data, which were collected for the year 2020 by BAUER Spezialtiefbau GmbH.

The declaration owner is liable for the information and evidence on which this declaration is based; liability of the IBU regarding manufacturer's information, life cycle assessment data and evidence is excluded. The EPD has been created in accordance with the specifications of *EN 15804+A2*. In the following, the name of the standard is simplified as *EN 15804*.

Verification
The European standard *EN 15804* is the key PCR
Independent verification of the declaration and information in accordance with *ISO 14025:2011*

☐ internal ☐ external

Angela Schindler,
Independent verifier

2. Product

2.1 Product description/Product definition The Mixed-in-Place construction material (MIP construction material) is created directly in the construction soil. The MIP method involves breaking open the existing ground with a single or triple auger, moving it and filling the pores with binder slurry (Figure 1). The binder slurry, consisting of concrete, water, as well as bentonite and concrete additives where appropriate, is manufactured in-situ on the MIP construction site. When manufacturing MIP walls, the individual cuts in the construction soil, which were already created using the MIP equipment and are still fresh, are combined into walls using the pilgrim step method. The declared product is therefore produced in the construction soil and consists of the binder slurry and the ground which has been incorporated, where the dimensions of the auger(s) determine the dimensions of the construction component.

The MIP construction material which has been produced cures in the specified form by hydrating the cement, creating solid, artificial stone.

The declared product is the unreinforced MIP construction material or does not contain steel beams or other built-in components. In case of reinforced construction components, structural built-in components or non-structural built-in components, the respective share must be considered separately.

The determination of the life cycle assessment of the average MIP construction material with a cement content of 520 kg/m^3 to 600 kg/m^3 was based on

the production data.

For the use of the product in construction components which are relevant for national technical approvals, *DIN 4093* as well as the "BAUER Mixed-In-Place (MIP)" type approval with approval number Z-34.26-200 apply at the place of use (general type approval (*GTA*)).

For construction components outside the scope relevant for building authorities, reference is made to the DWA set of rules DWA-M 512-1 "Sealing Systems in Hydraulic Engineering - Part 1: Earthwork Structures" (*DWA*).

2.2 Application

The MIP construction material has many applications in the construction soil.

Typical applications of MIP construction materials are:

- Retaining walls for retaining structures or height differences in the terrain
- Cut-off walls for flood protection facilities, groundwater barriers or for dike or dam rehabilitation
- Encompassment of abandoned polluted areas
- Foundation elements (as pile-like elements).

2.3 Technical data

The BAUER MIP® Class VI construction material (cement content of 520 kg/m^3 to < 600 kg/m^3) has the following technical properties:

Construction data

The properties that can be achieved are influenced by the conditions of the construction soil.

Values for class VI

Description	Value	Unit
Thermal conductivity	–	W/(mK)
Design value of thermal conductivity	1.15 - 1.65	W/(mK)
Water vapor diffusion resistance coefficient	10 - 80	–
Degree of noise absorption	–	%
Bulk density	1500 - 2600	kg/m^3
Compressive strength f_m,i acc. to DIN EN ISO 17892-7 or DIN EN 12390- 3 after 28 days	4 - 25	N/mm^2
Modulus of elasticity	1400 - 22500	N/mm2
Equilibrium moisture content approx.	3	%
Compressive strength f_m,i acc. to DIN EN ISO 17892-7 or DIN EN 12390-3	0.1 - 2	N/mm^2
Water permeability coefficient	1E-07 - 1E-12	m/s
Spec. thermal capacity cp	300 - 500	J/kg K
Tensile strength approx.	8 - 15	% of f_m,i
Flexural strength approx.	15 - 30	% of f_m,i

Decisive test standards are /*DIN EN ISO 17892-7*/ and /*DIN EN 12390-3*/.

Performance data of the MIP construction material regarding its characteristics in accordance with the decisive technical regulation (no CE marking).

2.4 Delivery status

The MIP construction material is produced directly on the construction site and at the point of application in the construction soil. The required binder slurry is mixed on-site on the construction site ready for application and fed to the MIP equipment. The MIP equipment processes the binder slurry with the existing ground in the planned dimensions of the construction component to be produced.

2.5 Base materials/Ancillary materials

- Cement, CEM III/B*: 23.6 – 33.3 m% (* special binding agent with same composition is possible)
- Mixing water: 8.3 – 22.3 m%
- Bentonite: 0 – 1.7 m%
- Additive: 0 – 0.6 m%
- Ground, moist (solids + inherent moisture): 42.2 – 68.0 m%

The total mass of the MIP construction material depends to a significant extent on the existing ground, which is a component of the MIP construction material. The density of the ground itself can differ from site to site. For this reason, the percentage by mass refers to 2,000 kg/m^3 ready-to-use MIP construction material to illustrate the product composition.

The product/at least one partial product contains substances on the ECHA List of Candidate Substances of Very High Concern (SVHC) (dated June 10, 2022) exceeding 0.1% by mass: No

The product/at least one partial product contains additional CMR substances in category 1A or 1B, which are not on the List of Candidates, exceeding 0.1% by mass in at least one partial product: No

Biocide products were added to this construction product or it has been treated with biocide products (this then concerns a treated product as defined by the (EU) Ordinance on Biocide Products No. 528/2012): No

2.6 Manufacture

First, the binder slurry is manufactured directly on the construction site using the base materials (cement, mixing water, bentonite, additives) (see 2.5 Base materials).

The MIP construction material is created directly in the construction soil by breaking open the existing ground with a single or triple auger, moving it and filling the pores with binder slurry that has been produced (Figure 1).

In accordance with Figure 1, cement-based binder slurries are generally incorporated in the construction

soil. As an alternative to standard cement in accordance with EN 197-1, special cement-based binding agents can also be used, whose composition corresponds to a CEM III/B, i.e. a mixture of Portland cement and granulated slag.

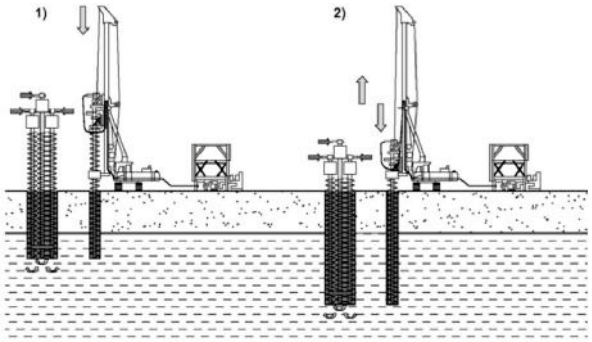


Figure 1: MIP method with triple auger [DWA-M 512-1], left: Drilling and concreting process; right: Homogenization process

To ensure the required quality of the MIP elements or walls, the manufacturing process is monitored in accordance with the decisive parameters for the properties.

2.7 Environment and health during manufacturing

The mixing and processing of binder slurries is common practice on many specialist foundation engineering construction sites. Uncured slurry residues in mixers, as well as reservoirs, pumps and delivery hoses, where appropriate, are disposed of properly (see Section 2.15).

The fresh binder slurry as well as the finished MIP construction material contain a strongly alkaline solution, which is created when mixing cement with water and can cause irritation to skin and eyes.

Due to the water-soluble chromate contained in cements other than low-chromate cements, sustained contact with binder slurries or MIP construction materials made of such cements can lead to the development of allergic chromate dermatitis. In accordance with the REACH Regulation (*REACH*), low-chromate cements are therefore used if there is a danger of skin contact.

Additional information is provided in the safety data sheets of the cement manufacturer.

2.8 Product processing/Installation

The binder slurry is manufactured on the construction site, stored for a short period of time if necessary and then transported to the MIP equipment, which mixes the binder slurry with the ground during and after the drilling process.

2.9 Packaging

The base materials of the binder slurry are delivered without packaging.

2.10 Condition of use

As a rule, the composition of the MIP construction material does not change its condition during use.

2.11 Environment and health during use

The naturally ionizing radiation of the MIP construction material is low and does not pose a health hazard [see Section 7]. Construction components in contact with the ground which are made from the MIP construction material can significantly reduce the influx of radon from the ground (*ZEM*).

The environmental compatibility of the MIP construction material is ensured by using only base materials which are considered to be harmless or whose environmental compatibility has been verified through a National Technical Approval.

The existing ground becomes part of the MIP construction material and therefore does not require verification of its environmental compatibility.

The base materials of the MIP construction material which are mixed in via the binder slurry are predominantly standardized materials which a priori do not require further verification (*DAfStb1).* Instead of standard cement, a special binding agent can be used in the binder slurry, whose composition is similar to standard cement. In addition, bentonite can be used.

Bentonite can be used on the basis of the product-specific water hazard class in combination with the administrative regulations of the German Federal Environmental Agency *(VwVWS* May 17, 1999 and July 27, 2005*).* Bentonite is also listed in the list for substances for "Safe Construction Products for Health and the Environment" of the German Federal Environmental Agency (*Umwelt1*).

2.12 Reference service life

The MIP construction material is designed for an intended service life of at least 50 years for permanent structures, taking into account the existing exposure classes/environmental conditions (general type approval (*GTA*)). The MIP construction material can also be used for temporary purposes. A calculation of the reference service life in accordance with *ISO 15686-8* is not possible for temporary applications.

2.13 Accidental actions

Fire

MIP construction materials meet the requirements of construction material class A1, "non-flammable" in accordance with *DIN 4102-1* and *EN 13501-1.* No toxic gases and fumes can occur in case of fire, and burning construction material components do not drop or fall off.

Fire protection

Description	Value
Construction material class	A1 "non-flammable"

Water

When exposed to water (e.g. floods), the MIP construction material remains mostly inert. Substances are not washed out in quantities which could be hazardous to water.

Mechanical destruction

Not relevant for MIP construction material.

2.14 Re-use phase
Construction components made of MIP construction material can be dismantled. In order to recycle reinforced construction components, the demolished material is separated from the structural steel or reinforcing steel and is processed. For this purpose, the MIP construction material is first crushed and separated into individual grain fractions. In small amounts, they can then be used as recycled rock gravel, e.g. for the construction of earth concrete walls. The reinforcing steel or structural steel is recycled as scrap steel.

If separate base elements are used in the MIP construction material, they can consist of steel or other construction materials (such as glass-reinforced plastic, carbon fiber-reinforced plastic, wood, composite reinforcement). When using pre-fabricated elements or structural elements, structural elements, it is generally possible to re-use them in their entirety.

2.15 Disposal
In Germany, disposal is generally ensured in accordance with Z1.1/Z1.2 according to the Working Group of the Federal States on Waste - Ground (*LAGA Ground)* or "Framework paper Bavaria" („*Eckpunktepapier-Bayern*"). In individual cases, the Landfill Regulation (*DepV2009*) may become relevant for disposal.

For MIP waste made of cement-bound material, waste codes 17 01 01, 17 01 07 and 17 05 04 (*AVV*) apply in accordance with the waste recycling list. For steel which may be contained in the MIP construction material (not included in the EPD), waste code 17 04 05 applies (*AVV*).

2.16 Additional information
https://www.bauer.de/bst/

3. LCA: Calculation rules

3.1 Declared unit
The declared unit is one cubic meter (1 m^3) of Mixed-in-Place construction material.

If MIP construction components contain steel beams, lattice girders or other built-in components, a separate life cycle assessment must be carried out for them.

Declared unit

Description	Value	Unit
Declared unit	1	m^3
Density (mean value)	1900	kg/m^3

The cement content in the composition of the construction material can be 520 to < 600 kg/m^3 MIP construction material in this class. For the life cycle assessment, a cement content of 560 kg/m^3 was assumed.

3.2 System boundary
Type of EPD: "From cradle to plant gate, with options." Declared are the production phase as well as other selected life cycle phases.

Module A1:
Production of cement and bentonite as well as the provision of water.

Module A2:
Transport of the base materials and the required equipment to the construction site.

Module A3:
Mixing of the binder slurry on the construction site.

Module A4:
As the production site and the construction site are identical, no environmental impacts are specified in this module.

Module A5:
Insertion of the slurry which has been produced, incl. the drilling process and the mixing process with the ground (diesel consumption).

Module B1:
No environmental impacts arise from the use of the MIP construction material. In this module, the CO_2 absorption due to carbonation during the service life is listed as having negative global warming potential.

Module B2 and B3:
For Mixed-in-Place construction components, there are generally no environmental impacts during their reference service life.

Module C1:
Dismantling/demolition of Mixed-in-Place construction components.

Module C2:
Transport of Mixed-in-Place demolition material to the processing facility.

Module C3:
Breaking and treatment of Mixed-in-Place demolition material (until the "end of being characterized as waste" is reached).

Module C4:
As only a very small amount of the demolished construction debris is disposed of in landfill and the "Treatment and use" scenario was selected for end-of-life, no environmental impacts are specified for the landfill disposal of MIP construction material.

Module D:
Benefit for use of MIP demolition material in earthworks and road construction.

3.3 Estimates and assumptions
There were no estimates and assumptions.

3.4 Cut-off criteria
All base materials and processes used were taken into account. The small amounts of waste arising from cement production (e.g. packaging material) are ignored in the life cycle assessment and are therefore not listed under "Other environmental information describing different waste categories".

3.5 Background data

The production data for the manufacture of Mixed-in-Place construction material was determined by BAUER Spezialtiefbau GmbH. Data from the year 2020 were used for the life cycle assessment of the cement production, which were determined by VDZ gGmbH as part of the life cycle assessment of cements. The life cycle assessment was carried out with *GaBi ts* 10.6.1.35 software (Sphera Solutions GmbH). Generic records from the *GaBi ts*-database (CUP 2021.1) were used for the life cycle assessment.

3.6 Data quality

The following applies for the foreground data: The geographical, technological and temporal representativeness of the data can be assessed as "very good". The following applies for the generic background data: The geographical and technological representativeness of the data can be assessed as "very good", the temporal representativeness as "good".

3.7 Period under review

The data used relate to the production of MIP construction material in 2020.

3.8 Allocation

An economical allocation was carried out for granulated slag and fly ash, which are used for cement production.

3.9 Comparability

As a matter of principle, a comparison or the assessment of EPD data is only possible if all the records to be compared were created in accordance with *EN 15804* and the building context or the product-specific performance characteristics are taken into account.

Database used: *GaBi ts*-database (CUP 2021.1)

4. LCA: Scenarios and additional technical information

Characteristic product properties of biogenic carbon

Information on the description of the biogenic carbon content at the plant gate

Description	Value	Unit
Biogenic carbon in the product	0	kg C
Biogenic carbon in the associated packaging	0	kg C

The following technical information forms the basis for the declared modules.

Module B1:
Due to carbonation, cement-bound construction materials absorb carbon dioxide from the environment during their service life. This can be expressed as negative global warming potential in module B1. Assumption: Carbonation on one side in contact with the ground, thickness of MIP construction component 55 cm.

C1: Dismantling:
No experience has yet been gained with the dismantling of MIP construction components. For life cycle assessment, it is assumed that the environmental impacts correspond to the dismantling of concrete construction components. The assumptions that form the basis of the *EPDs* for concrete issued by the InformationsZentrum Beton GmbH (September 2018) have been adopted. Typically, the dismantling of concrete structures is predominantly carried out with long reach excavators, which are equipped with demolition shears. The concrete structures are dismantled using so-called "pressure-cutting", i.e. the crushing of concrete by applying compressive force.

C2: Transport from MIP demolition material to the crushing plant:
The assumptions that form the basis of the EPDs for concrete issued by the InformationsZentrum Beton GmbH (September 2018) have been adopted. In this EPD, the average transport distance for the transport of concrete waste to the treatment process is estimated at approx. 50 km.

C3: Waste treatment:
No experience has yet been gained with the waste treatment of MIP construction components. For life cycle assessment, it is assumed that the environmental impacts correspond to the waste treatment of concrete construction components. The assumptions that form the basis of the EPDs for concrete issued by the InformationsZentrum Beton GmbH (September 2018) have been adopted. Treatment generally takes place using jaw crushers or impact crushers. In addition to crushing, pre-screening and metal separation is also carried out.

End of life (C1-C4)

Description	Value	Unit
Separately collected mineral construction waste	1900	kg
Collected as mixed construction waste	0	kg
For reuse	0	kg
For recycling	1900	kg
For energy recovery	0	kg
For landfill disposal	0	kg

D: Benefits and loads after end-of-life: In the crushing plant, the MIP construction material reaches the end of being characterized as waste. The output at the end of the crushing process is a secondary material that can replace the primary materials sand and gravel. Life cycle assessment benefits are specified for this in module D.
Additional information on carbonation: *EN 16757* specifies 75% of the maximum possible CO_2 absorption as the average guide value for the long-term absorption of CO_2 by cement-bound construction materials. This value results in 60.1 kg/m^3 MIP construction material for a MIP construction material of class VI. However, this value should only be understood as a reference value, as it is subject to many influencing factors.

5. LCA: Results

DESCRIPTION OF THE SYSTEM BOUNDARY (X = INCLUDED IN LIFE CYCLE ASSESSMENT; ND = MODULE OR INDICATOR NOT DECLARED; MNR = MODULE NOT RELEVANT)

Production stage			Construction process stage		Use stage							End of life stage				Benefits and loads beyond the system boundaries
Raw materials supply	Transport	Manufacture	Transport from the gate to the site	Installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Dismantling/ demolition	Transport	Waste treatment	Disposal	Reuse, Recovery or Recycling potential
A1	**A2**	**A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
X	X	X	X	X	X	ND	MNR	MNR	MNR	ND	ND	X	X	X	ND	X

RESULTS OF LIFE CYCLE ASSESSMENT – ENVIRONMENTAL IMPACTS in accordance with EN 15804+A2: 1 m³ Mixed-in-Place (MIP) construction material, BAUER MIP® Class VI, cement contents from 520 kg/m³ to < 600 kg/m³

Core indicator	Unit	A1-A3	A4	A5	B1	C1	C2	C3	D
GWP-total	[kg CO_2-eq.]	198.00	0.00	23.30	-1.30	3.15	7.94	4.15	-4.45
GWP-fossil	[kg CO_2-eq.]	198.00	0.00	23.10	-1.30	3.13	7.88	4.10	-4.41
GWP-biogenic	[kg CO_2-eq.]	4.70E-1	0.00E+0	8.07E-2	0.00E+0	1.00E-2	2.90E-2	3.90E-2	-3.00E-2
GWP-luluc	[kg CO_2-eq.]	6.00E-2	0.00E+0	7.45E-2	0.00E+0	1.00E-2	3.00E-2	9.20E-3	-1.00E-2
ODP	[kg CFC11-eq.]	4.04E-8	0.00E+0	2.10E-11	0.00E+0	6.47E-13	1.61E-12	5.34E-11	-3.51E-11
AP	[mol H^+-eq.]	3.44E-1	0.00E+0	2.55E-1	0.00E+0	4.22E-2	2.70E-2	3.21E-2	-1.47E-2
EP-freshwater	[kg P-eq.]	2.80E-4	0.00E+0	4.41E-5	0.00E+0	6.30E-6	1.57E-5	1.49E-5	-1.25E-5
EP-marine	[kg N-eq.]	1.05E-1	0.00E+0	1.06E-1	0.00E+0	1.92E-2	1.27E-2	1.42E-2	-5.74E-3
EP-terrestrial	[mol N-eq.]	1.22E+0	0.00E+0	1.16E+0	0.00E+0	2.11E-1	1.42E-1	1.56E-1	-6.32E-2
POCP	[kg NMVOC-	3.29E-1	0.00E+0	3.15E-1	0.00E+0	5.74E-2	2.46E-2	4.20E-2	-1.35E-2
ADPE	[kg Sb-eq.]	2.42E-5	0.00E+0	2.35E-6	0.00E+0	3.17E-7	7.89E-7	1.35E-6	-1.00E-6
ADPF	[MJ]	992.00	0.00	307.00	0.00	41.90	104.00	54.60	-58.20
WDP	[m^3 world-eq. extracted]	1.81E+1	0.00E+0	8.83E-1	0.00E+0	1.00E-2	3.40E-2	6.00E-2	-1.10E-1

Key	GWP = Global Warming Potential; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential of land and water; EP = Eutrophication potential; POCP = Formation potential of tropospheric ozone; ADPE = Abiotic depletion potential for non-fossil resources (ADP – substances); ADPF = Abiotic depletion potential for fossil resources (ADP – fossil energy resources); WDP = Water deprivation potential (user)

RESULTS OF LIFE CYCLE ASSESSMENT – INDICATORS FOR THE DESCRIPTION OF RESOURCE USE in accordance with EN 15804+A2: 1 m³ Mixed-in-Place (MIP) construction material, BAUER MIP® Class VI, cement contents from 520 kg/m³ to < 600 kg/m³

Indicator	Unit	A1-A3	A4	A5	B1	C1	C2	C3	D
PERE	[MJ]	337.00	0.00	28.50	0.00	2.75	6.85	27.10	-18.40
PERM	[MJ]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PERT	[MJ]	337.00	0.00	28.50	0.00	2.75	6.85	27.10	-18.40
PENRE	[MJ]	992.00	0.00	307.00	0.00	41.90	104.00	54.60	-53.80
PENRM	[MJ]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PENRT	[MJ]	992.00	0.00	307.00	0.00	41.90	104.00	54.60	-53.80
SM	[kg]	2.91	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RSF	[MJ]	126.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NRSF	[MJ]	295.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FW	[m^3]	1.25	0.00	0.77	0.00	0.04	0.11	0.08	-0.11

Key	PERE = Renewable primary energy as energy source; PERM = Renewable primary energy for material utilization; PERT = Total use of renewable primary energy; PENRE = Non-renewable primary energy as energy source; PENRM = Non-renewable primary energy for material utilization; PENRT = Total use of non-renewable primary energy; SM = Use of secondary materials; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels; FW = Net use of fresh water

RESULTS OF LIFE CYCLE ASSESSMENT – WASTE CATEGORIES AND OUTPUT FLOWS in accordance with EN 15804+A2:

Indicator	Unit	A1-A3	A4	A5	B1	C1	C2	C3	D
HWD	[kg]	3.10E-3	0.00E+0	5.94E-9	0.00E+0	1.83E-10	4.54E-10	3.24E-9	-2.58E-9
NHWD	[kg]	1.13E+0	0.00E+0	5.01E+2	0.00E+0	6.80E-3	1.69E-2	3.30E-2	-3.96E+1
RWD	[kg]	3.81E-2	0.00E+0	1.33E-3	0.00E+0	5.26E-5	1.31E-4	2.56E-3	-1.83E-3
CRU	[kg]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MFR	[kg]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MER	[kg]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EEE	[MJ]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EET	[MJ]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Key	HWD = Hazardous waste disposed; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed; CRU = Components for re-use; MFR = Materials for recycling; MER = Materials for energy recovery; EEE = Exported electrical energy; EEE = Exported thermal energy

RESULTS OF LIFE CYCLE ASSESSMENT – additional impact categories in accordance with EN 15804+A2 optional: 1 m³ Mixed-in-Place (MIP) construction material, BAUER MIP® Class VI, cement contents from

Indicator	Unit	A1-A3	A4	A5	B1	C1	C2	C3	D
PM	[Cases of illness]	2.22E-6	0.00E+0	1.13E-5	0.00E+0	2.25E-6	1.51E-7	1.58E-6	-9.31E-7
IRP	[kBq U235-eq.]	5.05E+0	0.00E+0	1.43E-1	0.00E+0	5.35E-3	1.33E-2	2.34E-1	-1.82E-1
ETP-fw	[CTUe]	5.34E+2	0.00E+0	2.15E+2	0.00E+0	3.29E-1	7.97E+1	3.31E+1	-3.65E+1
HTP-c	[CTUh]	2.84E-8	0.00E+0	1.16E-8	0.00E+0	6.42E-10	1.60E-9	9.31E-10	-1.87E-9
HTP-nc	[CTUh]	2.90E-6	0.00E+0	1.16E-6	0.00E+0	4.84E-8	9.28E-8	4.94E-8	-1.64E-7
SQP	[-]	576.30	0.00	83.90	0.00	12.60	31.20	24.90	-22.60

Key	PM = Potential incidence of disease due to particulate matter emissions; IRP = Potential effect from human exposure to U235; ETP-fw = Potential toxicity comparison unit for ecosystems; HTP-c = Potential toxicity comparison unit for humans (carcinogenic effect); HTP-nc = Potential toxicity comparison unit for humans (non-carcinogenic effect); SQP = Potential soil quality index

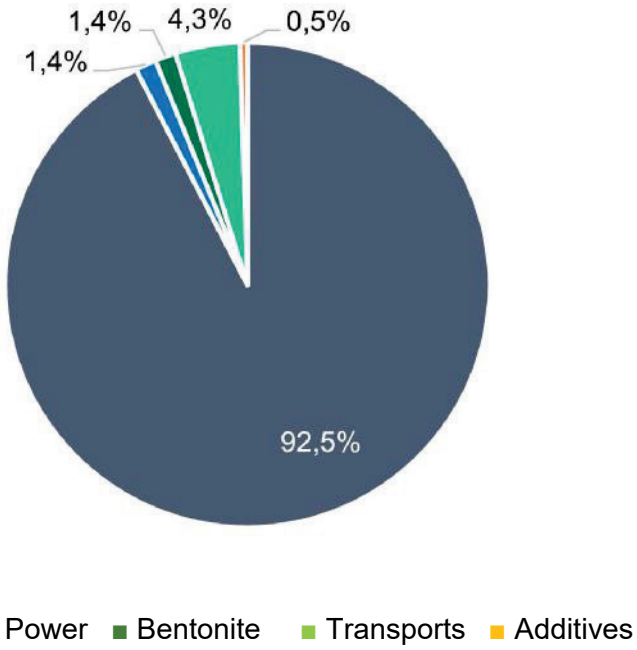
Net values are declared in A1–A3 for all GWP (global warming potential) indicators. The waste status of the (waste-based) energy sources has been verified. The gross emissions (i.e. including CO_2 from the combustion of waste) are:
235.2 kg CO_2-eq/m^3 (GWP-total)
223.1 kg CO_2-eq/m^3 (GWP-fossil)
12.0 kg CO_2-eq/m^3 (GWP-biogenic)
with these values representing the corresponding sums from the net values and the emissions resulting from the incineration of verified waste materials.

Disclaimer 1 — applies for the indicator "Potential effect from human exposure to U235". This impact category deals mainly with the possible impact of low dose ionizing radiation on human health in the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents or occupational exposure, nor due to radioactive waste disposal in underground facilities. Potential ionizing radiation from the ground, from radon and from some construction materials is also not measured by this indicator.

Disclaimer 2 — applies for the indicators: "Abiotic depletion potential - non-fossil resources", "Abiotic depletion potential - fossil resources", "Water deprivation potential (user)", "Potential toxicity comparison unit for ecosystems", "Potential toxicity comparison unit for humans - carcinogenic effect"; "Potential toxicity comparison unit for humans - non-carcinogenic effect"; "Potential soil quality index".
The results of these environmental indicators must be used with caution, as there is a high level of uncertainty regarding these results or there is only limited experience in relation to the indicator.

6. LCA: Interpretation

The following diagram indicates the most important influencing factors for the global warming potential (Module A1–A3):



The range of the MIP construction materials used to generate the average values encompasses

- MIP construction materials where the environmental impact parameters listed in Section 5 and the resource use (Module A1–A3) are exceeded by up to 20%

up to

- MIP construction materials where the environmental impact parameters listed in Section 5 and the resource use (Module A1–A3) fall short by up to 20%

7. Requisite evidence

7.1 Radioactivity

Measurement of nuclide contents in Bq/kg for Ra-226, Th-232, K-40. In Germany, there are currently no legally specified limit values for assessing the radioactivity of construction materials. Assessment can be carried out in accordance with:
- Document of the European Commission 'Radiation Protection 112'
- OENORM 5200
- Nordic Countries' Recommendation 2000.

7.2 Leaching

To test the leaching of construction materials, test procedures such as *CEN/TS 16637-2* (monolithic test specimens) as well as *CEN/TS 16637-3* (permeable construction materials, e.g. rock gravel) are used. Tests are not required for most of the base materials of MIP construction materials and fields of application (e.g. natural rock gravel or cements in accordance with *EN 197-1*).

Requirements for leaching may arise for MIP construction materials containing cement additives in the relevant fields of application. If the construction materials are not covered by harmonized standards, their compliance with requirements is verified as part of the technical approval of the materials.

8. Literature references

Standards

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DIN 4093
DIN 4093:2015-11 Design of strengthened soil - Set up by means of jet grouting, deep mixing or grouting.

DIN 4102-1
DIN 4102-1:1998-05 Fire behaviour of building materials and building components - Part 1: Building materials; concepts, requirements and tests.

EN 197-1
DIN EN 197-1:2011-11 Cement - Part 1: Composition, specifications and conformity criteria for common cements.

EN 12390-3
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EN 13501-1
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ISO 15686-8:2008-06 Buildings and constructed assets - Service-life planning - Part 8: Reference service life and service-life estimation.

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ISO 17892-7:2017-11 Geotechnical Investigation And Testing - Laboratory Testing Of Soil - Part 7: Unconfined Compression Test.

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Data sheet DWA-M 512-1, February 2012. Sealing Systems in Hydraulic Engineering. Part: 1: Earthwork Structures. Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall e. V. (*German Association for Water, Wastewater and Waste*) (DWA) (Publisher).

"Framework paper Bavaria"
Requirements for fill materials for pits and quarries as well as open-cast mines, version dated July 15, 2021.

LAGA-ground
Notification of the Ländergemeinschaft (LAGA) (*German Association of Federal Government and Federal States*) M20, Requirements for the recycling of mineral-based residual materials/waste - Technical Regulations - Status November 6, 2003.

REACH
REGULATION (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/E.

VwVWS
Administrative Regulation on Substances Hazardous to Water dated 17/05/1999 (Federal Gazette No. 98a dated 29/05/1999), amended by Administrative Regulation dated 27/07/2005 (Federal Gazette No. 142a dated 30/07/2005).

Other sources

General type approval
National technical approval "BAUER Mixed-In-Place (MIP)" Z-34.26-200, Deutsches Institut für Bautechnik (*German Institute of Construction Technology*), Berlin

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- Environmental Product Declaration Concrete of compressive strength class C 20/25, EPD-IZB-20180097-IBG1-DE
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