

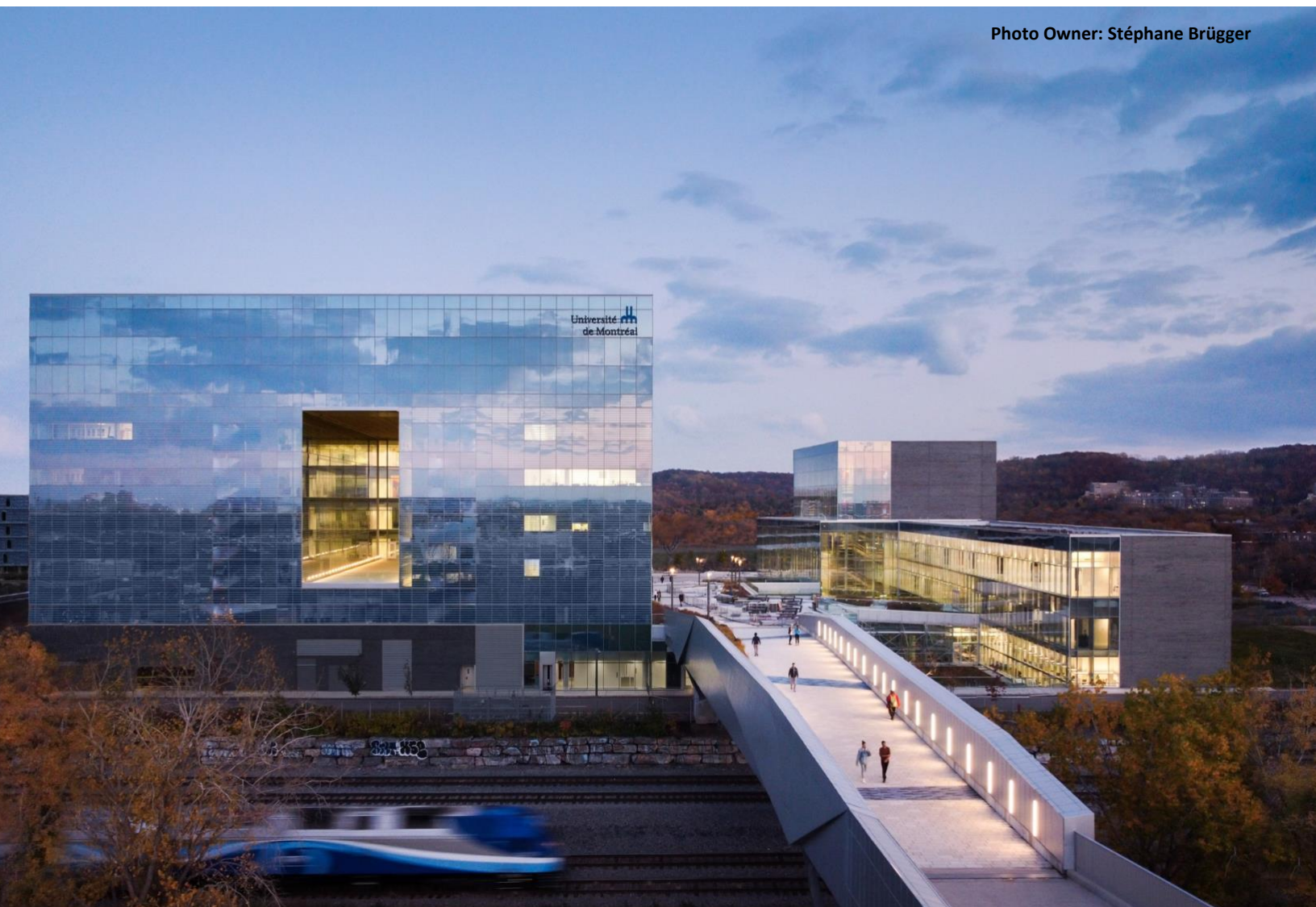
Environmental Product Declaration



Association béton Québec (ABQ) Member
Industry-Wide EPD for

READY-MIXED CONCRETE

Photo Owner: Stéphane Brügger



ASTM International Certified Environmental Product Declaration

Declared Product	This Environmental Product Declaration (EPD) covers concrete mixes produced by Association béton Québec (ABQ) members.	
Declaration Owner	Association béton Québec (ABQ) 520, D'Avaugour, bureau 2200 Boucherville, QC J4B 0G6, Canada Phone: (450) 650-0930 Website: betonabq.org	
Program Operator	ASTM International 100 Bar Harbor Drive West Conshohocken, PA 19428-2959, USA Website: www.astm.org	 ASTM INTERNATIONAL Helping our world work better
LCA and EPD Developer	Athena Sustainable Materials Institute 280 Albert Street, Suite 404 Ottawa, ON K1P 5G8, Canada Website: www.athenasmi.org	 Athena Sustainable Materials Institute
Core PCR	ISO 21930:2017 Sustainability in Building Construction - Environmental Declaration of Building Products	
Sub-category PCR	NSF International Product Category Rule (PCR) for Concrete Version 2.1 (August 2021), Verified by Thomas P. Gloria, Ph.D., Industrial Ecology Consultants	
Independent LCA Reviewer and EPD Verifier	Independent verification of the declaration and data, according to ISO 21930:2017 and ISO 14025:2006 ☐ Internal ☒ External	
	Thomas P. Gloria, Ph.D., Industrial Ecology Consultants, ASTM International	
Date of Issue	July 27, 2022	
Period of Validity	5 Years – Valid until July 27, 2027	
EPD Number	EPD 352	
The declared product meets the following product specifications: • ACI 211: Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete • CSA A3000: Cementitious materials compendium • CSA A23.1/A23.2 Concrete materials and methods of concrete construction/Test methods and standard practices for concrete • ACI 318: Building Code Requirements for Structural Concrete • ASTM C94 Standard Specification for Ready-Mixed Concrete • CSI MasterFormat Division 03-30-00: Cast-in-Place Concrete • UNSPSC Code 30111500: Ready Mix Disclaimer: EPDs are comparable only if they comply with this document, use the same sub-category PCR where applicable, include all relevant information modules and are based on equivalent scenarios with respect to the context of construction works. The ready mixed concrete products represented in this EPD are comprised of (in order of greatest mass per mix): natural and crushed aggregates, Portland cement, fly ash/slag cement, silica fume, batch water, and admixtures. The performance of concrete may vary according to the characteristics and origins of its constituents.		

Methodology of Underlying LCA

Declared Unit

The declared unit is 1 cubic metre of ready mixed concrete. Products covered by this EPD satisfy general purpose concrete as used in residential, commercial and public works applications in Québec. Key product variables include:

- **28-day strength** – Different compressive strengths were considered;
- **Slag cement/Fly Ash** – Varies between 0% and 30%;
- **Admixture use** – The use of air-entraining, water reducing, and high range water reducing admixture varies;
- **Aggregate use** – The use of crushed coarse, crushed fine, natural coarse, and natural fine aggregates varies.

Product (mix design) components include the following: Portland cement (GU), Portland limestone cement (GUL), silica fume, slag cement, fly ash, natural and crushed aggregates, admixtures and batch water.

Scope

The modeled concrete mixes included benchmarks for each strength class. This EPD is intended for use in Business to Business (B-to-B) communication. This EPD can only be used and referenced by members of ABQ as having participated in the study. The scope of this EPD is cradle-to-gate and considers the following life cycle stages (Figure 1):

- **A1 - Raw Material Supply:** Includes all upstream processes related to extraction, handling, and processing of the raw materials and intermediate component products as well as fuels used in the production of concrete. Component products include cement, supplementary cementitious materials, aggregate (coarse and fine), water, admixtures and other materials or chemicals used in concrete mixtures.
- **A2 - Transportation:** Accounts for the transportation of all input materials and fuels from the supplier to the gate of the concrete plant.
- **A3 - Manufacturing (Core Processes):** Includes all core processes and the energy and water used to store, move, batch and mix the concrete and operate the concrete plant as well as the transportation and processing of wastes from these core processes.

Building Life Cycle Information Modules															
Product stage			Construction Process stage		Use stage							End-of-life stage			
Raw Material supply	Transport	Manufacturing	Transport	Construction/Installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational Energy Use	Operational Water Use	De-Construction/ Demolition Transport	Waste processing	Disposal	
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4

Figure 1: Life cycle stage schematic – alpha-numeric designations as per NSF PCR 2021

Description of Product

This EPD presents results for the range of products that are available across Québec. For each specified mix, variations were developed based on the use of GU and GUL cement as well as different SCM replacement levels. For each mix, a “baseline” mix was developed that represents the average product mix within Québec. The mixes presented in this EPD utilize the following naming convention:

Mix Name: Identify the 28-day specified compressive strength of the proposed product by type of cement unless otherwise stated. Portland cement, also known as Type I or General Use cement is labeled as “GU”. Portland limestone cement, also known as Type IL or General Use Limestone cement is labeled as “GUL”. The name of the mix also notes whether it is “air entrained” and also includes other specifications of the mix recognized in the marketplace. For instance, mixes may also be tagged with an exposure class – (C) classes pertain to chloride exposure; (F) classes pertain to freezing and thawing exposure without chlorides; (N) class is exposed to neither chlorides nor freezing and thawing. For more information concerning exposure class see CSA standard A23.1.

SCM Replacement: Identify the supplementary cementing material (SCM) percentage. Fly ash is labeled in the mix designs as “FA”, slag cement as “SC”, and silica fume blended cement is labeled as “GUbSF”. For example, a mix with 20% fly ash is denoted in the mix identifier as “20 FA”. GU or GUL cements could be partially or fully replaced by GUbSF cement if the amount of silica fume is greater than 5%. For mixes containing GUbSF and ternary cement, the amount of silica fume could be converted into slag or fly ash'

Cut-off Rules

The cut-off criteria for all activity stage flows considered within the system boundary conform with ISO 14044:2006 and NSF PCR 2021. Specifically, the cut-off criteria were applied as follows:

- All inputs and outputs for which data are available are included in the calculated effects and no collected core process data are excluded.
- A one percent cut-off is considered for renewable and non-renewable primary energy consumption and the total mass of inputs within a unit process. The sum of the total neglected flows does not exceed 5% of all energy consumption and mass of inputs.
- All flows known to contribute a significant impact or to uncertainty are included.
- The cut-off rules are not applied to hazardous and toxic materials – all are included in the life cycle inventory.

Allocation

The allocation of co-products or secondary flows cross the system boundary conforms with ISO 21930: 2017 Section 7.2.4. Specifically, the allocation criteria were applied as follows:

- Allocation was not applied any of the gate-to-gate production facilities. For facilities that manufacture additional products (i.e. aggregate), the LCI flows at the facility specific to the concrete production were reported.
- For secondary data sources, the NSF PCR default allocation selection (i.e. “Cut-off” or “Alloc Rec”) was applied.
- The product category rules for this EPD recognize fly ash, silica fume and slag as recovered materials and thus the environmental impacts allocated to these materials are limited to the treatment and transportation required to use as a concrete material input.
- A portion (30%) of the reported fleet energy use for truck mixing plants was allocated to the mixing facility.

Participation

Participation in the concrete plant data collection was open to all members of the Association béton Québec (ABQ). Concrete plants were randomly selected based on size of operation and geographic distribution. The results of this report are applicable to the concrete produced from all members of ABQ and a list of certified concrete plants can be found on the Association website (betonabq.org).

Data Sources and Software

This EPD is based on foreground LCI data collected from the participating companies' production facilities. A representative sample of ABQ member facilities were selected based on technical attributes, production scale, and geographic location. In total, 27 facilities operated by ABQ member companies completed LCI data collection questionnaires representing over 21% of all ABQ member facilities.

All upstream material, resource and energy carrier inputs have been sourced from various industry-average datasets and literature as specified for use in NSF PCR 2021. Tables 1 to 3 describe each LCI data source for raw materials (A1), transportation by mode (A2), the core manufacture process (A3), and descriptions of data quality for each data source.

This EPD was calculated using manufacturer specific cement data that represents 100% of the total cement used in this mix. As part of the data collection process, each participating facility provided data as to their cement supplier. All cement facilities were represented with environmental product declarations, and thus a weighted average cement profile was created for each individual region.

Materials	LCI Data Source	Geography	Year	Data Quality Assessment
General Use Cement ASTM C150, C595, C1157, CSA A3000	Weighted Average of Results Specific to Concrete Producers in Region	Canada	2020-2021	• Technology: very good • Time: very good • Geography: very good • Completeness: very good • Reliability: very good
General Use Limestone Cement ASTM C150, C595, C1157, CSA A3000	Weighted Average of Results Specific to Concrete Producers in Region	Canada	2020-2021	• Technology: very good • Time: very good • Geography: very good • Completeness: very good • Reliability: very good
Fly Ash ASTM C618, CSA A3000	None, no incoming burden, only inbound transport was considered	N/A	N/A	• N/A • Recovered material
Slag Cement ASTM C989, CSA A3000	Slag Cement Association N. America EPD Slag Cement, 2021	N. America	2021	• Technology: good Process models ground granulated blast furnace slag • Time: good Data is within 3 years • Geography: good • Completeness: good • Reliability: very good, third-party verified EPD
Crushed Aggregates <i>coarse and fine</i> ASTM C33, A23.1/A23.2	ecoinvent 3.4: Gravel, crushed {RoW} production Cut-off, U Modified with regional electricity	EU/Canada	2004	• Technology: good • Time: fair Data is twelve years old but technology remains consistent across the industry
Natural Aggregates <i>coarse and fine</i> ASTM C30, A23.1/A23.2	ecoinvent 3.4: Gravel, round {RoW} gravel and sand quarry operation Cut-off, U Modified with regional electricity	EU/Canada	2004	• Geography: good Swiss production (modified with regional Electricity). • Completeness: very good • Reliability: very good
Admixtures ASTM C494, ASTM C260	EFCA EPDs for Air Entrainers, Plasticisers and superplasticisers (2015) Non-supported LCIA indicators estimated	EU	2015	• Technology: very good • Time: good • Geography: good • Completeness: good • Reliability: good
Water ASTM C1602, A23.1/A23.2	ecoinvent 3.4: Tap water {RoW} market for Cut-off, U	Global	2011	• Technology: very good • Time: good • Geography: fair • Completeness: very good • Reliability: very good,

Table 2. A2 - Transportation				
Process	LCI Data Source	Geography	Year	Data Quality Assessment
Truck Transportation	USLCI 2014: Transport, combination truck, short-haul, diesel powered/tkm/RNA	USA	2007	• Technology: good • Time: fair • Geography: very good • Completeness: good • Reliability: good
Rail Transportation	USLCI 2014: Transport, train, diesel powered /US U	USA	2007	• Technology: good • Time: fair • Geography: very good • Completeness: good • Reliability: good
Ocean Transportation	USLCI 2014: Transport, ocean freighter, average fuel mix /US U	USA	2007	• Technology: good • Time: fair • Geography: very good • Completeness: good • Reliability: good

Table 3. A3 - Manufacturing				
Process	LCI Data Source	Geography	Year	Data Quality Assessment
Electricity	ecoinvent 3.4: Electricity, low voltage, at grid, (CA)	Regional	2015	• Technology: very good • Time: good • Geography: very good • Completeness: good • Reliability: good
Natural Gas	USLCI 2014: Natural gas, combusted in industrial boiler/US	US	2008	• Technology: very good • Time: fair • Geography: fair • Completeness: good • Reliability: good
Diesel	USLCI 2014: Diesel, combusted in industrial equipment/US	US	2008	• Technology: very good • Time: fair • Geography: fair • Completeness: good • Reliability: good
Liquefied Propane Gas	USLCI 2014: Liquefied petroleum gas, combusted in industrial boiler/US	US	2008	• Technology: very good • Time: fair • Geography: fair • Completeness: good • Reliability: good
Hazardous Waste	ecoinvent 3.4: Hazardous waste, for incineration {ROW} treatment of hazardous waste, hazardous waste incineration Alloc Rec, U	EU	2008	• Technology: good • Time: fair • Geography: fair • Completeness: very good • Reliability: very good
Non-Hazardous Waste	ecoinvent 3.4: Inert waste {RoW} treatment of, sanitary landfill Alloc Rec, U	EU	2008	• Technology: good • Time: fair • Geography: fair • Completeness: very good • Reliability: very good

Athena's Concrete LCA Software V2 was used to gather the facility data, mix designs, and to conduct the LCA modeling. This software was third party reviewed and found to be in conformance with the following relevant standards: ISO 14040:2006b, ISO 14044:2006c, ISO 14025:2006, ISO 21930:2017, and the NSF PCR 2021.

Life Cycle Assessment Results

The LCA results presented in this EPD are intended for use in Business to Business (B-to-B) communication. The EPD supports 25 life cycle impact assessment indicators and inventory metrics as listed in Table 4. The Impact Assessment method and other calculation methodologies are specified in Table 4. Tables 5 through 26 present the LCA results for the mixes produced at the different facilities (Information module A1-A3 accumulated). The results are presented first based on a declared unit of 1 cubic metre.

Table 4. Life Cycle Category Indicators and Inventory Metrics			
Core Mandatory Impact Indicator	Abbreviation	Unit	Method/Source
Global warming potential	GWP	kg CO ₂ eq	TRACI 2.1 V1.02
Depletion potential of the stratospheric ozone layer	ODP	kg CFC-11 eq	TRACI 2.1 V1.02
Acidification potential of soil and water sources	AP	kg SO ₂ eq	TRACI 2.1 V1.02
Eutrophication potential	EP	kg N eq	TRACI 2.1 V1.02
Photochemical smog creation potential	POCP	kg O ₃ eq	TRACI 2.1 V1.02
Abiotic depletion potential (ADP _{fossil})*	ADP _f	MJ, NCV	CML-IA Baseline V3.02
Abiotic depletion potential (ADP _{elements})*	ADP _e	kg Sbe	CML-IA Baseline V3.02
Use of Primary Resources			
Renewable primary energy carrier used as energy*	RPRE	MJ, NCV	CED V1.10 NCV
Renewable primary energy carrier used as material*	RPRM	MJ, NCV	LCI Indicator
Non-renewable primary energy carrier used as energy*	NRPRE	MJ, NCV	CED V1.10 NCV
Non-renewable primary energy carrier used as material*	NRPRM	MJ, NCV	LCI Indicator
Secondary Material, Secondary Fuel and Recovered Energy			
Secondary material*	SM	kg	LCI Indicator
Renewable secondary fuel *	RSF	MJ, NCV	LCI Indicator
Non-renewable secondary fuel*	NRSF	MJ, NCV	LCI Indicator
Recovered energy*	RE	MJ, NCV	LCI Indicator
Mandatory Inventory Parameters			
Consumption of freshwater resources;	FW	m ³	LCI Indicator
Calcination and carbonation emissions	CCE	kg CO ₂ eq	LCI Indicator
Indicators Describing Waste			
Hazardous waste disposed*	HWD	kg	LCI Indicator
Non-hazardous waste disposed*	NHWD	kg	LCI Indicator
High-level radioactive waste*	HLRW	m ³	LCI Indicator
Intermediate- and low-level radioactive waste*	ILLRW	m ³	LCI Indicator
Components for re-use*	CRU	kg	LCI Indicator
Materials for recycling*	MR	kg	LCI Indicator
Materials for energy recovery*	MER	kg	LCI Indicator
Recovered energy exported from the product system*	EE	MJ, NCV	LCI Indicator

Emerging LCA impact categories and inventory items are still under development and can have high levels of uncertainty that preclude international acceptance pending further development. Use caution when interpreting data in categories marked with (*) in Table 4. Additionally, EPDs are comparable only if they comply with this document, use the same sub-category PCR where applicable, include all relevant information modules and are based on equivalent scenarios with respect to the context of construction works. No regulated substances of very high concern were identified in the LCA.

Table 5. LCA Results 20 MPa Concrete with air

Unit	Baseline 20 MPa Concrete with air	20 MPa Concrete with air GU	20 MPa Concrete with air GU 10 SL	20 MPa Concrete with air GU 20 SL	20 MPa Concrete with air GU 30 SL	20 MPa Concrete with air GU 10 FA	20 MPa Concrete with air GU 20 FA	20 MPa Concrete with air GU 30 FA	20 MPa Concrete with air GUL	20 MPa Concrete with air GUL 10 SL	20 MPa Concrete with air GUL 20 SL	20 MPa Concrete with air GUL 30 SL	20 MPa Concrete with air GUL 10 FA	20 MPa Concrete with air GUL 20 FA	20 MPa Concrete with air GUL 30 FA
Environmental impacts															
GWP	kg CO ₂ eq.	278.10	286.77	266.54	246.32	226.10	262.43	238.09	213.75	266.39	248.21	230.03	211.85	244.09	199.50
ODP	kg CFC-11 eq.	6.95E-06	7.38E-06	7.36E-06	7.33E-06	7.30E-06	6.68E-06	5.99E-06	5.29E-06	6.30E-06	6.38E-06	6.47E-06	6.55E-06	5.71E-06	4.53E-06
EP	kg N eq.	0.18	0.19	0.19	0.18	0.17	0.18	0.16	0.15	0.17	0.17	0.16	0.16	0.16	0.13
AP	kg SO ₂ eq.	1.57	1.62	1.56	1.51	1.45	1.50	1.39	1.28	1.51	1.47	1.42	1.38	1.41	1.21
POCP	kg O ₃ eq.	29.07	29.85	29.21	28.56	27.91	28.15	26.45	24.75	27.99	27.53	27.07	26.61	26.48	23.45
Use of primary resources															
RPR _E	MJ, NCV	248.50	257.83	238.49	219.14	199.80	236.96	216.09	195.21	235.24	218.16	201.09	184.01	216.63	179.42
RPR _M	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	2.00	3.00	4.00	6.00
NRPR _E	MJ, NCV	1348.33	1443.65	1428.61	1413.58	1398.55	1366.61	1289.57	1212.54	1201.93	1211.16	1220.38	1229.61	1149.15	1043.59
NRPR _M	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Use of secondary resources															
SM	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RSF	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NRSF	MJ, NCV	99.31	103.14	92.79	82.43	72.08	92.79	82.43	72.08	94.05	84.61	75.17	65.73	84.61	65.73
RE	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Abiotic depletion potential															
ADP _f	MJ, LHV	680.83	692.55	693.63	694.70	695.77	686.65	680.75	674.85	664.06	667.99	671.92	675.86	661.02	654.94
ADP _e	kg Sb	1.15E-04	1.17E-04	1.15E-04	1.14E-04	1.13E-04	1.13E-04	1.10E-04	1.07E-04	1.12E-04	1.11E-04	1.10E-04	1.09E-04	1.09E-04	1.03E-04
Consumption of freshwater resources															
FW	m ³	1.94	1.96	1.93	1.89	1.85	1.92	1.88	1.83	1.90	1.87	1.84	1.81	1.86	1.79
Waste and output flows															
HWD	kg	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
NHWD	kg	12.42	12.94	11.65	10.35	9.06	11.64	10.35	9.05	11.69	10.52	9.35	8.18	10.52	8.18
HLRW	m ³	3.95E-09	3.95E-09	3.95E-09	3.95E-09	3.95E-09	3.95E-09	3.95E-09	3.95E-09	3.95E-09	3.95E-09	3.95E-09	3.95E-09	3.95E-09	3.95E-09
ILLRW	m ³	5.68E-08	5.68E-08	5.68E-08	5.68E-08	5.68E-08	5.68E-08	5.68E-08	5.68E-08	5.68E-08	5.68E-08	5.68E-08	5.68E-08	5.68E-08	5.68E-08
CRU	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MR	kg	0.00	0.00	0.00	0.00	0.00	0.00	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	0.00	0.00	0.00	0.00	0.00	0.00
EE	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Additional inventory parameters for transparency															
CCE	kg CO ₂ eq.	123.82	134.21	120.74	107.27	93.81	120.74	107.27	93.81	108.14	97.28	86.43	75.58	97.28	75.58

Table 6. LCA Results 20 MPa Concrete without air (N)

Unit		Baseline 20 MPa Concrete without air (N)	20 MPa Concrete without air (N) GU	20 MPa Concrete without air (N) GU 10 SL	20 MPa Concrete without air (N) GU 20 SL	20 MPa Concrete without air (N) GU 30 SL	20 MPa Concrete without air (N) GU 10 FA	20 MPa Concrete without air (N) GU 20 FA	20 MPa Concrete without air (N) GU 30 FA	20 MPa Concrete without air (N) GUL	20 MPa Concrete without air (N) GUL 10 SL	20 MPa Concrete without air (N) GUL 20 SL	20 MPa Concrete without air (N) GUL 30 SL	20 MPa Concrete without air (N) GUL 10 FA	20 MPa Concrete without air (N) GUL 20 FA	20 MPa Concrete without air (N) GUL 30 FA
Environmental impacts																
GWP	kg CO ₂ eq.	263.80	272.17	252.48	233.89	215.11	248.65	226.10	203.50	252.96	235.24	218.56	201.68	231.42	210.76	190.06
ODP	kg CFC-11 eq.	6.57E-06	6.99E-06	6.94E-06	6.94E-06	6.91E-06	6.31E-06	5.66E-06	5.02E-06	5.97E-06	6.02E-06	6.12E-06	6.20E-06	5.40E-06	4.85E-06	4.30E-06
EP	kg N eq.	0.17	0.18	0.18	0.17	0.17	0.17	0.15	0.14	0.16	0.16	0.15	0.15	0.15	0.14	0.12
AP	kg SO ₂ eq.	1.50	1.54	1.49	1.44	1.39	1.44	1.33	1.23	1.44	1.40	1.36	1.32	1.35	1.26	1.16
POCP	kg O ₃ eq.	27.89	28.65	27.97	27.43	26.83	27.00	25.44	23.86	26.90	26.40	26.03	25.60	25.42	24.03	22.63
Use of primary resources																
RPR _E	MJ, NCV	236.63	245.63	226.93	209.02	191.06	225.51	206.12	186.74	224.34	207.81	192.01	176.16	206.40	189.12	171.84
RPR _M	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	2.00	3.00	4.00	5.00	6.00
NRPR _E	MJ, NCV	1296.65	1388.50	1371.06	1360.04	1346.09	1313.48	1242.68	1171.14	1160.64	1166.59	1178.11	1186.67	1109.02	1060.74	1011.73
NRPR _M	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Use of secondary resources																
SM	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RSF	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NRSF	MJ, NCV	93.53	97.22	87.24	77.63	68.02	87.24	77.63	68.02	88.65	79.55	70.79	62.02	79.55	70.79	62.02
RE	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Abiotic depletion potential																
ADP _f	MJ, LHV	667.38	678.69	678.79	680.72	681.72	672.31	667.52	662.04	651.83	654.69	659.28	662.93	648.21	646.08	643.25
ADP _e	kg Sb	1.11E-04	1.13E-04	1.11E-04	1.10E-04	1.09E-04	1.10E-04	1.06E-04	1.03E-04	1.08E-04	1.07E-04	1.06E-04	1.06E-04	1.05E-04	1.03E-04	1.00E-04
Consumption of freshwater resources																
FW	m ³	1.93	1.96	1.92	1.89	1.85	1.92	1.88	1.84	1.90	1.87	1.84	1.81	1.86	1.83	1.79
Waste and output flows																
HWD	kg	0.02	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
NHWD	kg	11.69	12.20	10.95	9.75	8.55	10.95	9.75	8.55	11.02	9.89	8.81	7.72	9.89	8.80	7.72
HLRW	m ³	3.96E-09	3.96E-09	3.96E-09	3.96E-09	3.96E-09	3.96E-09	3.96E-09	3.96E-09	3.96E-09	3.96E-09	3.96E-09	3.96E-09	3.96E-09	3.96E-09	3.96E-09
ILLRW	m ³	5.73E-08	5.73E-08	5.73E-08	5.73E-08	5.73E-08	5.73E-08	5.73E-08	5.73E-08	5.73E-08	5.73E-08	5.73E-08	5.73E-08	5.73E-08	5.73E-08	5.73E-08
CRU	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MR	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EE	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Additional inventory parameters for transparency																
CCE	kg CO ₂ eq.	116.50	126.52	113.53	101.02	88.51	113.53	101.02	88.51	101.93	91.47	81.39	71.31	91.47	81.39	71.31

Table 7. LCA Results 25 MPa Concrete without air (N)

Unit		Baseline 25 MPa Concrete without air (N)	25 MPa Concrete without air (N) GU	25 MPa Concrete without air (N) GU 10 SL	25 MPa Concrete without air (N) GU 20 SL	25 MPa Concrete without air (N) GU 30 SL	25 MPa Concrete without air (N) GU 10 FA	25 MPa Concrete without air (N) GU 20 FA	25 MPa Concrete without air (N) GU 30 FA	25 MPa Concrete without air (N) GUL	25 MPa Concrete without air (N) GUL 10 SL	25 MPa Concrete without air (N) GUL 20 SL	25 MPa Concrete without air (N) GUL 30 SL	25 MPa Concrete without air (N) GUL 10 FA	25 MPa Concrete without air (N) GUL 20 FA	25 MPa Concrete without air (N) GUL 30 FA
Environmental impacts																
GWP	kg CO ₂ eq.	287.42	295.96	275.02	254.07	232.93	270.75	245.54	220.28	274.93	256.10	237.27	218.25	251.83	228.74	205.60
ODP	kg CFC-11 eq.	7.16E-06	7.62E-06	7.59E-06	7.56E-06	7.51E-06	6.89E-06	6.17E-06	5.45E-06	6.50E-06	6.59E-06	6.67E-06	6.73E-06	5.89E-06	5.28E-06	4.67E-06
EP	kg N eq.	0.19	0.20	0.19	0.19	0.18	0.18	0.17	0.15	0.18	0.17	0.17	0.16	0.16	0.15	0.13
AP	kg SO ₂ eq.	1.62	1.66	1.61	1.55	1.49	1.55	1.44	1.32	1.56	1.51	1.47	1.42	1.45	1.35	1.25
POCP	kg O ₃ eq.	29.95	30.74	30.07	29.40	28.67	28.97	27.21	25.44	28.81	28.34	27.86	27.33	27.25	25.68	24.09
Use of primary resources																
RPR _E	MJ, NCV	256.48	265.95	245.92	225.89	205.80	244.34	222.72	201.10	242.63	224.95	207.26	189.52	223.36	204.09	184.82
RPR _M	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	2.00	3.00	4.00	5.00	6.00
NRPR _E	MJ, NCV	1389.87	1491.23	1475.66	1460.10	1441.58	1411.45	1331.66	1251.14	1241.72	1251.27	1260.83	1267.44	1187.06	1132.39	1077.00
NRPR _M	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Use of secondary resources																
SM	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RSF	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NRSF	MJ, NCV	102.65	106.46	95.74	85.02	74.30	95.74	85.02	74.30	97.08	87.30	77.53	67.75	87.30	77.53	67.75
RE	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Abiotic depletion potential																
ADP _f	MJ, LHV	703.96	715.91	717.02	718.13	718.30	709.80	703.68	696.88	686.50	690.57	694.64	697.78	683.35	680.20	676.36
ADP _e	kg Sb	1.27E-04	1.29E-04	1.27E-04	1.26E-04	1.25E-04	1.25E-04	1.22E-04	1.18E-04	1.24E-04	1.23E-04	1.22E-04	1.21E-04	1.21E-04	1.18E-04	1.15E-04
Consumption of freshwater resources																
FW	m ³	1.98	2.01	1.97	1.93	1.89	1.96	1.92	1.87	1.94	1.91	1.88	1.85	1.90	1.86	1.83
Waste and output flows																
HWD	kg	0.03	0.03	0.03	0.02	0.02	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
NHWD	kg	12.83	13.36	12.02	10.68	9.34	12.01	10.67	9.33	12.06	10.85	9.64	8.43	10.85	9.64	8.43
HLRW	m ³	4.00E-09	4.00E-09	4.00E-09	4.00E-09	4.00E-09	4.00E-09	4.00E-09	4.00E-09	4.00E-09	4.00E-09	4.00E-09	4.00E-09	4.00E-09	4.00E-09	4.00E-09
ILLRW	m ³	5.82E-08	5.82E-08	5.82E-08	5.82E-08	5.82E-08	5.82E-08	5.82E-08	5.82E-08	5.82E-08	5.82E-08	5.82E-08	5.82E-08	5.82E-08	5.82E-08	5.82E-08
CRU	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MR	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EE	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Additional inventory parameters for transparency																
GWPCCE	kg CO ₂ eq.	127.61	138.54	124.59	110.64	96.69	124.59	110.64	96.69	111.62	100.38	89.14	77.90	100.38	89.14	77.90

Table 8. LCA Results 25 MPa Concrete with air (F-2)

Unit	Baseline 25 MPa Concrete with air (F-2)	25 MPa Concrete with air (F-2) GU	25 MPa Concrete with air (F-2) GU 10 SL	25 MPa Concrete with air (F-2) GU 20 SL	25 MPa Concrete with air (F-2) GU 30 SL	25 MPa Concrete with air (F-2) GU 10 FA	25 MPa Concrete with air (F-2) GU 20 FA	25 MPa Concrete with air (F-2) GU 30 FA	25 MPa Concrete with air (F-2) GUL	25 MPa Concrete with air (F-2) GUL 10 SL	25 MPa Concrete with air (F-2) GUL 20 SL	25 MPa Concrete with air (F-2) GUL 30 SL	25 MPa Concrete with air (F-2) GUL 10 FA	25 MPa Concrete with air (F-2) GUL 20 FA	25 MPa Concrete with air (F-2) GUL 30 FA
Environmental impacts															
GWP kg CO ₂ eq.	298.87	307.78	286.11	263.52	242.05	281.70	254.70	228.67	285.72	266.24	245.92	226.64	261.83	237.10	213.26
ODP kg CFC-11 eq.	7.48E-06	7.95E-06	7.92E-06	7.87E-06	7.87E-06	7.20E-06	6.43E-06	5.68E-06	6.78E-06	6.87E-06	6.94E-06	7.05E-06	6.15E-06	5.50E-06	4.86E-06
EP kg N eq.	0.20	0.21	0.20	0.19	0.19	0.19	0.17	0.16	0.18	0.18	0.17	0.17	0.17	0.15	0.14
AP kg SO ₂ eq.	1.67	1.72	1.66	1.60	1.54	1.60	1.48	1.36	1.61	1.56	1.51	1.46	1.50	1.39	1.28
POCP kg O ₃ eq.	30.75	31.57	30.88	30.10	29.47	29.75	27.85	26.04	29.55	29.06	28.49	28.06	27.93	26.24	24.64
Use of primary resources															
RPR _E MJ, NCV	265.65	275.53	254.80	233.33	212.66	253.16	230.06	207.69	251.07	232.78	213.82	195.58	231.14	210.54	190.61
RPR _M MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	2.00	3.00	4.00	5.00	6.00
NRPR _E MJ, NCV	1418.10	1523.79	1507.69	1488.10	1474.94	1441.25	1355.23	1273.42	1262.15	1272.03	1279.30	1292.13	1205.60	1146.44	1090.62
NRPR _M MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Use of secondary resources															
SM kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RSF MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NRSF MJ, NCV	107.66	111.64	100.55	89.09	78.00	100.55	89.09	78.00	101.80	91.69	81.24	71.12	91.69	81.24	71.12
RE MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Abiotic depletion potential															
ADP _f MJ, LHV	700.83	713.29	714.44	714.69	716.78	706.97	699.75	694.11	682.45	686.66	690.08	695.23	679.19	675.14	672.57
ADP _e kg Sb	1.23E-04	1.26E-04	1.24E-04	1.23E-04	1.21E-04	1.22E-04	1.18E-04	1.15E-04	1.20E-04	1.19E-04	1.18E-04	1.17E-04	1.17E-04	1.14E-04	1.11E-04
Consumption of freshwater resources															
FW m ³	1.95	1.98	1.94	1.90	1.86	1.93	1.88	1.84	1.91	1.87	1.84	1.81	1.87	1.83	1.79
Waste and output flows															
HWD kg	0.03	0.03	0.03	0.02	0.02	0.03	0.02	0.02	0.03	0.02	0.02	0.02	0.02	0.02	0.02
NHWD kg	13.46	14.00	12.62	11.18	9.80	12.62	11.18	9.79	12.65	11.40	10.10	8.85	11.39	10.10	8.85
HLRW m ³	3.94E-09	3.94E-09	3.94E-09	3.94E-09	3.94E-09	3.94E-09	3.94E-09	3.94E-09	3.94E-09	3.94E-09	3.94E-09	3.94E-09	3.94E-09	3.94E-09	3.94E-09
ILLRW m ³	5.61E-08	5.61E-08	5.61E-08	5.61E-08	5.61E-08	5.61E-08	5.61E-08	5.61E-08	5.61E-08	5.61E-08	5.61E-08	5.61E-08	5.61E-08	5.61E-08	5.61E-08
CRU kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MR kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EE kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Additional inventory parameters for transparency															
GWPCCE kg CO ₂ eq.	133.87	145.28	130.85	115.93	101.50	130.85	115.93	101.50	117.05	105.42	93.41	81.78	105.42	93.41	81.78

Table 9. LCA Results 25 MPa Concrete without air & 0.55 W/CM ratio (N-CF/C-4)

Unit	Baseline 25	25 MPa	25 MPa	25 MPa	25 MPa	25 MPa	25 MPa	25 MPa	25 MPa	25 MPa	25 MPa	25 MPa	25 MPa	25 MPa	25 MPa	25 MPa
	MPa	Concrete	Concrete	Concrete	Concrete	Concrete	Concrete	Concrete	Concrete	Concrete	Concrete	Concrete	Concrete	Concrete	Concrete	Concrete
	Concrete	without air	without air	without air	without air	without air	without air	without air	without air	without air	without air	without air	without air	without air	without air	without air
	without air	& 0.55	& 0.55	& 0.55	& 0.55	& 0.55	& 0.55	& 0.55	& 0.55	& 0.55	& 0.55	& 0.55	& 0.55	& 0.55	& 0.55	& 0.55
	& 0.55	W/CM ratio	W/CM ratio	W/CM ratio	W/CM ratio	W/CM ratio	W/CM ratio	W/CM ratio	W/CM ratio	W/CM ratio	W/CM ratio	W/CM ratio	W/CM ratio	W/CM ratio	W/CM ratio	W/CM ratio
W/CM ratio	(N-CF/C-4)	(N-CF/C-4)	(N-CF/C-4)	(N-CF/C-4)	(N-CF/C-4)	(N-CF/C-4)	(N-CF/C-4)	(N-CF/C-4)	(N-CF/C-4)	(N-CF/C-4)	(N-CF/C-4)	(N-CF/C-4)	(N-CF/C-4)	(N-CF/C-4)	(N-CF/C-4)	(N-CF/C-4)
(N-CF/C-4)	GU	GU 10 SL	GU 20 SL	GU 30 SL	GU 10 FA	GU 20 FA	GU 30 FA	GUL	GUL 10 SL	GUL 20 SL	GUL 30 SL	GUL 10 FA	GUL 20 FA	GUL 30 FA		
Environmental impacts																
GWP	kg CO ₂ eq.	307.09	315.44	293.06	270.67	248.28	288.50	261.55	234.60	292.88	272.75	252.62	232.50	268.19	243.51	218.83
ODP	kg CFC-11 eq.	7.67E-06	8.14E-06	8.11E-06	8.08E-06	8.05E-06	7.36E-06	6.59E-06	5.82E-06	6.94E-06	7.03E-06	7.12E-06	7.21E-06	6.29E-06	5.63E-06	4.98E-06
EP	kg N eq.	0.20	0.21	0.21	0.20	0.19	0.19	0.18	0.16	0.19	0.18	0.18	0.17	0.17	0.16	0.14
AP	kg SO ₂ eq.	1.72	1.76	1.70	1.64	1.58	1.64	1.52	1.39	1.64	1.60	1.55	1.50	1.53	1.42	1.31
POCP	kg O ₃ eq.	31.56	32.33	31.61	30.90	30.18	30.45	28.57	26.69	30.27	29.76	29.25	28.74	28.59	26.92	25.24
Use of primary resources																
RPR _E	MJ, NCV	273.02	282.56	261.15	239.73	218.31	259.45	236.34	213.24	257.54	238.63	219.73	200.82	236.94	216.34	195.74
RPR _M	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	2.00	3.00	4.00	5.00	6.00
NRPR _E	MJ, NCV	1463.93	1570.48	1553.83	1537.19	1520.55	1485.19	1399.89	1314.60	1302.77	1312.98	1323.20	1333.41	1244.33	1185.90	1127.47
NRPR _M	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Use of secondary resources																
SM	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RSF	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NRSF	MJ, NCV	110.46	114.23	102.77	91.31	79.85	102.77	91.31	79.85	104.16	93.71	83.26	72.81	93.71	83.26	72.81
RE	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Abiotic depletion potential																
ADP _f	MJ, LHV	728.47	740.54	741.73	742.91	744.10	734.01	727.47	720.94	708.98	713.34	717.69	722.04	705.62	702.25	698.88
ADP _e	kg Sb	1.40E-04	1.42E-04	1.41E-04	1.39E-04	1.38E-04	1.38E-04	1.35E-04	1.31E-04	1.37E-04	1.36E-04	1.35E-04	1.34E-04	1.33E-04	1.30E-04	1.27E-04
Consumption of freshwater resources																
FW	m ³	2.00	2.03	1.99	1.95	1.91	1.98	1.94	1.89	1.96	1.93	1.89	1.86	1.92	1.88	1.84
Waste and output flows																
HWD	kg	0.03	0.03	0.03	0.02	0.02	0.03	0.02	0.02	0.03	0.02	0.02	0.02	0.02	0.02	0.02
NHWD	kg	13.80	14.33	12.89	11.46	10.03	12.89	11.46	10.03	12.94	11.65	10.35	9.06	11.64	10.35	9.06
HLRW	m ³	3.98E-09	3.98E-09	3.98E-09	3.98E-09	3.98E-09	3.98E-09	3.98E-09	3.98E-09	3.98E-09	3.98E-09	3.98E-09	3.98E-09	3.98E-09	3.98E-09	3.98E-09
ILLRW	m ³	5.77E-08	5.77E-08	5.77E-08	5.77E-08	5.77E-08	5.77E-08	5.77E-08	5.77E-08	5.77E-08	5.77E-08	5.77E-08	5.77E-08	5.77E-08	5.77E-08	5.77E-08
CRU	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MR	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EE	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Additional inventory parameters for transparency																
GWPCCE	kg CO ₂ eq.	137.26	148.65	133.73	118.82	103.91	133.73	118.82	103.91	119.76	107.75	95.73	83.72	107.75	95.73	83.72

Table 10. LCA Results 30 MPa Concrete with air (F-1)

Unit		Baseline 30 MPa Concrete with air (F-1)	30 MPa Concrete with air (F-1) GU	30 MPa Concrete with air (F-1) GU 10 SL	30 MPa Concrete with air (F-1) GU 20 SL	30 MPa Concrete with air (F-1) GU 30 SL	30 MPa Concrete with air (F-1) GU 10 FA	30 MPa Concrete with air (F-1) GU 20 FA	30 MPa Concrete with air (F-1) GU 30 FA	30 MPa Concrete with air (F-1) GUL	30 MPa Concrete with air (F-1) GUL 10 SL	30 MPa Concrete with air (F-1) GUL 20 SL	30 MPa Concrete with air (F-1) GUL 30 SL	30 MPa Concrete with air (F-1) GUL 10 FA	30 MPa Concrete with air (F-1) GUL 20 FA	30 MPa Concrete with air (F-1) GUL 30 FA
Environmental impacts																
GWP	kg CO ₂ eq.	342.52	353.25	327.97	302.69	277.61	322.83	292.40	262.03	327.54	304.82	282.10	259.57	299.67	271.81	243.99
ODP	kg CFC-11 eq.	8.62E-06	9.19E-06	9.16E-06	9.12E-06	9.11E-06	8.32E-06	7.44E-06	6.57E-06	7.83E-06	7.93E-06	8.03E-06	8.16E-06	7.09E-06	6.35E-06	5.61E-06
EP	kg N eq.	0.22	0.24	0.23	0.22	0.21	0.22	0.20	0.18	0.21	0.20	0.20	0.19	0.19	0.17	0.16
AP	kg SO ₂ eq.	1.89	1.94	1.87	1.81	1.74	1.80	1.67	1.53	1.81	1.76	1.70	1.65	1.69	1.56	1.44
POCP	kg O ₃ eq.	34.32	35.30	34.50	33.69	32.93	33.18	31.05	28.95	32.95	32.38	31.80	31.28	31.06	29.17	27.30
Use of primary resources																
RPR _E	MJ, NCV	301.28	313.19	289.01	264.83	240.70	287.10	261.00	234.91	284.68	263.34	241.99	220.70	261.42	238.17	214.91
RPR _M	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	2.00	3.00	4.00	5.00	6.00
NRPR _E	MJ, NCV	1565.88	1693.24	1674.45	1655.66	1639.81	1596.94	1500.64	1405.08	1388.27	1399.81	1411.34	1425.82	1322.30	1256.33	1191.09
NRPR _M	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Use of secondary resources																
SM	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RSF	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NRSF	MJ, NCV	125.33	130.12	117.18	104.24	91.31	117.18	104.24	91.31	118.65	106.86	95.06	83.26	106.86	95.06	83.26
RE	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Abiotic depletion potential																
ADP _f	MJ, LHV	738.87	753.88	755.22	756.56	758.84	746.51	739.13	732.44	717.93	722.85	727.76	733.62	714.13	710.33	707.22
ADP _e	kg Sb	1.35E-04	1.38E-04	1.36E-04	1.35E-04	1.33E-04	1.34E-04	1.30E-04	1.25E-04	1.32E-04	1.31E-04	1.30E-04	1.29E-04	1.28E-04	1.25E-04	1.21E-04
Consumption of freshwater resources																
FW	m ³	2.00	2.03	1.98	1.94	1.89	1.98	1.92	1.87	1.95	1.91	1.87	1.83	1.90	1.85	1.81
Waste and output flows																
HWD	kg	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.03	0.03	0.02	0.02	0.03	0.02	0.02
NHWD	kg	15.66	16.32	14.70	13.08	11.46	14.70	13.08	11.46	14.74	13.28	11.82	10.36	13.27	11.81	10.35
HLRW	m ³	3.91E-09	3.91E-09	3.91E-09	3.91E-09	3.91E-09	3.91E-09	3.91E-09	3.91E-09	3.91E-09	3.91E-09	3.91E-09	3.91E-09	3.91E-09	3.91E-09	3.91E-09
ILLRW	m ³	5.45E-08	5.45E-08	5.45E-08	5.45E-08	5.45E-08	5.45E-08	5.45E-08	5.45E-08	5.45E-08	5.45E-08	5.45E-08	5.45E-08	5.45E-08	5.45E-08	5.45E-08
CRU	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MR	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EE	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Additional inventory parameters for transparency																
GWPCCE	kg CO ₂ eq.	155.59	169.33	152.49	135.66	118.82	152.49	135.66	118.82	136.43	122.86	109.30	95.73	122.86	109.30	95.73

Table 11. LCA Results 30MPa Concrete without air (N, N-CF, C-4)

Unit	Baseline 30 MPa Concrete without ai(N, N-CF, C-4)	30 MPa Concrete without ai(N, N-CF, C-4) GU	30 MPa Concrete without ai(N, N-CF, C-4) GU 10 SL	30 MPa Concrete without ai(N, N-CF, C-4) GU 20 SL	30 MPa Concrete without ai(N, N-CF, C-4) GU 30 SL	30 MPa Concrete without ai(N, N-CF, C-4) GU 10 FA	30 MPa Concrete without ai(N, N-CF, C-4) GU 20 FA	30 MPa Concrete without ai(N, N-CF, C-4) GU 30 FA	30 MPa Concrete without ai(N, N-CF, C-4) GUL	30 MPa Concrete without ai(N, N-CF, C-4) GUL 10 SL	30 MPa Concrete without ai(N, N-CF, C-4) GUL 20 SL	30 MPa Concrete without ai(N, N-CF, C-4) GUL 30 SL	30 MPa Concrete without ai(N, N-CF, C-4) GUL 10 FA	30 MPa Concrete without ai(N, N-CF, C-4) GUL 20 FA	30 MPa Concrete without ai(N, N-CF, C-4) GUL 30 FA
Environmental impacts															
GWP	kg CO ₂ eq.	311.42	320.91	297.60	275.41	252.10	293.05	266.15	238.28	297.90	276.93	257.00	236.03	272.38	222.21
ODP	kg CFC-11 eq.	7.78E-06	8.29E-06	8.23E-06	8.23E-06	8.17E-06	7.49E-06	6.71E-06	5.92E-06	7.07E-06	7.14E-06	7.25E-06	7.32E-06	6.39E-06	5.06E-06
EP	kg N eq.	0.21	0.22	0.21	0.20	0.19	0.20	0.18	0.16	0.19	0.19	0.18	0.18	0.17	0.14
AP	kg SO ₂ eq.	1.74	1.79	1.72	1.67	1.60	1.66	1.54	1.41	1.67	1.62	1.57	1.52	1.55	1.33
POCP	kg O ₃ eq.	31.92	32.79	31.99	31.33	30.54	30.83	28.96	27.00	30.69	30.10	29.65	29.07	28.94	25.53
Use of primary resources															
RPR _E	MJ, NCV	276.62	287.15	264.99	243.63	221.46	263.29	240.18	216.33	261.64	242.07	223.22	203.65	240.38	198.52
RPR _M	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	2.00	3.00	4.00	6.00
NRPR _E	MJ, NCV	1478.07	1590.70	1570.58	1556.88	1536.75	1501.93	1417.37	1328.60	1317.79	1325.39	1338.55	1346.15	1256.74	1137.99
NRPR _M	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Use of secondary resources															
SM	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RSF	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NRSF	MJ, NCV	112.21	116.44	104.61	93.15	81.33	104.61	93.15	81.33	106.18	95.39	84.94	74.16	95.39	74.16
RE	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Abiotic depletion potential															
ADP _f	MJ, LHV	732.03	745.30	745.59	747.72	748.00	737.87	732.03	724.59	713.13	716.69	721.98	725.54	708.97	702.13
ADP _e	kg Sb	1.41E-04	1.43E-04	1.42E-04	1.40E-04	1.39E-04	1.39E-04	1.36E-04	1.32E-04	1.38E-04	1.37E-04	1.36E-04	1.35E-04	1.34E-04	1.28E-04
Consumption of freshwater resources															
FW	m ³	2.01	2.04	2.00	1.96	1.91	1.99	1.94	1.89	1.96	1.93	1.90	1.86	1.92	1.84
Waste and output flows															
HWD	kg	0.03	0.03	0.03	0.03	0.02	0.03	0.02	0.02	0.03	0.02	0.02	0.02	0.02	0.02
NHWD	kg	14.02	14.60	13.13	11.69	10.21	13.12	11.69	10.21	13.19	11.86	10.56	9.23	11.85	9.22
HLRW	m ³	3.99E-09	3.99E-09	3.99E-09	3.99E-09	3.99E-09	3.99E-09	3.99E-09	3.99E-09	3.99E-09	3.99E-09	3.99E-09	3.99E-09	3.99E-09	3.99E-09
ILLRW	m ³	5.77E-08	5.77E-08	5.77E-08	5.77E-08	5.77E-08	5.77E-08	5.77E-08	5.77E-08	5.77E-08	5.77E-08	5.77E-08	5.77E-08	5.77E-08	5.77E-08
CRU	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MR	kg	0.00	0.00	0.00	0.00	0.00	0.00	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	0.00	0.00	0.00	0.00	0.00	0.00
EE	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Additional inventory parameters for transparency															
GWPCCE	kg CO ₂ eq.	139.38	151.53	136.14	121.23	105.83	136.14	121.23	105.83	122.09	109.69	97.67	85.27	109.69	85.27

Table 12. LCA Results 32 MPa Concrete with air & 0.45 W/CM ratio (C-2)

Unit		Baseline 32	32 MPa	32 MPa	32 MPa	32 MPa	32 MPa	32 MPa	32 MPa	32 MPa	32 MPa	32 MPa	32 MPa	32 MPa	32 MPa	32 MPa	
		MPa	Concrete	Concrete	Concrete	Concrete	Concrete	Concrete	Concrete	Concrete	Concrete	Concrete	Concrete	Concrete	Concrete	Concrete	Concrete
		Concrete	with air &	with air &	with air &	with air &	with air &	with air &	with air &	with air &	with air &	with air &	with air &	with air &	with air &	with air &	with air &
		with air &	0.45 W/CM	0.45 W/CM	0.45 W/CM	0.45 W/CM	0.45 W/CM	0.45 W/CM	0.45 W/CM	0.45 W/CM	0.45 W/CM	0.45 W/CM	0.45 W/CM	0.45 W/CM	0.45 W/CM	0.45 W/CM	0.45 W/CM
		0.45 W/CM	ration (C-2)	ration (C-2)	ration (C-2)	ration (C-2)	ration (C-2)	ration (C-2)	ration (C-2)	ration (C-2)	ration (C-2)	ration (C-2)	ration (C-2)	ration (C-2)	ration (C-2)	ration (C-2)	
		ration (C-2)	GU	GU 10 SL	GU 20 SL	GU 30 SL	GU 10 FA	GU 20 FA	GU 30 FA	GUL	GUL 10 SL	GUL 20 SL	GUL 30 SL	GUL 10 FA	GUL 20 FA	GUL 30 FA	
Environmental impacts																	
GWP	kg CO ₂ eq.	362.80	374.40	347.88	320.23	293.71	342.29	309.21	277.09	347.01	323.19	298.32	274.50	317.60	287.30	257.88	
ODP	kg CFC-11 eq.	9.15E-06	9.76E-06	9.75E-06	9.69E-06	9.68E-06	8.84E-06	7.89E-06	6.97E-06	8.31E-06	8.44E-06	8.53E-06	8.66E-06	7.53E-06	6.73E-06	5.95E-06	
EP	kg N eq.	0.24	0.25	0.24	0.23	0.22	0.23	0.21	0.19	0.22	0.21	0.21	0.20	0.20	0.18	0.17	
AP	kg SO ₂ eq.	1.99	2.05	1.98	1.90	1.83	1.90	1.75	1.61	1.91	1.85	1.79	1.73	1.77	1.64	1.51	
POCP	kg O ₃ eq.	35.99	37.05	36.25	35.32	34.52	34.82	32.49	30.27	34.54	33.99	33.31	32.76	32.56	30.49	28.51	
Use of primary resources																	
RPR _E	MJ, NCV	318.22	331.06	305.55	279.25	253.74	303.48	275.15	247.57	300.69	278.18	254.95	232.44	276.10	250.86	226.27	
RPR _M	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	2.00	3.00	4.00	5.00	6.00	
NRPR _E	MJ, NCV	1639.31	1775.79	1758.87	1735.52	1718.60	1674.72	1569.44	1468.37	1450.90	1466.03	1475.61	1490.75	1381.88	1309.53	1240.51	
NRPR _M	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Use of secondary resources																	
SM	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
RSF	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
NRSF	MJ, NCV	133.45	138.62	124.95	110.90	97.22	124.95	110.90	97.22	126.41	113.93	101.12	88.65	113.93	101.12	88.65	
RE	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Abiotic depletion potential																	
ADPf	MJ, LHV	760.79	776.87	779.23	779.74	782.10	769.76	761.06	753.96	738.57	744.71	749.11	755.24	735.24	730.43	727.10	
ADPe	kg Sb	1.45E-04	1.48E-04	1.46E-04	1.44E-04	1.42E-04	1.43E-04	1.39E-04	1.34E-04	1.41E-04	1.40E-04	1.39E-04	1.37E-04	1.37E-04	1.33E-04	1.29E-04	
Consumption of freshwater resources																	
FW	m ³	2.02	2.05	2.00	1.95	1.90	2.00	1.94	1.88	1.96	1.92	1.88	1.84	1.92	1.87	1.82	
Waste and output flows																	
HWD	kg	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.03	0.03	0.02	
NHWD	kg	16.67	17.38	15.67	13.91	12.20	15.67	13.91	12.20	15.70	14.15	12.57	11.02	14.15	12.56	11.02	
HLRW	m ³	3.91E-09	3.91E-09	3.91E-09	3.91E-09	3.91E-09	3.91E-09	3.91E-09	3.91E-09	3.91E-09	3.91E-09	3.91E-09	3.91E-09	3.91E-09	3.91E-09	3.91E-09	
ILLRW	m ³	5.41E-08	5.41E-08	5.41E-08	5.41E-08	5.41E-08	5.41E-08	5.41E-08	5.41E-08	5.41E-08	5.41E-08	5.41E-08	5.41E-08	5.41E-08	5.41E-08	5.41E-08	
CRU	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
MR	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
EE	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Additional inventory parameters for transparency																	
GWPCCE	kg CO ₂ eq.	165.64	180.39	162.60	144.32	126.52	162.60	144.32	126.52	145.34	131.00	116.27	101.93	131.00	116.27	101.93	

Table 13. LCA Results 35 MPa Concrete with air (C-2 and lower)

Unit	Baseline 35 MPa Concrete with air (C-2 and lower)	35 MPa Concrete with air (C-2 and lower) GU	35 MPa Concrete with air (C-2 and lower) GUL	35 MPa Concrete with air (C-2 and lower) GU/GUb-8SF	35 MPa Concrete with air (C-2 and lower) GUL/GUb-8SF	35 MPa Concrete with air (C-2 and lower) GUb-8SF	35 MPa Concrete with air (C-2 and lower) GU 10 SL	35 MPa Concrete with air (C-2 and lower) GU 20 SL	35 MPa Concrete with air (C-2 and lower) GU 30 SL	35 MPa Concrete with air (C-2 and lower) GU 10 FA
Environmental impacts										
GWP kg CO ₂ eq.	393.24	406.75	376.81	392.43	377.45	378.10	377.14	347.53	317.91	371.11
ODP kg CFC-11 eq.	9.91E-06	1.06E-05	9.04E-06	1.02E-05	9.43E-06	9.81E-06	1.06E-05	1.06E-05	1.05E-05	9.61E-06
EP kg N eq.	0.26	0.27	0.24	0.26	0.25	0.25	0.26	0.25	0.24	0.25
AP kg SO ₂ eq.	2.14	2.21	2.05	2.14	2.07	2.08	2.13	2.05	1.97	2.04
POCP kg O ₃ eq.	38.47	39.70	36.97	38.77	37.40	37.83	38.76	37.81	36.86	37.22
Use of primary resources										
RPR _E MJ, NCV	343.46	358.44	325.24	346.21	329.61	333.99	330.12	301.79	273.47	327.88
RPR _M MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
NRPR _E MJ, NCV	1744.79	1905.07	1549.86	1858.47	1680.87	1811.88	1883.06	1861.05	1839.04	1792.27
NRPR _M MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Use of secondary resources										
SM kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RSF MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NRSF MJ, NCV	145.53	151.56	138.20	145.50	138.82	139.44	136.41	121.25	106.09	136.41
RE MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Abiotic depletion potential										
ADP _f MJ, LHV	796.42	815.31	773.44	810.46	789.52	805.61	816.88	818.45	820.02	806.67
ADP _e kg Sb	1.63E-04	1.67E-04	1.59E-04	1.65E-04	1.61E-04	1.63E-04	1.65E-04	1.63E-04	1.61E-04	1.62E-04
Consumption of freshwater resources										
FW m ³	2.05	2.09	1.99	2.07	2.02	2.04	2.04	1.98	1.93	2.03
Waste and output flows										
HWD kg	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
NHWD kg	18.17	19.00	17.16	18.24	17.32	17.48	17.10	15.21	13.32	17.10
HLRW m ³	3.88E-09	3.88E-09	3.88E-09	3.88E-09	3.88E-09	3.88E-09	3.88E-09	3.88E-09	3.88E-09	3.88E-09
ILLRW m ³	5.32E-08	5.32E-08	5.32E-08	5.32E-08	5.32E-08	5.32E-08	5.32E-08	5.32E-08	5.32E-08	5.32E-08
CRU kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MR kg	0.00	0.00	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	0.00	0.00
EE kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Additional inventory parameters for transparency										
GWPCCE kg CO ₂ eq.	179.94	197.23	158.91	189.34	170.18	181.45	177.51	157.79	138.06	177.51

Table 13. LCA Results 35 MPa Concrete with air (C-2 and lower)

35 MPa Concrete with air (C-2 and lower) GU 20 FA	35 MPa Concrete with air (C-2 and lower) GU 30 FA	35 MPa Concrete with air (C-2 and lower) GUL 10 SL	35 MPa Concrete with air (C-2 and lower) GUL 20 SL	35 MPa Concrete with air (C-2 and lower) GUL 30 SL	35 MPa Concrete with air (C-2 and lower) GUL 10 FA	35 MPa Concrete with air (C-2 and lower) GUL 20 FA	35 MPa Concrete with air (C-2 and lower) GUL 30 FA
Environmental impacts							
335.47	299.83	350.19	323.57	296.95	344.16	311.51	278.87
8.58E-06	7.56E-06	9.16E-06	9.28E-06	9.40E-06	8.18E-06	7.31E-06	6.45E-06
0.23	0.20	0.23	0.23	0.22	0.22	0.20	0.18
1.88	1.72	1.99	1.92	1.86	1.91	1.76	1.61
34.73	32.24	36.29	35.62	34.95	34.75	32.54	30.32
Use of primary resources							
297.31	266.75	300.23	275.23	250.23	297.99	270.75	243.51
2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00
1679.46	1566.66	1563.37	1576.88	1590.39	1472.58	1395.29	1318.01
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Use of secondary resources							
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
121.25	106.09	124.38	110.56	96.74	124.38	110.56	96.74
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Abiotic depletion potential							
798.03	789.39	779.20	784.95	790.71	768.98	764.53	760.08
1.57E-04	1.52E-04	1.58E-04	1.57E-04	1.55E-04	1.55E-04	1.51E-04	1.46E-04
Consumption of freshwater resources							
1.96	1.90	1.95	1.91	1.86	1.94	1.89	1.83
Waste and output flows							
0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02
15.21	13.31	15.45	13.74	12.03	15.45	13.73	12.02
3.88E-09	3.88E-09	3.88E-09	3.88E-09	3.88E-09	3.88E-09	3.88E-09	3.88E-09
5.32E-08	5.32E-08	5.32E-08	5.32E-08	5.32E-08	5.32E-08	5.32E-08	5.32E-08
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Additional inventory parameters for transparency							
157.79	138.06	143.02	127.13	111.24	143.02	127.13	111.24

Table 14. LCA Results 35 MPa Concrete with air & 0.40 W/CM ratio (C-1)

Unit		Baseline 35 MPa Concrete with air & 0.40 W/CM ratio (C-1)	35 MPa Concrete with air & 0.40 W/CM ratio (C-1) GU/GUB-8SF	35 MPa Concrete with air & 0.40 W/CM ratio (C-1) GUL/GUB-8SF	35 MPa Concrete with air & 0.40 W/CM ratio (C-1) GUB-8SF	35 MPa Concrete with air & 0.40 W/CM ratio (C-1) GU 10 SL	35 MPa Concrete with air & 0.40 W/CM ratio (C-1) GU 20 SL	35 MPa Concrete with air & 0.40 W/CM ratio (C-1) GU 30 SL	35 MPa Concrete with air & 0.40 W/CM ratio (C-1) GU 10 FA	35 MPa Concrete with air & 0.40 W/CM ratio (C-1) GU 20 FA	35 MPa Concrete with air & 0.40 W/CM ratio (C-1) GU 30 FA
Environmental impacts											
GWP	kg CO ₂ eq.	380.46	376.85	362.54	363.16	362.38	334.22	306.24	356.65	322.75	288.89
ODP	kg CFC-11 eq.	9.81E-06	9.79E-06	9.03E-06	9.40E-06	1.01E-05	1.01E-05	1.01E-05	9.21E-06	8.24E-06	7.27E-06
EP	kg N eq.	0.25	0.25	0.24	0.24	0.25	0.24	0.23	0.24	0.22	0.20
AP	kg SO ₂ eq.	2.08	2.07	1.99	2.01	2.05	1.98	1.90	1.97	1.82	1.67
POCP	kg O ₃ eq.	37.68	37.50	36.19	36.60	37.50	36.60	35.75	36.03	33.66	31.31
Use of primary resources											
RPR _E	MJ, NCV	334.54	333.54	317.67	321.85	318.28	291.34	264.45	316.15	287.08	258.01
RPR _M	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
NRPR _E	MJ, NCV	1763.27	1802.28	1632.47	1757.73	1825.89	1804.96	1786.96	1739.53	1632.23	1525.66
NRPR _M	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Use of secondary resources											
SM	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RSF	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NRSF	MJ, NCV	140.21	139.11	132.73	133.31	130.49	116.07	101.66	130.49	116.07	101.66
RE	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Abiotic depletion potential											
ADP _f	MJ, LHV	794.40	798.65	778.64	794.02	804.78	806.28	808.71	795.07	786.85	779.32
ADP _e	kg Sb	1.62E-04	1.62E-04	1.58E-04	1.60E-04	1.62E-04	1.60E-04	1.58E-04	1.59E-04	1.54E-04	1.50E-04
Consumption of freshwater resources											
FW	m ³	2.04	2.05	2.00	2.02	2.02	1.97	1.91	2.01	1.95	1.89
Waste and output flows											
HWD	kg	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
NHWD	kg	17.54	17.44	16.56	16.71	16.36	14.56	12.76	16.36	14.56	12.75
HLRW	m ³	3.91E-09	3.91E-09	3.91E-09	3.91E-09	3.91E-09	3.91E-09	3.91E-09	3.91E-09	3.91E-09	3.91E-09
ILLRW	m ³	5.41E-08	5.41E-08	5.41E-08	5.41E-08	5.41E-08	5.41E-08	5.41E-08	5.41E-08	5.41E-08	5.41E-08
CRU	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MR	kg	0.00	0.00	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	0.00	0.00
EE	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Additional inventory parameters for transparency											
GWPCCE	kg CO ₂ eq.	177.71	181.03	162.71	173.49	169.81	151.05	132.29	169.81	151.05	132.29

Table 14. LCA Results 35 MPa Concrete with air & 0.40 W/CM ratio (C-1)

35 MPa Concrete with air & 0.40 W/CM ratio (C- 1) GUL 10 SL	35 MPa Concrete with air & 0.40 W/CM ratio (C- 1) GUL 20 SL	35 MPa Concrete with air & 0.40 W/CM ratio (C- 1) GUL 30 SL	35 MPa Concrete with air & 0.40 W/CM ratio (C- 1) GUL 10 FA	35 MPa Concrete with air & 0.40 W/CM ratio (C- 1) GUL 20 FA	35 MPa Concrete with air & 0.40 W/CM ratio (C- 1) GUL 30 FA
Environmental impacts					
336.60	311.28	286.16	330.87	299.81	268.81
8.78E-06	8.89E-06	9.03E-06	7.84E-06	7.02E-06	6.20E-06
0.22	0.22	0.21	0.21	0.19	0.17
1.92	1.86	1.80	1.84	1.70	1.56
35.14	34.50	33.92	33.67	31.57	29.48
Use of primary resources					
289.70	265.91	242.18	287.57	261.65	235.74
2.00	3.00	4.00	5.00	6.00	7.00
1520.06	1532.92	1548.71	1433.70	1360.19	1287.41
0.00	0.00	0.00	0.00	0.00	0.00
Use of secondary resources					
0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00
118.99	105.84	92.70	118.99	105.84	92.70
0.00	0.00	0.00	0.00	0.00	0.00
Abiotic depletion potential					
768.73	774.21	780.62	759.02	754.78	751.24
1.55E-04	1.54E-04	1.53E-04	1.53E-04	1.49E-04	1.45E-04
Consumption of freshwater resources					
1.93	1.89	1.85	1.93	1.87	1.82
Waste and output flows					
0.03	0.03	0.02	0.03	0.03	0.02
14.78	13.15	11.53	14.78	13.15	11.52
3.91E-09	3.91E-09	3.91E-09	3.91E-09	3.91E-09	3.91E-09
5.41E-08	5.41E-08	5.41E-08	5.41E-08	5.41E-08	5.41E-08
0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00
Additional inventory parameters for transparency					
136.82	121.70	106.58	136.82	121.70	106.58

Table 15. LCA Results 35 MPa Concrete without air (N)

Unit		Baseline 35 MPa Concrete without air (N)	35 MPa Concrete without air (N) GU	35 MPa Concrete without air (N) GUL	35 MPa Concrete without air (N) GU/GUb-8SF	35 MPa Concrete without air (N) GUL/GUb-8SF	35 MPa Concrete without air (N) GUb-8SF	35 MPa Concrete without air (N) GU 10 SL	35 MPa Concrete without air (N) GU 20 SL	35 MPa Concrete without air (N) GU 30 SL	35 MPa Concrete without air (N) GU 10 FA
Environmental impacts											
GWP	kg CO ₂ eq.	345.40	355.63	329.84	344.18	331.25	330.96	330.35	305.27	279.07	325.20
ODP	kg CFC-11 eq.	8.69E-06	9.23E-06	7.87E-06	8.90E-06	8.22E-06	8.53E-06	9.20E-06	9.19E-06	9.13E-06	8.36E-06
EP	kg N eq.	0.23	0.24	0.21	0.23	0.22	0.22	0.23	0.22	0.21	0.22
AP	kg SO ₂ eq.	1.91	1.96	1.83	1.91	1.84	1.85	1.89	1.83	1.75	1.82
POCP	kg O ₃ eq.	34.76	35.69	33.34	34.96	33.78	34.08	34.89	34.13	33.25	33.57
Use of primary resources											
RPR _E	MJ, NCV	304.63	315.96	287.38	306.15	291.82	294.91	291.78	267.66	242.73	289.87
RPR _M	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
NRPR _E	MJ, NCV	1599.63	1720.92	1415.09	1684.17	1530.82	1640.69	1702.13	1686.29	1664.02	1624.63
NRPR _M	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Use of secondary resources											
SM	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RSF	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NRSF	MJ, NCV	125.93	130.49	118.99	125.63	119.86	120.05	117.55	104.61	91.31	117.55
RE	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Abiotic depletion potential											
ADP _f	MJ, LHV	763.21	777.51	741.46	774.22	756.14	769.16	778.85	781.13	781.57	770.13
ADP _e	kg Sb	1.49E-04	1.52E-04	1.45E-04	1.50E-04	1.47E-04	1.48E-04	1.50E-04	1.48E-04	1.46E-04	1.47E-04
Consumption of freshwater resources											
FW	m ³	2.05	2.08	2.00	2.06	2.02	2.04	2.04	1.99	1.94	2.03
Waste and output flows											
HWD	kg	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
NHWD	kg	15.73	16.36	14.78	15.75	14.96	15.06	14.74	13.13	11.46	14.74
HLRW	m ³	4.00E-09	4.00E-09	4.00E-09	4.00E-09	4.00E-09	4.00E-09	4.00E-09	4.00E-09	4.00E-09	4.00E-09
ILLRW	m ³	5.72E-08	5.72E-08	5.72E-08	5.72E-08	5.72E-08	5.72E-08	5.72E-08	5.72E-08	5.72E-08	5.72E-08
CRU	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MR	kg	0.00	0.00	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	0.00	0.00
EE	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Additional inventory parameters for transparency											
GWPCCE	kg CO ₂ eq.	156.73	169.81	136.82	163.48	146.94	156.23	152.97	136.14	118.82	152.97

Table 15. LCA Results 35 MPa Concrete without air (N)

35 MPa Concrete without air (N) GU 20 FA	35 MPa Concrete without air (N) GU 30 FA	35 MPa Concrete without air (N) GUL 10 SL	35 MPa Concrete without air (N) GUL 20 SL	35 MPa Concrete without air (N) GUL 30 SL	35 MPa Concrete without air (N) GUL 10 FA	35 MPa Concrete without air (N) GUL 20 FA	35 MPa Concrete without air (N) GUL 30 FA
Environmental impacts							
294.83	263.48	307.12	284.60	261.03	301.98	274.16	245.44
7.49E-06	6.59E-06	7.97E-06	8.09E-06	8.18E-06	7.13E-06	6.39E-06	5.63E-06
0.20	0.18	0.20	0.20	0.19	0.19	0.18	0.16
1.68	1.54	1.77	1.72	1.66	1.70	1.58	1.45
31.46	29.26	32.76	32.24	31.60	31.45	29.57	27.61
Use of primary resources							
263.78	236.95	266.03	244.74	222.73	264.12	240.86	216.94
2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00
1529.06	1429.28	1426.63	1441.10	1450.02	1349.12	1283.88	1215.29
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Use of secondary resources							
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
104.61	91.31	107.19	95.39	83.26	107.19	95.39	83.26
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Abiotic depletion potential							
763.44	755.17	746.37	752.22	756.34	737.65	734.54	729.94
1.43E-04	1.39E-04	1.44E-04	1.43E-04	1.42E-04	1.42E-04	1.38E-04	1.34E-04
Consumption of freshwater resources							
1.97	1.92	1.96	1.92	1.88	1.95	1.91	1.86
Waste and output flows							
0.03	0.02	0.03	0.02	0.02	0.03	0.02	0.02
13.12	11.46	13.32	11.86	10.36	13.32	11.85	10.35
4.00E-09	4.00E-09	4.00E-09	4.00E-09	4.00E-09	4.00E-09	4.00E-09	4.00E-09
5.72E-08	5.72E-08	5.72E-08	5.72E-08	5.72E-08	5.72E-08	5.72E-08	5.72E-08
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Additional inventory parameters for transparency							
136.14	118.82	123.25	109.69	95.73	123.25	109.69	95.73

Table16. LCA Results 35 MPa SCC with air (F-1)

Unit		Baseline 35 MPa SCC with air (F-1)	35 MPa SCC with air (F-1) GU	35 MPa SCC with air (F-1) GUL	35 MPa SCC with air (F-1) GU/ GUb-8SF	35 MPa SCC with air (F-1) GUL/ GUb-8SF	35 MPa SCC with air (F-1) GUb-8SF	35 MPa SCC with air (F-1) GU 10 SL	35 MPa SCC with air (F-1) GU 20 SL	35 MPa SCC with air (F-1) GU 30 SL	35 MPa SCC with air (F-1) GU 10 FA
Environmental impacts											
GWP	kg CO ₂ eq.	434.92	453.27	419.60	436.28	419.48	421.06	420.05	386.82	352.68	413.28
ODP	kg CFC-11 eq.	1.09E-05	1.19E-05	1.01E-05	1.14E-05	1.05E-05	1.10E-05	1.18E-05	1.18E-05	1.17E-05	1.07E-05
EP	kg N eq.	0.28	0.30	0.26	0.29	0.27	0.28	0.29	0.28	0.27	0.28
AP	kg SO ₂ eq.	2.34	2.43	2.26	2.35	2.27	2.29	2.34	2.25	2.16	2.25
POCP	kg O ₃ eq.	41.72	43.37	40.29	42.23	40.70	41.25	42.30	41.24	40.10	40.57
Use of primary resources											
RPR _E	MJ, NCV	377.29	397.33	360.00	382.87	364.24	369.84	365.55	333.77	301.25	363.04
RPR _M	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
NRPR _E	MJ, NCV	1878.07	2085.53	1686.13	2029.77	1830.50	1980.74	2060.83	2036.14	2007.96	1958.97
NRPR _M	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Use of secondary resources											
SM	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RSF	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NRSF	MJ, NCV	162.26	170.41	155.40	163.24	155.75	156.78	153.41	136.41	119.03	153.41
RE	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Abiotic depletion potential											
ADPf	MJ, LHV	839.47	863.87	816.79	857.53	834.04	852.96	865.63	867.39	868.25	854.17
ADPe	kg Sb	1.91E-04	1.95E-04	1.87E-04	1.93E-04	1.89E-04	1.91E-04	1.93E-04	1.91E-04	1.88E-04	1.90E-04
Consumption of freshwater resources											
FW	m ³	2.10	2.16	2.05	2.13	2.08	2.10	2.10	2.04	1.98	2.09
Waste and output flows											
HWD	kg	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
NHWD	kg	20.24	21.36	19.29	20.46	19.43	19.65	19.23	17.11	14.93	19.23
HLRW	m ³	3.74E-09	3.74E-09	3.74E-09	3.74E-09	3.74E-09	3.74E-09	3.74E-09	3.74E-09	3.74E-09	3.74E-09
ILLRW	m ³	4.99E-08	4.99E-08	4.99E-08	4.99E-08	4.99E-08	4.99E-08	4.99E-08	4.99E-08	4.99E-08	4.99E-08
CRU	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MR	kg	0.00	0.00	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	0.00	0.00
EE	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Additional inventory parameters for transparency											
GWPCCE	kg CO ₂ eq.	199.15	221.77	178.68	212.43	190.93	204.02	199.64	177.51	154.90	199.64

Table16. LCA Results 35 MPa SCC with air (F-1)

35 MPa SCC with air (F-1) GU 20 FA	35 MPa SCC with air (F-1) GU 30 FA	35 MPa SCC with air (F-1) GUL 10 SL	35 MPa SCC with air (F-1) GUL 20 SL	35 MPa SCC with air (F-1) GUL 30 SL	35 MPa SCC with air (F-1) GUL 10 FA	35 MPa SCC with air (F-1) GUL 20 FA	35 MPa SCC with air (F-1) GUL 30 FA
Environmental impacts							
373.30	332.39	389.74	359.87	329.16	382.97	346.35	308.87
9.59E-06	8.42E-06	1.02E-05	1.04E-05	1.05E-05	9.13E-06	8.16E-06	7.17E-06
0.25	0.22	0.26	0.25	0.24	0.24	0.22	0.20
2.07	1.88	2.18	2.11	2.04	2.09	1.93	1.76
37.78	34.91	39.53	38.78	37.95	37.80	35.32	32.76
Use of primary resources							
328.75	293.71	331.94	303.89	275.17	329.43	298.87	267.64
2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00
1832.41	1702.36	1701.29	1716.44	1728.99	1599.42	1512.72	1423.39
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Use of secondary resources							
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
136.41	119.03	139.89	124.38	108.54	139.89	124.38	108.54
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Abiotic depletion potential							
844.48	833.88	823.25	829.71	835.37	811.79	806.79	801.00
1.84E-04	1.78E-04	1.85E-04	1.84E-04	1.82E-04	1.82E-04	1.77E-04	1.72E-04
Consumption of freshwater resources							
2.02	1.94	2.00	1.95	1.90	1.99	1.93	1.87
Waste and output flows							
0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
17.10	14.93	17.37	15.45	13.49	17.37	15.45	13.48
3.74E-09	3.74E-09	3.74E-09	3.74E-09	3.74E-09	3.74E-09	3.74E-09	3.74E-09
4.99E-08	4.99E-08	4.99E-08	4.99E-08	4.99E-08	4.99E-08	4.99E-08	4.99E-08
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Additional inventory parameters for transparency							
177.51	154.90	160.85	143.02	124.80	160.85	143.02	124.80

Table 17. LCA Results 40 MPa Concrete without air (N)

Unit		Baseline 40 MPa Concrete without air (N)	40 MPa Concrete without air (N) GU	40 MPa Concrete without air (N) GUL	40 MPa Concrete without air (N) GU/ GUb-8SF	40 MPa Concrete without air (N) GUL/ GUb-8SF	40 MPa Concrete without air (N) GUb-8SF	40 MPa Concrete without air (N) GU 10 SL	40 MPa Concrete without air (N) GU 20 SL	40 MPa Concrete without air (N) GU 30 SL	40 MPa Concrete without air (N) GU 10 FA
Environmental impacts											
GWP	kg CO ₂ eq.	364.24	372.17	345.07	360.09	346.51	346.24	345.45	318.72	292.00	340.01
ODP	kg CFC-11 eq.	9.28E-06	9.68E-06	8.24E-06	9.33E-06	8.61E-06	8.94E-06	9.65E-06	9.61E-06	9.57E-06	8.76E-06
EP	kg N eq.	0.24	0.25	0.22	0.24	0.23	0.23	0.24	0.23	0.22	0.23
AP	kg SO ₂ eq.	2.00	2.04	1.90	1.99	1.92	1.93	1.97	1.90	1.83	1.90
POCP	kg O ₃ eq.	36.39	37.10	34.62	36.32	35.08	35.40	36.24	35.39	34.53	34.85
Use of primary resources											
RPR _E	MJ, NCV	320.85	329.48	299.44	319.13	304.07	307.36	303.92	278.36	252.80	301.90
RPR _M	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
NRPR _E	MJ, NCV	1695.65	1784.34	1462.91	1745.54	1584.39	1700.01	1764.47	1744.61	1724.74	1682.54
NRPR _M	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Use of secondary resources											
SM	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RSF	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NRSF	MJ, NCV	133.62	137.14	125.06	132.01	125.95	126.17	123.47	109.79	96.11	123.47
RE	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Abiotic depletion potential											
ADPf	MJ, LHV	783.98	794.40	756.51	790.90	771.91	785.63	795.82	797.24	798.65	786.60
ADPe	kg Sb	1.54E-04	1.56E-04	1.49E-04	1.54E-04	1.51E-04	1.52E-04	1.54E-04	1.52E-04	1.50E-04	1.51E-04
Consumption of freshwater resources											
FW	m ³	2.08	2.11	2.02	2.08	2.04	2.06	2.06	2.01	1.96	2.05
Waste and output flows											
HWD	kg	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
NHWD	kg	16.71	17.19	15.53	16.55	15.72	15.82	15.48	13.78	12.07	15.48
HLRW	m ³	3.99E-09	3.99E-09	3.99E-09	3.99E-09	3.99E-09	3.99E-09	3.99E-09	3.99E-09	3.99E-09	3.99E-09
ILLRW	m ³	5.70E-08	5.70E-08	5.70E-08	5.70E-08	5.70E-08	5.70E-08	5.70E-08	5.70E-08	5.70E-08	5.70E-08
CRU	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MR	kg	0.00	0.00	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	0.00	0.00
EE	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Additional inventory parameters for transparency											
GWPCCE	kg CO ₂ eq.	168.78	178.47	143.79	171.79	154.41	164.19	160.67	142.87	125.07	160.67

Table 17. LCA Results 40 MPa Concrete without air (N)

40 MPa Concrete without air (N) GU 20 FA	40 MPa Concrete without air (N) GU 30 FA	40 MPa Concrete without air (N) GUL 10 SL	40 MPa Concrete without air (N) GUL 20 SL	40 MPa Concrete without air (N) GUL 30 SL	40 MPa Concrete without air (N) GUL 10 FA	40 MPa Concrete without air (N) GUL 20 FA	40 MPa Concrete without air (N) GUL 30 FA
Environmental impacts							
307.84	275.68	321.05	297.03	273.01	315.61	286.15	256.69
7.83E-06	6.91E-06	8.35E-06	8.46E-06	8.57E-06	7.46E-06	6.68E-06	5.90E-06
0.21	0.19	0.21	0.21	0.20	0.20	0.18	0.17
1.75	1.61	1.85	1.79	1.73	1.77	1.64	1.51
32.60	30.36	34.01	33.40	32.80	32.62	30.62	28.62
Use of primary resources							
274.32	246.74	276.87	254.31	231.74	274.85	250.27	225.68
2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00
1580.74	1478.94	1475.10	1487.30	1499.49	1393.17	1323.43	1253.68
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Use of secondary resources							
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
109.79	96.11	112.59	100.11	87.64	112.59	100.11	87.64
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Abiotic depletion potential							
778.81	771.01	761.71	766.91	772.10	752.50	748.48	744.46
1.47E-04	1.42E-04	1.48E-04	1.47E-04	1.46E-04	1.45E-04	1.41E-04	1.38E-04
Consumption of freshwater resources							
1.99	1.93	1.98	1.94	1.90	1.97	1.92	1.87
Waste and output flows							
0.03	0.03	0.03	0.03	0.02	0.03	0.03	0.02
13.77	12.06	13.99	12.44	10.90	13.98	12.44	10.89
3.99E-09	3.99E-09	3.99E-09	3.99E-09	3.99E-09	3.99E-09	3.99E-09	3.99E-09
5.70E-08	5.70E-08	5.70E-08	5.70E-08	5.70E-08	5.70E-08	5.70E-08	5.70E-08
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Additional inventory parameters for transparency							
142.87	125.07	129.45	115.11	100.77	129.45	115.11	100.77

Table 18. LCA Results 40 MPa Concrete with air (C-1)

Unit		Baseline 40 MPa Concrete with air (C-1)	40 MPa Concrete with air (C-1) GU/ GUB-8SF	40 MPa Concrete with air (C-1) GUL/ GUB-8SF	40 MPa Concrete with air (C-1) GUB-8SF	40 MPa Concrete with air (C-1) GU 10 SL	40 MPa Concrete with air (C-1) GU 20 SL	40 MPa Concrete with air (C-1) GU 30 SL	40 MPa Concrete with air (C-1) GU 10 FA	40 MPa Concrete with air (C-1) GU 20 FA	40 MPa Concrete with air (C-1) GU 30 FA
Environmental impacts											
GWP	kg CO ₂ eq.	396.62	392.96	377.92	379.42	377.75	348.33	318.72	371.72	336.13	300.49
ODP	kg CFC-11 eq.	1.03E-05	1.03E-05	9.45E-06	9.86E-06	1.06E-05	1.06E-05	1.06E-05	9.64E-06	8.62E-06	7.59E-06
EP	kg N eq.	0.26	0.26	0.25	0.25	0.26	0.25	0.24	0.25	0.23	0.20
AP	kg SO ₂ eq.	2.15	2.14	2.06	2.08	2.12	2.04	1.96	2.04	1.88	1.72
POCP	kg O ₃ eq.	38.68	38.52	37.14	37.65	38.51	37.62	36.67	36.97	34.50	32.01
Use of primary resources											
RPR _E	MJ, NCV	348.49	347.58	330.89	335.98	331.54	303.27	274.94	329.30	298.73	268.17
RPR _M	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
NRPR _E	MJ, NCV	1804.69	1847.94	1669.47	1804.37	1872.76	1853.69	1831.68	1781.96	1669.89	1557.09
NRPR _M	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Use of secondary resources											
SM	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RSF	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NRSF	MJ, NCV	147.31	146.21	139.50	140.46	137.14	121.99	106.83	137.14	121.99	106.83
RE	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Abiotic depletion potential											
ADPf	MJ, LHV	791.18	795.96	774.93	791.97	802.41	804.92	806.49	792.20	784.24	775.60
ADPe	kg Sb	1.68E-04	1.69E-04	1.65E-04	1.67E-04	1.69E-04	1.67E-04	1.65E-04	1.66E-04	1.61E-04	1.56E-04
Consumption of freshwater resources											
FW	m ³	2.00	2.01	1.96	1.98	1.98	1.92	1.87	1.97	1.90	1.84
Waste and output flows											
HWD	kg	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
NHWD	kg	18.43	18.33	17.40	17.61	17.20	15.30	13.41	17.19	15.30	13.40
HLRW	m ³	3.83E-09	3.83E-09	3.83E-09	3.83E-09	3.83E-09	3.83E-09	3.83E-09	3.83E-09	3.83E-09	3.83E-09
ILLRW	m ³	5.03E-08	5.03E-08	5.03E-08	5.03E-08	5.03E-08	5.03E-08	5.03E-08	5.03E-08	5.03E-08	5.03E-08
CRU	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MR	kg	0.00	0.00	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	0.00	0.00
EE	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Additional inventory parameters for transparency											
GWPCCE	kg CO ₂ eq.	186.60	190.27	171.01	182.78	178.47	158.75	139.02	178.47	158.75	139.02

Table 18. LCA Results 40 MPa Concrete with air (C-1)

40 MPa Concrete with air (C-1) GUL 10 SL	40 MPa Concrete with air (C-1) GUL 20 SL	40 MPa Concrete with air (C-1) GUL 30 SL	40 MPa Concrete with air (C-1) GUL 10 FA	40 MPa Concrete with air (C-1) GUL 20 FA	40 MPa Concrete with air (C-1) GUL 30 FA
Environmental impacts					
350.65	324.23	297.61	344.62	312.02	279.38
9.19E-06	9.33E-06	9.45E-06	8.20E-06	7.34E-06	6.47E-06
0.23	0.23	0.22	0.22	0.20	0.18
1.98	1.92	1.85	1.90	1.75	1.61
36.03	35.42	34.74	34.49	32.30	30.08
Use of primary resources					
301.49	276.54	251.54	299.25	272.01	244.77
2.00	3.00	4.00	5.00	6.00	7.00
1551.33	1567.79	1581.30	1460.54	1383.99	1306.71
0.00	0.00	0.00	0.00	0.00	0.00
Use of secondary resources					
0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00
125.06	111.24	97.42	125.06	111.24	97.42
0.00	0.00	0.00	0.00	0.00	0.00
Abiotic depletion potential					
764.52	771.21	776.97	754.31	750.54	746.09
1.62E-04	1.61E-04	1.59E-04	1.59E-04	1.55E-04	1.50E-04
Consumption of freshwater resources					
1.89	1.84	1.80	1.88	1.83	1.77
Waste and output flows					
0.03	0.03	0.03	0.03	0.03	0.02
15.53	13.82	12.11	15.53	13.82	12.10
3.83E-09	3.83E-09	3.83E-09	3.83E-09	3.83E-09	3.83E-09
5.03E-08	5.03E-08	5.03E-08	5.03E-08	5.03E-08	5.03E-08
0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00
Additional inventory parameters for transparency					
143.79	127.90	112.01	143.79	127.90	112.01

Table 19. LCA Results 45 MPa Concrete without air (N)

Unit		Baseline 45 MPa Concrete without air (N)	45 MPa Concrete without air (N) GU	45 MPa Concrete without air (N) GUL	45 MPa Concrete without air (N) GU/ GUb-8SF	45 MPa Concrete without air (N) GUL/ GUb-8SF	45 MPa Concrete without air (N) GUb-8SF	45 MPa Concrete without air (N) GU 10 SL	45 MPa Concrete without air (N) GU 20 SL	45 MPa Concrete without air (N) GU 30 SL	45 MPa Concrete without air (N) GU 10 FA
Environmental impacts											
GWP	kg CO ₂ eq.	381.16	388.59	360.18	375.89	361.64	361.41	360.43	332.26	304.09	354.69
ODP	kg CFC-11 eq.	9.79E-06	1.01E-05	8.62E-06	9.76E-06	9.01E-06	9.35E-06	1.01E-05	1.01E-05	1.00E-05	9.15E-06
EP	kg N eq.	0.25	0.26	0.23	0.25	0.24	0.24	0.25	0.24	0.23	0.24
AP	kg SO ₂ eq.	2.09	2.12	1.98	2.07	2.00	2.00	2.05	1.97	1.90	1.97
POCP	kg O ₃ eq.	37.82	38.46	35.86	37.64	36.34	36.68	37.56	36.66	35.76	36.09
Use of primary resources											
RPR _E	MJ, NCV	335.46	343.08	311.58	332.20	316.41	319.89	316.14	289.20	262.26	314.01
RPR _M	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
NRPR _E	MJ, NCV	1776.73	1846.04	1509.02	1805.20	1636.26	1757.62	1825.11	1804.17	1783.23	1738.74
NRPR _M	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Use of secondary resources											
SM	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RSF	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NRSF	MJ, NCV	140.55	143.80	131.13	138.40	132.05	132.29	129.38	114.96	100.55	129.38
RE	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Abiotic depletion potential											
ADP _f	MJ, LHV	801.09	809.69	769.96	805.97	786.06	800.48	811.18	812.67	814.17	801.47
ADP _e	kg Sb	1.59E-04	1.60E-04	1.53E-04	1.58E-04	1.55E-04	1.56E-04	1.58E-04	1.56E-04	1.54E-04	1.55E-04
Consumption of freshwater resources											
FW	m ³	2.10	2.12	2.03	2.10	2.05	2.07	2.07	2.01	1.96	2.06
Waste and output flows											
HWD	kg	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
NHWD	kg	17.59	18.03	16.28	17.35	16.48	16.59	16.22	14.42	12.62	16.22
HLRW	m ³	3.98E-09	3.98E-09	3.98E-09	3.98E-09	3.98E-09	3.98E-09	3.98E-09	3.98E-09	3.98E-09	3.98E-09
ILLRW	m ³	5.65E-08	5.65E-08	5.65E-08	5.65E-08	5.65E-08	5.65E-08	5.65E-08	5.65E-08	5.65E-08	5.65E-08
CRU	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MR	kg	0.00	0.00	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	0.00	0.00
EE	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Additional inventory parameters for transparency											
GWPCCE	kg CO ₂ eq.	179.28	187.13	150.77	180.11	161.88	172.16	168.37	149.61	130.85	168.37

Table 19. LCA Results 45 MPa Concrete without air (N)

45 MPa Concrete without air (N) GU 20 FA	45 MPa Concrete without air (N) GU 30 FA	45 MPa Concrete without air (N) GUL 10 SL	45 MPa Concrete without air (N) GUL 20 SL	45 MPa Concrete without air (N) GUL 30 SL	45 MPa Concrete without air (N) GUL 10 FA	45 MPa Concrete without air (N) GUL 20 FA	45 MPa Concrete without air (N) GUL 30 FA
Environmental impacts							
320.79	286.89	334.86	309.54	284.22	329.13	298.07	267.02
8.18E-06	7.21E-06	8.73E-06	8.85E-06	8.96E-06	7.80E-06	6.97E-06	6.15E-06
0.22	0.19	0.22	0.22	0.21	0.21	0.19	0.17
1.82	1.66	1.92	1.86	1.79	1.84	1.70	1.56
33.72	31.36	35.22	34.58	33.94	33.75	31.65	29.54
Use of primary resources							
284.94	255.87	287.80	264.01	240.23	285.67	259.75	233.84
2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00
1631.44	1524.14	1521.88	1534.73	1547.58	1435.51	1362.00	1288.49
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Use of secondary resources							
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
114.96	100.55	117.98	104.83	91.69	117.98	104.83	91.69
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Abiotic depletion potential							
793.25	785.03	775.44	780.91	786.39	765.72	761.49	757.25
1.51E-04	1.46E-04	1.52E-04	1.51E-04	1.50E-04	1.49E-04	1.45E-04	1.41E-04
Consumption of freshwater resources							
2.00	1.94	1.98	1.94	1.90	1.97	1.92	1.87
Waste and output flows							
0.03	0.03	0.03	0.03	0.02	0.03	0.03	0.02
14.42	12.62	14.65	13.03	11.40	14.65	13.02	11.39
3.98E-09	3.98E-09	3.98E-09	3.98E-09	3.98E-09	3.98E-09	3.98E-09	3.98E-09
5.65E-08	5.65E-08	5.65E-08	5.65E-08	5.65E-08	5.65E-08	5.65E-08	5.65E-08
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Additional inventory parameters for transparency							
149.61	130.85	135.65	120.54	105.42	135.65	120.54	105.42

Table 20. LCA Results 45 MPa Concrete with air (C-1)

Unit		Baseline 45 MPa Concrete with air (C-1)	45 MPa Concrete with air (C-1) GU/ GUB-8SF	45 MPa Concrete with air (C-1) GUL/ GUB-8SF	45 MPa Concrete with air (C-1) GUB-8SF	45 MPa Concrete with air (C-1) GU 10 SL	45 MPa Concrete with air (C-1) GU 20 SL	45 MPa Concrete with air (C-1) GU 30 SL	45 MPa Concrete with air (C-1) GU 10 FA	45 MPa Concrete with air (C-1) GU 20 FA	45 MPa Concrete with air (C-1) GU 30 FA
Environmental impacts											
GWP	kg CO ₂ eq.	413.72	429.61	413.10	414.67	412.90	380.60	348.09	406.28	367.22	328.10
ODP	kg CFC-11 eq.	1.07E-05	1.12E-05	1.03E-05	1.08E-05	1.16E-05	1.16E-05	1.16E-05	1.06E-05	9.43E-06	8.31E-06
EP	kg N eq.	0.28	0.29	0.27	0.28	0.29	0.28	0.27	0.27	0.25	0.22
AP	kg SO ₂ eq.	2.26	2.33	2.24	2.26	2.31	2.23	2.14	2.22	2.04	1.87
POCP	kg O ₃ eq.	40.80	41.95	40.44	40.98	41.94	40.96	39.92	40.25	37.54	34.80
Use of primary resources											
RPR _E	MJ, NCV	361.50	376.54	358.23	363.74	358.93	327.89	296.81	356.47	322.92	289.38
RPR _M	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
NRPR _E	MJ, NCV	1923.76	2002.69	1806.89	1954.57	2029.90	2008.68	1984.52	1930.25	1807.17	1683.36
NRPR _M	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Use of secondary resources											
SM	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RSF	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NRSF	MJ, NCV	153.28	160.40	153.04	154.06	150.45	133.82	117.18	150.45	133.82	117.18
RE	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Abiotic depletion potential											
ADP _f	MJ, LHV	843.78	850.34	827.26	845.87	857.41	860.07	861.80	846.21	837.41	827.93
ADP _e	kg Sb	1.72E-04	1.74E-04	1.70E-04	1.72E-04	1.74E-04	1.72E-04	1.70E-04	1.71E-04	1.66E-04	1.60E-04
Consumption of freshwater resources											
FW	m ³	2.09	2.12	2.07	2.10	2.09	2.03	1.97	2.08	2.01	1.94
Waste and output flows											
HWD	kg	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
NHWD	kg	19.19	20.10	19.09	19.31	18.86	16.78	14.70	18.86	16.78	14.70
HLRW	m ³	3.85E-09	3.85E-09	3.85E-09	3.85E-09	3.85E-09	3.85E-09	3.85E-09	3.85E-09	3.85E-09	3.85E-09
ILLRW	m ³	5.27E-08	5.27E-08	5.27E-08	5.27E-08	5.27E-08	5.27E-08	5.27E-08	5.27E-08	5.27E-08	5.27E-08
CRU	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MR	kg	0.00	0.00	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	0.00	0.00
EE	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Additional inventory parameters for transparency											
GWPCCE	kg CO ₂ eq.	196.51	208.74	187.61	200.48	195.79	174.14	152.49	195.79	174.14	152.49

Table 20. LCA Results 45 MPa Concrete with air (C-1)

45 MPa Concrete with air (C-1) GUL 10 SL	45 MPa Concrete with air (C-1) GUL 20 SL	45 MPa Concrete with air (C-1) GUL 30 SL	45 MPa Concrete with air (C-1) GUL 10 FA	45 MPa Concrete with air (C-1) GUL 20 FA	45 MPa Concrete with air (C-1) GUL 30 FA
Environmental impacts					
383.17	354.16	324.94	376.56	340.78	304.94
1.01E-05	1.02E-05	1.03E-05	8.98E-06	8.03E-06	7.08E-06
0.25	0.25	0.24	0.24	0.22	0.20
2.16	2.09	2.02	2.07	1.91	1.75
39.22	38.54	37.80	37.53	35.12	32.69
Use of primary resources					
325.97	298.58	271.13	323.51	293.61	263.71
2.00	3.00	4.00	5.00	6.00	7.00
1677.28	1695.06	1709.88	1577.63	1493.54	1408.72
0.00	0.00	0.00	0.00	0.00	0.00
Use of secondary resources					
0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00
137.19	122.02	106.86	137.19	122.02	106.86
0.00	0.00	0.00	0.00	0.00	0.00
Abiotic depletion potential					
815.85	823.10	829.42	804.64	800.44	795.55
1.67E-04	1.66E-04	1.64E-04	1.64E-04	1.59E-04	1.55E-04
Consumption of freshwater resources					
1.99	1.94	1.90	1.98	1.92	1.86
Waste and output flows					
0.03	0.03	0.03	0.03	0.03	0.03
17.03	15.16	13.28	17.03	15.15	13.27
3.85E-09	3.85E-09	3.85E-09	3.85E-09	3.85E-09	3.85E-09
5.27E-08	5.27E-08	5.27E-08	5.27E-08	5.27E-08	5.27E-08
0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00
Additional inventory parameters for transparency					
157.75	140.30	122.86	157.75	140.30	122.86

Table 21. LCA Results 50 MPa Concrete with air (C-1)

Unit		Baseline 50 MPa Concrete with air (C-1)	50 MPa Concrete with air (C-1) GU/ GUB-8SF	50 MPa Concrete with air (C-1) GUL/ GUB-8SF	50 MPa Concrete with air (C-1) GUB-8SF	50 MPa Concrete with air (C-1) GU 10 SL	50 MPa Concrete with air (C-1) GU 20 SL	50 MPa Concrete with air (C-1) GU 30 SL	50 MPa Concrete with air (C-1) GU 10 FA	50 MPa Concrete with air (C-1) GU 20 FA	50 MPa Concrete with air (C-1) GU 30 FA
Environmental impacts											
GWP	kg CO ₂ eq.	410.80	411.44	395.74	395.57	394.49	363.43	332.38	388.17	350.79	313.41
ODP	kg CFC-11 eq.	1.10E-05	1.07E-05	9.87E-06	1.02E-05	1.11E-05	1.10E-05	1.10E-05	1.00E-05	8.96E-06	7.88E-06
EP	kg N eq.	0.28	0.28	0.26	0.27	0.27	0.26	0.25	0.26	0.24	0.21
AP	kg SO ₂ eq.	2.26	2.24	2.16	2.17	2.21	2.13	2.05	2.13	1.96	1.79
POCP	kg O ₃ eq.	40.68	40.30	38.86	39.24	40.21	39.22	38.23	38.60	35.99	33.38
Use of primary resources											
RPR _E	MJ, NCV	362.13	363.98	346.57	350.47	346.35	316.64	286.94	344.00	311.95	279.89
RPR _M	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
NRPR _E	MJ, NCV	1986.53	1956.49	1770.22	1904.36	1978.79	1955.70	1932.62	1883.57	1765.26	1646.96
NRPR _M	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Use of secondary resources											
SM	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RSF	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NRSF	MJ, NCV	151.19	152.60	145.59	145.90	142.69	126.79	110.90	142.69	126.79	110.90
RE	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Abiotic depletion potential											
ADP _f	MJ, LHV	861.25	856.97	835.01	851.01	862.80	864.45	866.10	852.09	843.03	833.97
ADP _e	kg Sb	2.05E-04	2.04E-04	2.00E-04	2.02E-04	2.04E-04	2.02E-04	1.99E-04	2.01E-04	1.95E-04	1.90E-04
Consumption of freshwater resources											
FW	m ³	2.10	2.10	2.05	2.07	2.07	2.01	1.96	2.06	1.99	1.93
Waste and output flows											
HWD	kg	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
NHWD	kg	18.95	19.13	18.16	18.29	17.89	15.90	13.92	17.89	15.90	13.91
HLRW	m ³	3.85E-09	3.85E-09	3.85E-09	3.85E-09	3.85E-09	3.85E-09	3.85E-09	3.85E-09	3.85E-09	3.85E-09
ILLRW	m ³	5.30E-08	5.30E-08	5.30E-08	5.30E-08	5.30E-08	5.30E-08	5.30E-08	5.30E-08	5.30E-08	5.30E-08
CRU	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MR	kg	0.00	0.00	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	0.00	0.00
EE	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Additional inventory parameters for transparency											
GWPCCE	kg CO ₂ eq.	196.75	198.58	178.48	189.86	185.69	165.00	144.32	185.69	165.00	144.32

Table 21. LCA Results 50 MPa Concrete with air (C-1)

50 MPa Concrete with air (C-1) GUL 10 SL	50 MPa Concrete with air (C-1) GUL 20 SL	50 MPa Concrete with air (C-1) GUL 30 SL	50 MPa Concrete with air (C-1) GUL 10 FA	50 MPa Concrete with air (C-1) GUL 20 FA	50 MPa Concrete with air (C-1) GUL 30 FA
Environmental impacts					
366.30	338.38	310.47	359.98	325.74	291.50
9.57E-06	9.69E-06	9.82E-06	8.53E-06	7.63E-06	6.72E-06
0.24	0.24	0.23	0.23	0.21	0.19
2.07	2.00	1.93	1.98	1.83	1.68
37.64	36.93	36.22	36.02	33.70	31.37
Use of primary resources					
315.09	288.87	262.64	312.74	284.17	255.60
2.00	3.00	4.00	5.00	6.00	7.00
1644.37	1658.54	1672.71	1549.15	1468.10	1387.04
0.00	0.00	0.00	0.00	0.00	0.00
Use of secondary resources					
0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00
130.11	115.62	101.12	130.11	115.62	101.12
0.00	0.00	0.00	0.00	0.00	0.00
Abiotic depletion potential					
823.38	829.42	835.46	812.67	808.00	803.33
1.97E-04	1.95E-04	1.94E-04	1.94E-04	1.89E-04	1.85E-04
Consumption of freshwater resources					
1.98	1.93	1.89	1.97	1.91	1.86
Waste and output flows					
0.03	0.03	0.03	0.03	0.03	0.03
16.16	14.36	12.57	16.16	14.36	12.56
3.85E-09	3.85E-09	3.85E-09	3.85E-09	3.85E-09	3.85E-09
5.30E-08	5.30E-08	5.30E-08	5.30E-08	5.30E-08	5.30E-08
0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00
Additional inventory parameters for transparency					
149.61	132.94	116.27	149.61	132.94	116.27

Table 22. LCA Results 50 MPa Concrete with air (C-XL)

Unit		Baseline 50 MPa Concrete with air (C-XL)	50 MPa Concrete with air (C-XL)GU/GUB-8SF	50 MPa Concrete with air (C-XL)GUL/GUB-8SF	50 MPa Concrete with air (C-XL)GUB-8SF	50 MPa Concrete with air (C-XL)GU 10 SL	50 MPa Concrete with air (C-XL)GU 20 SL	50 MPa Concrete with air (C-XL)GU 30 SL	50 MPa Concrete with air (C-XL)GU 10 FA	50 MPa Concrete with air (C-XL)GU 20 FA	50 MPa Concrete with air (C-XL)GU 30 FA
Environmental impacts											
GWP	kg CO ₂ eq.	411.30	429.54	413.03	414.59	413.75	380.52	348.02	407.13	367.14	328.03
ODP	kg CFC-11 eq.	1.10E-05	1.12E-05	1.03E-05	1.08E-05	1.17E-05	1.16E-05	1.16E-05	1.06E-05	9.43E-06	8.31E-06
EP	kg N eq.	0.28	0.29	0.27	0.28	0.29	0.28	0.27	0.27	0.25	0.22
AP	kg SO ₂ eq.	2.26	2.33	2.24	2.26	2.32	2.23	2.14	2.23	2.05	1.87
POCP	kg O ₃ eq.	41.03	41.96	40.45	41.00	42.04	40.97	39.93	40.34	37.55	34.82
Use of primary resources											
RPR _E	MJ, NCV	359.32	376.05	357.75	363.26	359.19	327.41	296.32	356.73	322.44	288.90
RPR _M	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
NRPR _E	MJ, NCV	1969.25	2000.72	1804.92	1952.60	2031.41	2006.72	1982.56	1931.76	1805.20	1681.39
NRPR _M	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Use of secondary resources											
SM	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RSF	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NRSF	MJ, NCV	151.72	160.40	153.04	154.06	150.82	133.82	117.18	150.82	133.82	117.18
RE	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Abiotic depletion potential											
ADP _f	MJ, LHV	849.06	848.51	825.43	844.04	856.48	858.24	859.97	845.28	835.58	826.10
ADP _e	kg Sb	1.69E-04	1.71E-04	1.67E-04	1.69E-04	1.71E-04	1.69E-04	1.67E-04	1.68E-04	1.62E-04	1.57E-04
Consumption of freshwater resources											
FW	m ³	2.09	2.12	2.07	2.10	2.09	2.03	1.97	2.08	2.01	1.94
Waste and output flows											
HWD	kg	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
NHWD	kg	19.02	20.10	19.09	19.31	18.91	16.78	14.70	18.91	16.78	14.70
HLRW	m ³	3.83E-09	3.83E-09	3.83E-09	3.83E-09	3.83E-09	3.83E-09	3.83E-09	3.83E-09	3.83E-09	3.83E-09
ILLRW	m ³	5.27E-08	5.27E-08	5.27E-08	5.27E-08	5.27E-08	5.27E-08	5.27E-08	5.27E-08	5.27E-08	5.27E-08
CRU	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MR	kg	0.00	0.00	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	0.00	0.00
EE	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Additional inventory parameters for transparency											
GWPCCE	kg CO ₂ eq.	197.44	208.74	187.61	200.48	196.27	174.14	152.49	196.27	174.14	152.49

Table 22. LCA Results 50 MPa Concrete with air (C-XL)

50 MPa Concrete with air (C-XL) GUL 10 SL	50 MPa Concrete with air (C-XL) GUL 20 SL	50 MPa Concrete with air (C-XL) GUL 30 SL	50 MPa Concrete with air (C-XL) GUL 10 FA	50 MPa Concrete with air (C-XL) GUL 20 FA	50 MPa Concrete with air (C-XL) GUL 30 FA
Environmental impacts					
383.95	354.08	324.87	377.33	340.70	304.87
1.01E-05	1.02E-05	1.03E-05	9.00E-06	8.03E-06	7.08E-06
0.25	0.25	0.24	0.24	0.22	0.20
2.16	2.09	2.02	2.07	1.91	1.75
39.31	38.56	37.82	37.62	35.13	32.70
Use of primary resources					
326.15	298.10	270.65	323.69	293.13	263.23
2.00	3.00	4.00	5.00	6.00	7.00
1677.93	1693.09	1707.92	1578.28	1491.58	1406.75
0.00	0.00	0.00	0.00	0.00	0.00
Use of secondary resources					
0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00
137.53	122.02	106.86	137.53	122.02	106.86
0.00	0.00	0.00	0.00	0.00	0.00
Abiotic depletion potential					
814.82	821.28	827.59	803.61	798.61	793.72
1.64E-04	1.62E-04	1.61E-04	1.61E-04	1.56E-04	1.51E-04
Consumption of freshwater resources					
2.00	1.95	1.90	1.99	1.92	1.87
Waste and output flows					
0.03	0.03	0.03	0.03	0.03	0.03
17.08	15.16	13.28	17.07	15.15	13.27
3.83E-09	3.83E-09	3.83E-09	3.83E-09	3.83E-09	3.83E-09
5.27E-08	5.27E-08	5.27E-08	5.27E-08	5.27E-08	5.27E-08
0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00
Additional inventory parameters for transparency					
158.13	140.30	122.86	158.13	140.30	122.86

Table 23. LCA Results 50 MPa Concrete without air (N)

Unit		Baseline 50 MPa Concrete without air (N)	50 MPa Concrete without air (N) GU	50 MPa Concrete without air (N) GUL	50 MPa Concrete without air (N) GU/ GUb-8SF	50 MPa Concrete without air (N) GUL/ GUb-8SF	50 MPa Concrete without air (N) GUb-8SF	50 MPa Concrete without air (N) GU 10 SL	50 MPa Concrete without air (N) GU 20 SL	50 MPa Concrete without air (N) GU 30 SL	50 MPa Concrete without air (N) GU 10 FA
Environmental impacts											
GWP	kg CO ₂ eq.	404.38	411.08	380.84	396.62	381.50	382.15	380.55	351.13	320.60	374.52
ODP	kg CFC-11 eq.	1.04E-05	1.07E-05	9.14E-06	1.03E-05	9.53E-06	9.92E-06	1.07E-05	1.07E-05	1.06E-05	9.70E-06
EP	kg N eq.	0.27	0.27	0.24	0.27	0.25	0.26	0.26	0.26	0.25	0.25
AP	kg SO ₂ eq.	2.20	2.24	2.08	2.17	2.10	2.11	2.15	2.08	1.99	2.07
POCP	kg O ₃ eq.	39.81	40.38	37.61	39.43	38.05	38.48	39.35	38.46	37.44	37.81
Use of primary resources											
RPR _E	MJ, NCV	353.83	360.65	327.12	348.31	331.54	335.96	331.58	303.31	274.24	329.34
RPR _M	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
NRPR _E	MJ, NCV	1863.00	1923.65	1564.97	1876.60	1697.26	1829.55	1898.16	1879.09	1853.60	1807.37
NRPR _M	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Use of secondary resources											
SM	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RSF	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NRSF	MJ, NCV	150.12	153.04	139.55	146.92	140.17	140.80	137.51	122.36	106.83	137.51
RE	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Abiotic depletion potential											
ADPf	MJ, LHV	815.75	823.33	781.05	818.44	797.30	813.54	824.00	826.51	827.18	813.79
ADPe	kg Sb	1.53E-04	1.55E-04	1.47E-04	1.53E-04	1.49E-04	1.51E-04	1.53E-04	1.51E-04	1.49E-04	1.50E-04
Consumption of freshwater resources											
FW	m ³	2.13	2.15	2.05	2.13	2.08	2.10	2.10	2.04	1.99	2.09
Waste and output flows											
HWD	kg	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
NHWD	kg	18.79	19.18	17.32	18.42	17.49	17.65	17.24	15.35	13.41	17.24
HLRW	m ³	3.95E-09	3.95E-09	3.95E-09	3.95E-09	3.95E-09	3.95E-09	3.95E-09	3.95E-09	3.95E-09	3.95E-09
ILLRW	m ³	5.60E-08	5.60E-08	5.60E-08	5.60E-08	5.60E-08	5.60E-08	5.60E-08	5.60E-08	5.60E-08	5.60E-08
CRU	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MR	kg	0.00	0.00	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	0.00	0.00
EE	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Additional inventory parameters for transparency											
GWPCCE	kg CO ₂ eq.	192.24	199.16	160.46	191.19	171.84	183.22	178.95	159.23	139.02	178.95

Table 23. LCA Results 50 MPa Concrete without air (N)

50 MPa Concrete without air (N) GU 20 FA	50 MPa Concrete without air (N) GU 30 FA	50 MPa Concrete without air (N) GUL 10 SL	50 MPa Concrete without air (N) GUL 20 SL	50 MPa Concrete without air (N) GUL 30 SL	50 MPa Concrete without air (N) GUL 10 FA	50 MPa Concrete without air (N) GUL 20 FA	50 MPa Concrete without air (N) GUL 30 FA
Environmental impacts							
338.93	302.37	353.38	326.96	299.49	347.35	314.75	281.26
8.68E-06	7.63E-06	9.24E-06	9.39E-06	9.48E-06	8.26E-06	7.39E-06	6.51E-06
0.23	0.20	0.23	0.23	0.22	0.22	0.20	0.18
1.91	1.74	2.01	1.95	1.88	1.93	1.79	1.63
35.34	32.77	36.87	36.25	35.51	35.33	33.13	30.84
Use of primary resources							
298.78	267.47	301.46	276.51	250.84	299.22	271.97	244.07
2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00
1695.29	1579.01	1575.87	1592.32	1603.22	1485.08	1408.52	1328.63
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Use of secondary resources							
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
122.36	106.83	125.39	111.57	97.42	125.39	111.57	97.42
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Abiotic depletion potential							
805.84	796.30	786.01	792.71	797.67	775.80	772.04	766.79
1.45E-04	1.40E-04	1.46E-04	1.45E-04	1.43E-04	1.43E-04	1.39E-04	1.34E-04
Consumption of freshwater resources							
2.02	1.96	2.01	1.96	1.92	2.00	1.94	1.89
Waste and output flows							
0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02
15.34	13.40	15.57	13.86	12.11	15.57	13.86	12.10
3.95E-09	3.95E-09	3.95E-09	3.95E-09	3.95E-09	3.95E-09	3.95E-09	3.95E-09
5.60E-08	5.60E-08	5.60E-08	5.60E-08	5.60E-08	5.60E-08	5.60E-08	5.60E-08
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Additional inventory parameters for transparency							
159.23	139.02	144.18	128.29	112.01	144.18	128.29	112.01

Table 24. LCA Results 60 MPa Concrete without air (N)

Unit		Baseline 60 MPa Concrete without air (N)	60 MPa Concrete without air (N) GU	60 MPa Concrete without air (N) GUL	60 MPa Concrete without air (N) GU/ GUb-8SF	60 MPa Concrete without air (N) GUL/ GUb-8SF	60 MPa Concrete without air (N) GUb-8SF	60 MPa Concrete without air (N) GU 10 SL	60 MPa Concrete without air (N) GU 20 SL	60 MPa Concrete without air (N) GU 30 SL	60 MPa Concrete without air (N) GU 10 FA
Environmental impacts											
GWP	kg CO ₂ eq.	424.74	431.17	399.32	415.94	400.01	400.70	400.31	368.33	336.55	393.84
ODP	kg CFC-11 eq.	1.10E-05	1.13E-05	9.61E-06	1.09E-05	1.00E-05	1.04E-05	1.13E-05	1.12E-05	1.12E-05	1.02E-05
EP	kg N eq.	0.28	0.29	0.25	0.28	0.26	0.27	0.28	0.27	0.26	0.26
AP	kg SO ₂ eq.	2.31	2.34	2.17	2.27	2.19	2.20	2.26	2.17	2.08	2.17
POCP	kg O ₃ eq.	41.52	42.06	39.15	41.06	39.61	40.06	41.12	40.05	39.04	39.47
Use of primary resources											
RPR _E	MJ, NCV	370.41	377.13	341.82	364.12	346.47	351.12	347.47	317.02	286.63	345.07
RPR _M	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
NRPR _E	MJ, NCV	1936.56	1998.97	1621.23	1949.42	1760.55	1899.87	1978.83	1952.27	1928.64	1881.40
NRPR _M	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Use of secondary resources											
SM	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RSF	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NRSF	MJ, NCV	158.34	161.17	146.97	154.73	147.62	148.28	145.28	129.01	112.75	145.28
RE	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Abiotic depletion potential											
ADPf	MJ, LHV	834.64	841.92	797.40	836.76	814.50	831.61	844.51	845.25	846.94	833.55
ADPe	kg Sb	1.58E-04	1.59E-04	1.51E-04	1.57E-04	1.53E-04	1.55E-04	1.57E-04	1.55E-04	1.53E-04	1.54E-04
Consumption of freshwater resources											
FW	m ³	2.16	2.18	2.07	2.15	2.10	2.12	2.12	2.06	2.00	2.11
Waste and output flows											
HWD	kg	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
NHWD	kg	19.82	20.20	18.24	19.39	18.42	18.59	18.21	16.18	14.15	18.21
HLRW	m ³	3.94E-09	3.94E-09	3.94E-09	3.94E-09	3.94E-09	3.94E-09	3.94E-09	3.94E-09	3.94E-09	3.94E-09
ILLRW	m ³	5.56E-08	5.56E-08	5.56E-08	5.56E-08	5.56E-08	5.56E-08	5.56E-08	5.56E-08	5.56E-08	5.56E-08
CRU	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MR	kg	0.00	0.00	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	0.00	0.00
EE	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Additional inventory parameters for transparency											
GWPCCE	kg CO ₂ eq.	202.68	209.74	168.99	201.35	180.97	192.96	189.05	167.89	146.72	189.05

Table 24. LCA Results 60 MPa Concrete without air (N)

60 MPa Concrete without air (N) GU 20 FA	60 MPa Concrete without air (N) GU 30 FA	60 MPa Concrete without air (N) GUL 10 SL	60 MPa Concrete without air (N) GUL 20 SL	60 MPa Concrete without air (N) GUL 30 SL	60 MPa Concrete without air (N) GUL 10 FA	60 MPa Concrete without air (N) GUL 20 FA	60 MPa Concrete without air (N) GUL 30 FA
Environmental impacts							
355.54	317.29	371.60	342.84	314.28	365.14	330.05	295.02
9.12E-06	8.02E-06	9.75E-06	9.86E-06	9.99E-06	8.70E-06	7.77E-06	6.84E-06
0.24	0.21	0.25	0.24	0.23	0.23	0.21	0.19
1.99	1.82	2.11	2.04	1.97	2.02	1.86	1.71
36.78	34.11	38.50	37.72	37.00	36.85	34.45	32.07
Use of primary resources							
312.27	279.47	315.65	288.76	261.93	313.25	284.01	254.77
2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00
1759.61	1638.55	1638.35	1649.90	1664.40	1540.91	1457.24	1374.31
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Use of secondary resources							
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
129.01	112.75	132.47	117.64	102.81	132.47	117.64	102.81
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Abiotic depletion potential							
823.59	814.31	804.37	809.61	815.79	793.41	787.94	783.16
1.48E-04	1.43E-04	1.50E-04	1.48E-04	1.47E-04	1.47E-04	1.42E-04	1.38E-04
Consumption of freshwater resources							
2.04	1.97	2.03	1.98	1.93	2.02	1.96	1.90
Waste and output flows							
0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
16.18	14.14	16.45	14.61	12.78	16.45	14.61	12.77
3.94E-09	3.94E-09	3.94E-09	3.94E-09	3.94E-09	3.94E-09	3.94E-09	3.94E-09
5.56E-08	5.56E-08	5.56E-08	5.56E-08	5.56E-08	5.56E-08	5.56E-08	5.56E-08
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Additional inventory parameters for transparency							
167.89	146.72	152.32	135.27	118.21	152.32	135.27	118.21

Table 25 LCA Results 60 MPa Concrete with air (C-1)

Unit		Baseline 60 MPa Concrete with air (C-1)	60 MPa Concrete with air (C-1) GU/ GUB-8SF	60 MPa Concrete with air (C-1) GUL/ GUB-8SF	60 MPa Concrete with air (C-1) GUB-8SF	60 MPa Concrete with air (C-1) GU 10 SL	60 MPa Concrete with air (C-1) GU 20 SL	60 MPa Concrete with air (C-1) GU 30 SL	60 MPa Concrete with air (C-1) GU 10 FA	60 MPa Concrete with air (C-1) GU 20 FA	60 MPa Concrete with air (C-1) GU 30 FA
Environmental impacts											
GWP	kg CO ₂ eq.	444.71	444.53	427.44	428.18	426.94	392.99	358.85	420.02	379.17	338.26
ODP	kg CFC-11 eq.	1.20E-05	1.16E-05	1.07E-05	1.11E-05	1.20E-05	1.20E-05	1.19E-05	1.09E-05	9.73E-06	8.55E-06
EP	kg N eq.	0.30	0.30	0.28	0.29	0.30	0.29	0.27	0.28	0.25	0.23
AP	kg SO ₂ eq.	2.43	2.40	2.31	2.33	2.38	2.29	2.20	2.29	2.10	1.92
POCP	kg O ₃ eq.	43.61	43.14	41.57	42.06	43.12	42.04	40.89	41.35	38.50	35.63
Use of primary resources											
RPR _E	MJ, NCV	389.28	390.54	371.59	376.59	372.03	339.56	307.04	369.46	334.43	299.39
RPR _M	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
NRPR _E	MJ, NCV	2110.32	2075.29	1872.56	2022.10	2103.24	2078.01	2049.83	1999.17	1869.85	1739.81
NRPR _M	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Use of secondary resources											
SM	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RSF	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NRSF	MJ, NCV	164.94	166.08	158.46	159.16	155.63	138.25	120.88	155.63	138.25	120.88
RE	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Abiotic depletion potential											
ADP _f	MJ, LHV	887.52	882.08	858.19	876.55	889.42	891.22	892.08	877.71	867.81	857.21
ADP _e	kg Sb	2.03E-04	2.02E-04	1.98E-04	1.99E-04	2.02E-04	1.99E-04	1.97E-04	1.98E-04	1.93E-04	1.87E-04
Consumption of freshwater resources											
FW	m ³	2.14	2.14	2.08	2.11	2.11	2.04	1.98	2.10	2.02	1.95
Waste and output flows											
HWD	kg	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
NHWD	kg	20.67	20.81	19.76	19.95	19.51	17.34	15.17	19.51	17.33	15.16
HLRW	m ³	3.85E-09	3.85E-09	3.85E-09	3.85E-09	3.85E-09	3.85E-09	3.85E-09	3.85E-09	3.85E-09	3.85E-09
ILLRW	m ³	5.25E-08	5.25E-08	5.25E-08	5.25E-08	5.25E-08	5.25E-08	5.25E-08	5.25E-08	5.25E-08	5.25E-08
CRU	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MR	kg	0.00	0.00	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	0.00	0.00
EE	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Additional inventory parameters for transparency											
GWPCCE	kg CO ₂ eq.	214.65	216.13	194.26	207.12	202.52	179.91	157.30	202.52	179.91	157.30

Table 25. LCA Results 60 MPa Concrete with air (C-1)

60 MPa Concrete with air (C-1) GUL 10 SL	60 MPa Concrete with air (C-1) GUL 20 SL	60 MPa Concrete with air (C-1) GUL 30 SL	60 MPa Concrete with air (C-1) GUL 10 FA	60 MPa Concrete with air (C-1) GUL 20 FA	60 MPa Concrete with air (C-1) GUL 30 FA
Environmental impacts					
396.19	365.67	334.96	389.28	351.85	314.38
1.04E-05	1.05E-05	1.06E-05	9.27E-06	8.28E-06	7.29E-06
0.26	0.26	0.25	0.25	0.22	0.20
2.23	2.15	2.08	2.13	1.96	1.79
40.31	39.54	38.71	38.54	36.00	33.45
Use of primary resources					
337.94	309.27	280.56	335.37	304.14	272.91
2.00	3.00	4.00	5.00	6.00	7.00
1738.50	1753.99	1766.53	1634.42	1545.83	1456.51
0.00	0.00	0.00	0.00	0.00	0.00
Use of secondary resources					
0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00
141.91	126.07	110.23	141.91	126.07	110.23
0.00	0.00	0.00	0.00	0.00	0.00
Abiotic depletion potential					
846.43	853.02	858.69	834.72	829.61	823.82
1.94E-04	1.93E-04	1.91E-04	1.91E-04	1.86E-04	1.81E-04
Consumption of freshwater resources					
2.01	1.95	1.90	2.00	1.93	1.87
Waste and output flows					
0.03	0.03	0.03	0.03	0.03	0.03
17.62	15.66	13.70	17.62	15.65	13.69
3.85E-09	3.85E-09	3.85E-09	3.85E-09	3.85E-09	3.85E-09
5.25E-08	5.25E-08	5.25E-08	5.25E-08	5.25E-08	5.25E-08
0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00
Additional inventory parameters for transparency					
163.17	144.96	126.74	163.17	144.96	126.74

Table 26. LCA Results 80 MPa Concrete without air (N)

Unit		Baseline 80 MPa Concrete without air (N)	80 MPa Concrete without air (N) GU	80 MPa Concrete without air (N) GUL	80 MPa Concrete without air (N) GU/ GUb-8SF	80 MPa Concrete without air (N) GUL/ GUb-8SF	80 MPa Concrete without air (N) GUb-8SF	80 MPa Concrete without air (N) GU 10 SL	80 MPa Concrete without air (N) GU 20 SL	80 MPa Concrete without air (N) GU 30 SL	80 MPa Concrete without air (N) GU 10 FA
Environmental impacts											
GWP	kg CO ₂ eq.	485.72	515.46	476.90	497.01	477.73	478.57	478.10	439.82	401.54	470.31
ODP	kg CFC-11 eq.	1.27E-05	1.36E-05	1.15E-05	1.30E-05	1.20E-05	1.25E-05	1.35E-05	1.35E-05	1.34E-05	1.23E-05
EP	kg N eq.	0.32	0.34	0.30	0.33	0.31	0.32	0.33	0.32	0.31	0.31
AP	kg SO ₂ eq.	2.62	2.75	2.55	2.67	2.57	2.59	2.65	2.55	2.45	2.55
POCP	kg O ₃ eq.	46.89	48.95	45.43	47.74	45.98	46.53	47.81	46.58	45.36	45.82
Use of primary resources											
RPR _E	MJ, NCV	422.11	447.60	404.85	431.86	410.48	416.12	411.73	375.12	338.51	408.84
RPR _M	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
NRPR _E	MJ, NCV	2230.15	2324.53	1867.09	2264.52	2035.80	2204.51	2299.56	2271.10	2242.65	2182.19
NRPR _M	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Use of secondary resources											
SM	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RSF	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NRSF	MJ, NCV	182.54	195.18	177.98	187.37	178.77	179.57	175.96	156.37	136.78	175.96
RE	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Abiotic depletion potential											
ADPf	MJ, LHV	922.09	929.57	875.65	923.32	896.36	917.08	932.50	934.53	936.56	919.30
ADPe	kg Sb	1.93E-04	1.97E-04	1.88E-04	1.95E-04	1.90E-04	1.92E-04	1.95E-04	1.92E-04	1.90E-04	1.91E-04
Consumption of freshwater resources											
FW	m ³	2.21	2.27	2.14	2.23	2.17	2.20	2.20	2.13	2.06	2.18
Waste and output flows											
HWD	kg	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
NHWD	kg	22.87	24.46	22.09	23.48	22.29	22.50	22.05	19.60	17.16	22.05
HLRW	m ³	3.84E-09	3.84E-09	3.84E-09	3.84E-09	3.84E-09	3.84E-09	3.84E-09	3.84E-09	3.84E-09	3.84E-09
ILLRW	m ³	5.25E-08	5.25E-08	5.25E-08	5.25E-08	5.25E-08	5.25E-08	5.25E-08	5.25E-08	5.25E-08	5.25E-08
CRU	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MR	kg	0.00	0.00	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	0.00	0.00
EE	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Additional inventory parameters for transparency											
GWPCCE	kg CO ₂ eq.	237.54	254.00	204.64	243.84	219.16	233.68	228.98	203.49	177.99	228.98

Table 26. LCA Results 80 MPa Concrete without air (N)

80 MPa Concrete without air (N) GU 20 FA	80 MPa Concrete without air (N) GU 30 FA	80 MPa Concrete without air (N) GUL 10 SL	80 MPa Concrete without air (N) GUL 20 SL	80 MPa Concrete without air (N) GUL 30 SL	80 MPa Concrete without air (N) GUL 10 FA	80 MPa Concrete without air (N) GUL 20 FA	80 MPa Concrete without air (N) GUL 30 FA
Environmental impacts							
424.24	378.16	443.33	408.93	374.52	435.54	393.34	351.14
1.09E-05	9.63E-06	1.17E-05	1.19E-05	1.20E-05	1.04E-05	9.31E-06	8.19E-06
0.28	0.25	0.29	0.28	0.28	0.28	0.25	0.22
2.34	2.13	2.47	2.39	2.31	2.37	2.18	1.99
42.60	39.38	44.63	43.76	42.89	42.64	39.77	36.91
Use of primary resources							
369.33	329.82	373.19	340.87	308.54	370.29	335.08	299.86
2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00
2036.37	1890.55	1887.17	1904.63	1922.09	1769.80	1669.90	1570.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Use of secondary resources							
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
156.37	136.78	160.45	142.59	124.72	160.45	142.59	124.72
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Abiotic depletion potential							
908.13	896.96	883.89	891.33	898.77	870.69	864.93	859.17
1.85E-04	1.78E-04	1.86E-04	1.85E-04	1.83E-04	1.82E-04	1.77E-04	1.72E-04
Consumption of freshwater resources							
2.10	2.02	2.08	2.02	1.97	2.07	2.00	1.93
Waste and output flows							
0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
19.60	17.15	19.92	17.71	15.49	19.91	17.70	15.49
3.84E-09	3.84E-09	3.84E-09	3.84E-09	3.84E-09	3.84E-09	3.84E-09	3.84E-09
5.25E-08	5.25E-08	5.25E-08	5.25E-08	5.25E-08	5.25E-08	5.25E-08	5.25E-08
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Additional inventory parameters for transparency							
203.49	177.99	184.49	163.95	143.41	184.49	163.95	143.41

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