Environmental Product Declaration

In accordance with ISO 14025 ad EN 15804:2012+A2:2019

1 m^3 of Ready-Mix Concrete

EPD registration number:	**S-P-06471**
Publication date:	**2022-11-01**
Validity date:	**2027-10-31**
Geographical scope:	**India**

1. Introduction

JSW Cement, a part of the JSW Group, is India's leading green cement company with a current capacity of 17 MTPA across 7 manufacturing units. The company primarily manufactures different types of cements such as Portland Slag Cement (PSC), Ordinary Portland Cement (OPC), Composite Cement (CC) and Ground Granulated Blast-Furnace Slag (GGBS). JSW Cement has forayed into the ready-mix concrete (RMC) business which is operated through its fully owned subsidiary known as 'JSW Green Cement Private Limited'. Ready-mix concrete was first manufactured in its Dolvi unit in Maharashtra however, its first commercial unit was started in Deonar, Maharashtra.

Concrete is the most used building material on the planet and most of the infrastructure for modern civilization has been built using concrete in some form or other. Concrete has a low embodied energy and a significant number of inherent characteristics which contribute to sustainability of concrete structures. In order to improve the sustainability of all concrete structures, there is a need to understand the interactive effect of the many issues from 'cradle to grave' in the design phase, during construction and end-of-life and, most importantly, the energy savings achievable during the usage stage. Therefore, to help build environmentally sustainable structures, JSW Cement's operations are driven by considerations of durability and environmentally friendly. JSW Cement business vision has been acknowledged through various awards, Greentech Energy Conservation Award 2021 by Greentech Foundation, Iconic Brand 2021 and Best Infrastructure Brand 2021 by Economic Times. Significant Achievement in Environment Management in CII ITC Sustainability Awards 2020.

Thinkstep Sustainability Solutions Pvt. Ltd, a Sphera Company (formerly thinkstep AG). has been entrusted to conduct Life Cycle Assessment for 1 m^3 of ready-mix concrete of various grades (M-7.5 to M-60) as per the standards ISO 14040:2006 (and its amendment 14040:2006/Amd 1:2020), ISO 14044:2006 (and its amendments 14044:2006/Amd 1:2018 and 14044:2006/Amd 2:2020) along with EN15804-A2:2019 (Core rules for the product category of construction products) for the preparation of Environmental Product Declaration (EPD).

The reference period for the data used within this EPD is April 2021 to March 2022. The geographical scope of this EPD is India.

The LCA model was created using the GaBi 10.5 Software system for life cycle engineering, developed by Sphera (formerly thinkstep AG). The current document is based on Life Cycle Assessment report of 1 m^3 of ready-mix concrete and is developed for providing a measurable and verifiable input for the environmental assessment of ready-mix concrete manufactured at Dolvi, Vijaynagar and Deonar locations in India.

2. General Information

2.1 EPD, PCR, LCA Information

Table 1: EPD Information

Programme	The International EPD® System www.environdec.com	
Program operator	EPD International AB Box 210 60, SE-100 31 Stockholm, Sweden.	Indian Regional Hub www.envirodecindia.com
Declaration holder	Mr. Goutam Saha JSW Green Cement Private Limited Near MMRDA Grounds, Kolivery Village, MMRDA Area, Bandra Kurla Complex, Bandra East, Mumbai, Maharashtra 400051 Email- goutam.saha@jsw.in Web- https://www.jswcement.in/	
Product	Ready Mixed Concrete (RMC)	
CPC Code	375	
EPD registration number	S-P-06471	
Publication date	2022-11-01	
Validity date	2027-10-31	
Geographical scope	India	
Reference standards	ISO 14025:2006, ISO 14040/44, EN 15804:2012 +A2:2019, GPI 3.0	

Table 2: PCR Information

Reference PCR	PCR CONSTRUCTION PRODUCTS' Version 1.11, 2019:14
Date of Issue	2021-02-05 (Version 1.11) (VALID UNTIL: 2024-12-20)

Table 3: Verification Information

Demonstration of verification	External, independent verification
Third party verifier	Dr Hüdai Kara, Metsims Sustainability Consulting, 4 Clear Water Place, Oxford OX2 7NL, UK Email: hudai.kara@metsims.com

Table 4: LCA Information

Title	Environmental Product Declaration of Ready Mixed Concrete
Preparer	Dr. Rajesh Kumar Singh thinkstep Sustainability Solutions - a Sphera Company 707, Meadows, Sahar Plaza, Andheri Kurla Road, Andheri East, Mumbai - 400059, India Email: rsingh@sphera.com

2.2 Reference Period of EPD Data

The reference period for the data used within this EPD is April 2021 to March 2022.

2.3 Geographical Scope of EPD Application

The geographical scope of this EPD is India.

2.4 Additional Information about EPD

This EPD provides information concerning the production of Ready-Mix Concrete manufactured at all manufacturing plants throughout the country. Most of the plants have RMC certification from Quality Council of India.

Product Category Rules (PCR) for the assessment of the environmental performance of Ready-Mix Concrete is 'Construction products, 2019:14, version 1.11' and 'Sub-PCR-G Concrete and concrete elements'' complying with the standard EN 15804. Product classification is UN CPC 375 Concrete 2013:02 Version 1.02. This PCR is applicable to the product "Ready Mix Concrete". EPD of construction products may not be comparable if they do not comply with EN15804. The environmental impacts were calculated on the basis of the functional unit wherein each flow related to material consumption, energy consumption, emissions, effluent and waste is scaled to the reference flow.

3. Product Description and System Boundaries

3.1 Product Identification and Usage

Concrete is a composite material obtained through the homogenization of cement, aggregates, water and additives. Concretes covered by this EPD are constituted from cement, coarse and fine aggregates, secondary materials, recycled or fresh water and admixtures, proportioned to exceed the target strength for the respective strength classes for this EPD.

The ready-mix concrete production volume of each of the grade as presented in Table 3-1, produced across each of the ready-mix concrete plants. This EPD covers grades from M-7.5 to M-60 of ready-mix concrete produced at JSW Green Cement Pvt Ltd. There are some other grades (M-05, M-65, M-70 & M-80) are also being produced in lesser quantities which have not been included in the EPD.

Table 3-1 Grade wise Production Volume

Grade	% Contribution
M 7.5	4.24%
M 10	5.84%
M 15	1.12%
M 20	2.70%
M 25	8.29%
M 30	55.16%
M 35	6.77%
M 40	12.98%
M 45	1.31%
M 50	0.52%
M 60	0.71%

3.2 System boundaries

The environmental analysis is conducted as a 'Cradle to Grave' Life Cycle Assessment (LCA), detailed in the below-mentioned life cycle phases, being. the production of ready-mix concrete including raw material extraction, transport, manufacturing, demolition followed by end-of-life stage.

Table 3-2 System Boundary and Product Stages

Module	Product Stage
A1	Raw Material Supply
A2	Transport
A3	Manufacturing
A4	Transport
C	Demolition, Waste Processing, Disposal
D	Reuse, Recovery and Recycling

This declaration qualifies as an attributional LCA, as it describes the environmentally relevant physical flows to and from the processes associated with the life cycle of ready-mix concrete.

Exclusions:

Table 3-3: Activities outside the scope of the LCA

Activity	Reason for exclusion
Construction of capital equipment, furnace rebuild (refractories) and moulds	It is expected that these impacts will be very small when allocated across the full production.
Maintenance and operation of support equipment	It is expected that these impacts will be very small when allocated across the full production.
Human labor and employee transport	These aspects are not the central focus of the LCA and are not easily attributable to product impacts
Use phase of the product	No maintenance/consumption during use phase

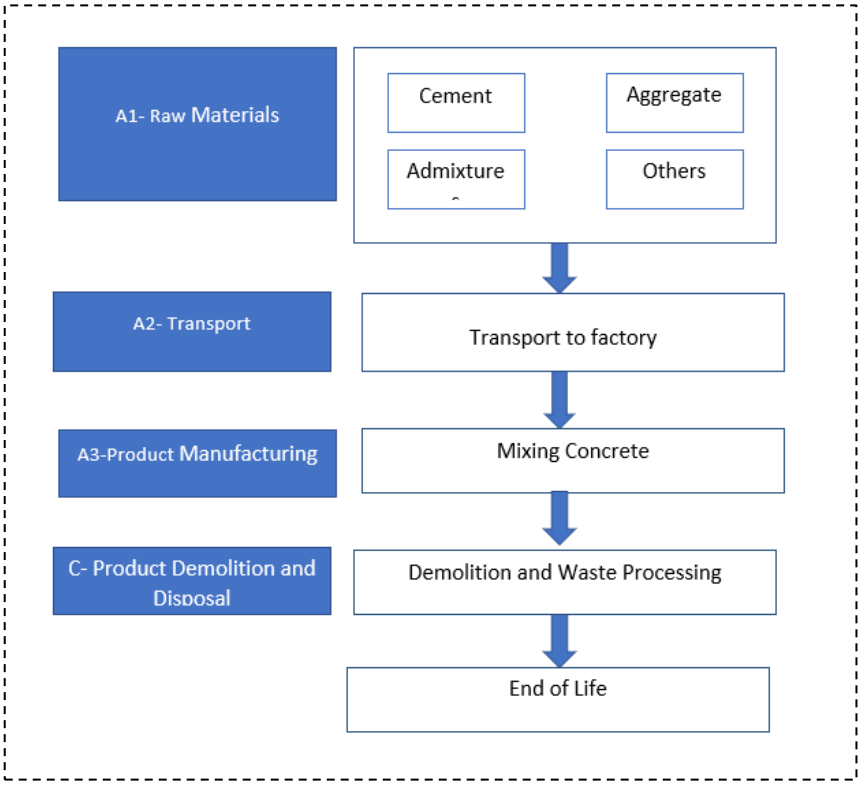


Figure 3-1 System Boundary for LCA Study

The process flow of production of cement and aggregates is considered upstream to ready mix concrete production and directly considered as materials ready for consumption in this EPD. The ingredients are blended in a mechanical mixer. Energy for the concrete production is supplied by electricity and fuel.

4. LCA

4.1 Information Sources and Data Quality

It is important that data quality is in accordance with the requirements of the declaration‘s goal and scope. This is essential to the reliability of the declaration and achievement of the intended application. The quality of the LCI data for modelling the life cycle stages at JSW Green Cement Pvt. Limited ready mix’s units have been assessed according to ISO 14044 (ISO, 2006b). Data quality is judged by its quality (measured, calculated or estimated), completeness (e.g. are there unreported emissions), consistency (degree of uniformity of the methodology applied on a study serving as a data source) and representativeness (geographical, time period, technology). To cover these requirements and to ensure reliable results, first-hand industry data in combination with consistent, upstream LCA information is used. The datasets have been used in LCA-models worldwide for several years in industrial and scientific applications for internal as well as critically reviewed studies. In the process of providing these datasets, they have been crosschecked with other databases and values from industry and science.

JSW Green Cement Pvt Ltd ready mix provided the most accurate and representative data for ready mix concrete production. For all data requirements, primary data were used where possible, and finally upstream LCA data from GaBi 10.5 professional database was used.

4.2 Methodological Details

4.2.1 Declared unit

The declared unit for the EPD is 1m^3 of ready-mix concrete.

4.2.2 Selection of application of LCIA categories

A list of relevant impact categories and category indicators is defined and associated with the inventory data. The methods that have been selected for evaluation of environmental impacts are mentioned in (Table 4-1). These indicators are scientifically and technically valid.

The environmental impact per declared unit for the following environmental impact categories were reported in the EPD according to the mentioned PCR in modular format of A-D. EN 15804:2012+A2:2019. The same has been used and documented below.

Table 4-1 Environmental Impacts Indicators for EN15804+A2:2019

Impact category	Indicator	Unit
Climate change – total	Global Warming Potential total (GWP-total)	kg CO_2 eq.
Climate change - fossil	Global Warming Potential fossil fuels (GWP-fossil)	kg CO_2 eq.
Climate change - biogenic	Global Warming Potential biogenic (GWP-biogenic)	kg CO_2 eq.
Climate change - luluc	Global Warming Potential land use and land use change (GWP-luluc)	kg CO_2 eq.
Ozone Depletion	Depletion potential of the stratospheric ozone layer (ODP)	kg CFC-11 eq.
Acidification	Acidification potential, Accumulated Exceedance (AP)	Mole of H+ eq.
Eutrophication aquatic freshwater	Eutrophication potential, fraction of nutrients reaching freshwater end compartment (EP-freshwater)	kg P eq.
Eutrophication aquatic marine	Eutrophication potential, fraction of nutrients reaching marine end compartment (EP-marine)	kg N eq.
Eutrophication terrestrial	Eutrophication potential, Accumulated Exceedance (EP-terrestrial)	Mole of N eq.
Photochemical ozone formation	Formation potential of tropospheric ozone (POCP)	kg NMVOC eq.
Depletion of abiotic resources - minerals and metals	Abiotic depletion potential for non-fossil resources (ADP-minerals & metals)	kg Sb eq.
Depletion of abiotic resources - fossil fuels	Abiotic depletion for fossil resources potential (ADP-fossil)	MJ
Water use	Water (user) deprivation potential, deprivation-weighted water consumption (WDP)	m^3 world equiv.

Table 4-2 Resources Use Parameters

Parameter	Unit
Renewable primary energy as energy carrier (PERE)	MJ
Renewable primary energy resources as material utilization (PERM)	MJ
Total use of renewable primary energy resources (PERT)	MJ
Non-renewable primary energy as energy carrier (PENRE)	MJ
Non-renewable primary energy as material utilization (PENRM)	MJ
Total use of non-renewable primary energy resources (PENRT)	MJ
Use of secondary material (SM)	kg
Use of renewable secondary fuels (RSF)	MJ

Use of non-renewable secondary fuels (NRSF)	MJ
Net freshwater Use (FW)	m^3

Table 4-3 Output flows and waste categories parameters

Parameter	Unit
Hazardous waste disposed (HWD)	kg
Non-hazardous waste disposed (NHWD)	kg
Radioactive waste disposed (RWD)	kg
Components for re-use (CRU)	kg
Materials for recycling (MFR)	kg
Materials for energy recovery (MER)	kg
Exported electrical energy (EEE)	MJ
Exported thermal energy (EET)	MJ

Table 4-4 Additional Parameters

Impact category	Indicator	Unit
Particulate matter emissions	Potential incidence of disease due to PM emissions (PM)	Disease incidences
Ionising radiation	Potential Human exposure efficiency relative to U235 (IRP)	kBq U235 eq.
Eco-toxicity (freshwater)	Potential Comparative Toxic Unit for ecosystems (ETP-fw)	CTUe
Human toxicity, cancer effects	Potential Comparative Toxic Unit for humans (HTP-c)	CTUh
Human toxicity, non-cancer effects	Potential Comparative Toxic Unit for humans (HTP-nc)	CTUh
Land use related impacts/ Soil quality potential	Potential soil quality index (SQP)	Pt

4.3 Cut-off Criteria

Input and output data have been collected through detailed questionnaires which have been developed and refined. In practice, this means that, at least, all material flows going into the production processes (inputs) higher than 1% of the total mass flow (t) or higher than 1% of the total primary energy input (MJ) are part of the system and modelled in order to calculate elementary flows. Inputs with less than 1% of mass flow and less than 1% of the total primary energy input are also considered as all these were environmentally relevant.

4.4 Allocation

No allocation has been done. As no co-products are produced, the flow of materials and energy and the associated release of substances and energy into the environment is related exclusively to the Entropy model produced. Any allocation performed in the background processes is according to the PCR.

4.5 System Boundaries

The system boundary for ready mix concrete represents a Cradle-to-Grave, which covers production and End of life phase. The production phase includes the raw material extraction, production of the raw

materials, auxiliary material production, upstream transportation, manufacturing process of the final product. End of life phase includes waste processing for reuse, recovery or recycling and disposal.

Table 4-5 Details of system boundary included in the study

EPD Module	Life Cycle Stages	Life Cycle Sub-stages	Definitions
A1	Materials	Primary raw material production	Extraction and production of raw material in the upstream
A2	Upstream Transport	-	Transport of raw material to the manufacturing site
A3	Manufacturing	-	Preparing concrete mix
A4	Downstream Transport	-	Transport of ready-mix concrete to the construction site
C1	Deconstruction and demolition	-	Demolition of building has been considered.
C2	Transport	-	With a collection rate of 100%, the transports are carried out by truck over 50 km.
C3	Waste Processing		There is no recycling practiced so waste processing has not been considered.
C4	Disposal	-	The demolished material is considered for landfill.
D	EOL Credit	-	There is no recycling practiced so in the EoL no credit has been considered.

4.5.1 Geographic System Boundaries

The geographical coverage of this declaration covers the production of ready-mix concrete in India. Wherever possible, the country specific (India) boundaries have been adapted and other datasets were chosen from EU if no Asian Countries datasets were available.

4.5.2 Temporal System Boundaries

The data collection is related to one year of operation and the year of the data is indicated in the questionnaire for each data point. The majority of data was derived for the year 2021-22 (April 2021 to March 2022) and is believed to be representative of production of ready-mix concrete in India during this time frame.

4.5.3 Technology coverage

The exact technological configuration was used for the various process's operation of its plant for efficient performance in production and minimizing environmental impacts. It was assumed that secondary data from databases that were used for this assessment, were temporally and technologically comparable to that of primary data and within the temporal coverage already addressed.

4.6 Software and database

The LCA model was created using the GaBi 10.5 Software system for life cycle engineering, developed by Sphera Solutions. The GaBi database provides the life cycle inventory data for several of the raw and process materials obtained from the upstream system. Detailed database documentation for GaBi

datasets can be accessed at http://www.gabi-software.com/international/support/gabi/gabi-database-2021-lci-documentation.

4.7 Comparability

According to the standards, EPDs do not compare the environmental performance of products in the sector. Any comparison of the declared environmental performance of products lies outside the scope of these standards and is suggested to be feasible only if all compared declarations follow equal standard provisions.

4.8 Results

Modules of the life cycle included as per PCR is given in Table 4-6.

Table 4-6 Modules of Production life cycle included (X= Declared Module; MND = Module not declared)

Production			Installation		Use Stage							End of Life				Next Product System
Raw material supply (extrac-tion, processing, recycled mate-rial)	Transport to manufacturer	Manufacturing	Transport to building site	Installation into building	Use / application	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Deconstruction / demolition	Transport to EoL	Waste processing for reuse, re-covery or recycling	Disposal	Reuse, recovery or recycling po-tential
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
X	X	X	X	MND	MND	MND	MND	MND	MND	MND	MND	X	X	X	X	X

4.8.1 LCIA and LCI Result for M 7.5 Concrete

The LCIA results for 1 m^3 of M-7.5 concrete are given in Table 4-7 to Table 4-10.

Table 4-7 Environmental impacts for 1 m^3 of M 7.5 Concrete

Environmental impact indicators	Unit	A1-A3	A4	C1	C2	C3	C4	D
Climate Change - total	[kg CO2 eq.]	9.68E+01	3.63E+00	1.60E+00	1.42E+01	0.00E+00	3.48E+01	0.00E+00
Climate Change, fossil	[kg CO2 eq.]	9.63E+01	3.63E+00	1.60E+00	1.42E+01	0.00E+00	3.58E+01	0.00E+00
Climate Change, biogenic	[kg CO2 eq.]	4.46E-01	-1.95E-03	-1.51E-03	7.02E-03	0.00E+00	-1.06E+00	0.00E+00
Climate Change, land use and land use change	[kg CO2 eq.]	2.56E-02	1.05E-04	4.57E-05	4.10E-04	0.00E+00	6.61E-02	0.00E+00
Ozone depletion	[kg CFC-11 eq.]	9.09E-11	1.99E-13	8.70E-14	7.80E-13	0.00E+00	8.42E-11	0.00E+00
Acidification	[Mole of H+ eq.]	3.94E-01	2.84E-02	8.18E-03	8.39E-02	0.00E+00	2.54E-01	0.00E+00
Eutrophication, freshwater	[kg P eq.]	3.84E-05	7.62E-07	3.33E-07	2.98E-06	0.00E+00	6.07E-05	0.00E+00
Eutrophication, marine	[kg N eq.]	1.16E-01	1.28E-02	3.49E-03	3.74E-02	0.00E+00	6.49E-02	0.00E+00
Eutrophication, terrestrial	[Mole of N eq.]	1.27E+00	1.41E-01	3.82E-02	4.11E-01	0.00E+00	7.13E-01	0.00E+00
Photochemical ozone formation, human health	[kg NMVOC eq.]	2.72E-01	2.44E-02	9.99E-03	7.44E-02	0.00E+00	1.97E-01	0.00E+00
Resource use, mineral and metals	[kg Sb eq.]	2.82E-06	7.27E-08	3.17E-08	2.85E-07	0.00E+00	3.67E-06	0.00E+00
Resource use, fossils	[MJ]	6.80E+02	4.81E+01	2.10E+01	1.88E+02	0.00E+00	4.69E+02	0.00E+00
Water use	[m^3 world equiv.]	8.41E+00	1.15E-02	5.00E-03	4.49E-02	0.00E+00	3.93E+00	0.00E+00

Table 4-8 Resource use Indicators for 1 m^3 M 7.5 Grade Concrete

Resource use indicators	Unit	A1-A3	A4	C1	C2	C3	C4	D
Use of renewable primary energy (PERE)	[MJ]	6.72E+01	2.32E-01	1.01E-01	7.18E-01	0.00E+00	7.04E+01	0.00E+00
Use of renewable primary energy as raw materials (PERM)	[MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total use of renewable primary energy resources (PERT)	[MJ]	6.72E+01	2.32E-01	1.01E-01	7.18E-01	0.00E+00	7.04E+01	0.00E+00
Use of non-renewable primary energy (PENRE)	[MJ]	9.52E+02	4.81E+01	2.10E+01	1.88E+02	0.00E+00	4.70E+02	0.00E+00
Use of non-renewable primary energy as raw materials (PENRM)	[MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total use of non-renewable primary energy resources (PENRT)	[MJ]	9.52E+02	4.81E+01	2.10E+01	1.88E+02	0.00E+00	4.70E+02	0.00E+00
Input of secondary material (SM)	[kg]	1.04E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of renewable secondary fuels (RSF)	[m3]	3.62E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of non-renewable secondary fuels (NRSF)	[MJ]	5.42E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of net fresh water (FW)	[m3]	3.03E-01	3.90E-04	1.70E-04	1.53E-03	0.00E+00	1.19E-01	0.00E+00

Table 4-9 Waste Categories and other Indicators for 1 m^3 M 7.5 Grade Concrete

Output flows and waste categories	Unit	A1-A3	A4	C1	C2	C3	C4	D
Hazardous waste disposed (HWD)	kg	2.20E-03	1.65E-10	7.20E-11	6.46E-10	0.00E+00	2.41E-08	0.00E+00
Non-hazardous waste disposed (NHWD)	kg	3.41E+01	7.23E-04	3.15E-04	2.83E-03	0.00E+00	2.40E+03	0.00E+00
Radioactive waste disposed (RWD)	kg	1.83E-02	1.09E-05	4.75E-06	4.26E-05	0.00E+00	5.23E-03	0.00E+00
Components for re-use (CRU)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for Recycling (MFR)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for Energy Recovery (MER)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported electrical energy (EEE)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported thermal energy (EET)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 4-10: Additional Parameters for 1 m^3 M 7.5 Grade Concrete

Other Indicators	Unit	A1-A3	A4	C1	C2	C3	C4	D
Particulate matter	Disease incidences	1.27E-05	1.66E-07	9.14E-08	3.57E-07	0.00E+00	3.12E-06	0.00E+00
Ionising radiation, human health	kBq U235 eq.	2.62E+00	1.02E-03	4.44E-04	3.98E-03	0.00E+00	5.81E-01	0.00E+00
Ecotoxicity, freshwater	CTUe	5.90E+02	1.75E+01	7.64E+00	6.85E+01	0.00E+00	2.63E+02	0.00E+00
Human toxicity, cancer	CTUh	2.68E-04	3.00E-10	1.29E-10	1.16E-09	0.00E+00	4.01E-08	0.00E+00
Human toxicity, non-cancer	CTUh	5.44E-06	1.28E-08	6.72E-09	4.83E-08	0.00E+00	4.44E-06	0.00E+00
Land Use	Pt	7.24E+01	2.04E-01	8.90E-02	7.99E-01	0.00E+00	9.76E+01	0.00E+00

4.8.2 LCIA and LCI Result for M 10 Concrete

The LCIA results for 1 m^3 of M-10 concrete are given in Table 4-11 to Table 4-14.

Table 4-11: Environmental impacts for 1 m3 of M 10 Concrete

Environmental impact indicators	Unit	A1-A3	A4	C1	C2	C3	C4	D
Climate Change - total	[kg CO2 eq.]	1.00E+02	3.63E+00	1.60E+00	1.42E+01	0.00E+00	3.48E+01	0.00E+00
Climate Change, fossil	[kg CO2 eq.]	9.92E+01	3.63E+00	1.60E+00	1.42E+01	0.00E+00	3.58E+01	0.00E+00
Climate Change, biogenic	[kg CO2 eq.]	9.79E-01	-1.95E-03	-1.51E-03	7.02E-03	0.00E+00	-1.06E+00	0.00E+00
Climate Change, land use and land use change	[kg CO2 eq.]	1.49E-02	1.05E-04	4.57E-05	4.10E-04	0.00E+00	6.61E-02	0.00E+00
Ozone depletion	[kg CFC-11 eq.]	6.62E-11	1.99E-13	8.70E-14	7.80E-13	0.00E+00	8.42E-11	0.00E+00
Acidification	[Mole of H+ eq.]	4.25E-01	2.84E-02	8.18E-03	8.39E-02	0.00E+00	2.54E-01	0.00E+00
Eutrophication, freshwater	[kg P eq.]	2.64E-05	7.62E-07	3.33E-07	2.98E-06	0.00E+00	6.07E-05	0.00E+00
Eutrophication, marine	[kg N eq.]	1.11E-01	1.28E-02	3.49E-03	3.74E-02	0.00E+00	6.49E-02	0.00E+00
Eutrophication, terrestrial	[Mole of N eq.]	1.21E+00	1.41E-01	3.82E-02	4.11E-01	0.00E+00	7.13E-01	0.00E+00
Photochemical ozone formation, human health	[kg NMVOC eq.]	2.73E-01	2.44E-02	9.99E-03	7.44E-02	0.00E+00	1.97E-01	0.00E+00
Resource use, mineral and metals	[kg Sb eq.]	1.38E-06	7.27E-08	3.17E-08	2.85E-07	0.00E+00	3.67E-06	0.00E+00
Resource use, fossils	[MJ]	3.85E+02	4.81E+01	2.10E+01	1.88E+02	0.00E+00	4.69E+02	0.00E+00
Water use	[m^3 world equiv.]	5.29E+00	1.15E-02	5.00E-03	4.49E-02	0.00E+00	3.93E+00	0.00E+00

Table 4-12: Resource use Indicators for 1 m3 of M 10 Grade Concrete

Resource use indicators	Unit	A1-A3	A4	C1	C2	C3	C4	D
Use of renewable primary energy (PERE)	[MJ]	4.81E+01	2.32E-01	1.01E-01	7.18E-01	0.00E+00	7.04E+01	0.00E+00
Use of renewable primary energy as raw materials (PERM)	[MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total use of renewable primary energy resources (PERT)	[MJ]	4.81E+01	2.32E-01	1.01E-01	7.18E-01	0.00E+00	7.04E+01	0.00E+00
Use of non-renewable primary energy (PENRE)	[MJ]	7.76E+02	4.81E+01	2.10E+01	1.88E+02	0.00E+00	4.70E+02	0.00E+00
Use of non-renewable primary energy as raw materials (PENRM)	[MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total use of non-renewable primary energy resources (PENRT)	[MJ]	7.76E+02	4.81E+01	2.10E+01	1.88E+02	0.00E+00	4.70E+02	0.00E+00
Input of secondary material (SM)	[kg]	1.49E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of renewable secondary fuels (RSF)	[m3]	5.21E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of non-renewable secondary fuels (NRSF)	[MJ]	7.79E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of net fresh water (FW)	[m3]	2.54E-01	3.90E-04	1.70E-04	1.53E-03	0.00E+00	1.19E-01	0.00E+00

Table 4-13: Waste Categories and other Indicators for 1 m3 of M 10 Grade Concrete

Output flows and waste categories	Unit	A1-A3	A4	C1	C2	C3	C4	D
Hazardous waste disposed (HWD)	kg	3.38E-08	1.65E-10	7.20E-11	6.46E-10	0.00E+00	2.41E-08	0.00E+00
Non-hazardous waste disposed (NHWD)	kg	3.03E+01	7.23E-04	3.15E-04	2.83E-03	0.00E+00	2.40E+03	0.00E+00
Radioactive waste disposed (RWD)	kg	5.27E-03	1.09E-05	4.75E-06	4.26E-05	0.00E+00	5.23E-03	0.00E+00
Components for re-use (CRU)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for Recycling (MFR)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for Energy Recovery (MER)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported electrical energy (EEE)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported thermal energy (EET)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 4-14: Additional Parameters for 1 m3 of M 10 Grade Concrete

Other Indicators	Unit	A1-A3	A4	C1	C2	C3	C4	D
Particulate matter	Disease incidences	4.89E-06	1.66E-07	9.14E-08	3.57E-07	0.00E+00	3.12E-06	0.00E+00
Ionising radiation, human health	kBq U235 eq.	9.04E-01	1.02E-03	4.44E-04	3.98E-03	0.00E+00	5.81E-01	0.00E+00
Ecotoxicity, freshwater	CTUe	2.17E+02	1.75E+01	7.64E+00	6.85E+01	0.00E+00	2.63E+02	0.00E+00
Human toxicity, cancer	CTUh	6.80E-05	3.00E-10	1.29E-10	1.16E-09	0.00E+00	4.01E-08	0.00E+00
Human toxicity, non-cancer	CTUh	5.44E-06	1.28E-08	6.72E-09	4.83E-08	0.00E+00	4.44E-06	0.00E+00
Land Use	Pt	7.24E+01	2.04E-01	8.90E-02	7.99E-01	0.00E+00	9.76E+01	0.00E+00

4.8.3 LCIA and LCI Result for M 25 Concrete

The LCIA results for 1 m^3 of M-25 concrete are given in Table 4-15 to Table 4-18.

Table 4-15: Environmental impacts for 1 m^3 of M 25 Concrete

Environmental impact indicators	Unit	A1-A3	A4	C1	C2	C3	C4	D
Climate Change - total	[kg CO2 eq.]	1.71E+02	3.63E+00	1.60E+00	1.42E+01	0.00E+00	3.48E+01	0.00E+00
Climate Change, fossil	[kg CO2 eq.]	1.68E+02	3.63E+00	1.60E+00	1.42E+01	0.00E+00	3.58E+01	0.00E+00
Climate Change, biogenic	[kg CO2 eq.]	2.65E+00	-1.95E-03	-1.51E-03	7.02E-03	0.00E+00	-1.06E+00	0.00E+00
Climate Change, land use and land use change	[kg CO2 eq.]	2.84E-02	1.05E-04	4.57E-05	4.10E-04	0.00E+00	6.61E-02	0.00E+00
Ozone depletion	[kg CFC-11 eq.]	1.41E-10	1.99E-13	8.70E-14	7.80E-13	0.00E+00	8.42E-11	0.00E+00
Acidification	[Mole of H+ eq.]	6.51E-01	2.84E-02	8.18E-03	8.39E-02	0.00E+00	2.54E-01	0.00E+00
Eutrophication, freshwater	[kg P eq.]	4.96E-05	7.62E-07	3.33E-07	2.98E-06	0.00E+00	6.07E-05	0.00E+00
Eutrophication, marine	[kg N eq.]	1.64E-01	1.28E-02	3.49E-03	3.74E-02	0.00E+00	6.49E-02	0.00E+00
Eutrophication, terrestrial	[Mole of N eq.]	1.79E+00	1.41E-01	3.82E-02	4.11E-01	0.00E+00	7.13E-01	0.00E+00
Photochemical ozone formation, human health	[kg NMVOC eq.]	4.17E-01	2.44E-02	9.99E-03	7.44E-02	0.00E+00	1.97E-01	0.00E+00
Resource use, mineral and metals	[kg Sb eq.]	3.01E-06	7.27E-08	3.17E-08	2.85E-07	0.00E+00	3.67E-06	0.00E+00
Resource use, fossils	[MJ]	7.49E+02	4.81E+01	2.10E+01	1.88E+02	0.00E+00	4.69E+02	0.00E+00
Water use	[m^3 world equiv.]	8.29E+00	1.15E-02	5.00E-03	4.49E-02	0.00E+00	3.93E+00	0.00E+00

Table 4-16: Resource use Indicators for 1 m^3 of M 25 Grade Concrete

Resource use indicators	Unit	A1-A3	A4	C1	C2	C3	C4	D
Use of renewable primary energy (PERE)	[MJ]	9.22E+01	2.32E-01	1.01E-01	7.18E-01	0.00E+00	7.04E+01	0.00E+00
Use of renewable primary energy as raw materials (PERM)	[MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total use of renewable primary energy resources (PERT)	[MJ]	9.22E+01	2.32E-01	1.01E-01	7.18E-01	0.00E+00	7.04E+01	0.00E+00
Use of non-renewable primary energy (PENRE)	[MJ]	1.39E+03	4.81E+01	2.10E+01	1.88E+02	0.00E+00	4.70E+02	0.00E+00
Use of non-renewable primary energy as raw materials (PENRM)	[MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total use of non-renewable primary energy resources (PENRT)	[MJ]	1.39E+03	4.81E+01	2.10E+01	1.88E+02	0.00E+00	4.70E+02	0.00E+00
Input of secondary material (SM)	[kg]	4.18E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of renewable secondary fuels (RSF)	[m3]	8.49E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of non-renewable secondary fuels (NRSF)	[MJ]	1.27E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of net fresh water (FW)	[m3]	4.11E-01	3.90E-04	1.70E-04	1.53E-03	0.00E+00	1.19E-01	0.00E+00

Table 4-17:Waste Categories and other Indicators for 1 m^3 of M 25 Grade Concrete

Output flows and waste categories	Unit	A1-A3	A4	C1	C2	C3	C4	D
Hazardous waste disposed (HWD)	kg	2.69E-04	1.65E-10	7.20E-11	6.46E-10	0.00E+00	2.41E-08	0.00E+00
Non-hazardous waste disposed (NHWD)	kg	3.25E+01	7.23E-04	3.15E-04	2.83E-03	0.00E+00	2.40E+03	0.00E+00
Radioactive waste disposed (RWD)	kg	1.25E-02	1.09E-05	4.75E-06	4.26E-05	0.00E+00	5.23E-03	0.00E+00
Components for re-use (CRU)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for Recycling (MFR)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for Energy Recovery (MER)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported electrical energy (EEE)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported thermal energy (EET)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 4-18:Additional Parameters for 1 m^3 of M 25 Grade Concrete

Other Indicators	Unit	A1-A3	A4	C1	C2	C3	C4	D
Particulate matter	Disease incidences	7.90E-06	1.66E-07	9.14E-08	3.57E-07	0.00E+00	3.12E-06	0.00E+00
Ionising radiation, human health	kBq U235 eq.	2.12E+00	1.02E-03	4.44E-04	3.98E-03	0.00E+00	5.81E-01	0.00E+00
Ecotoxicity, freshwater	CTUe	3.49E+02	1.75E+01	7.64E+00	6.85E+01	0.00E+00	2.63E+02	0.00E+00
Human toxicity, cancer	CTUh	1.11E-04	3.00E-10	1.29E-10	1.16E-09	0.00E+00	4.01E-08	0.00E+00
Human toxicity, non-cancer	CTUh	2.56E-06	1.28E-08	6.72E-09	4.83E-08	0.00E+00	4.44E-06	0.00E+00
Land Use	Pt	4.36E+01	2.04E-01	8.90E-02	7.99E-01	0.00E+00	9.76E+01	0.00E+00

4.8.4 LCIA and LCI Result for M 30 Concrete

The LCIA results for 1 m^3 of M-30 concrete are given in Table 4-19 to Table 4-22.

Table 4-19: LCIA and LCI Result for 1 m^3 of M 30 Concrete

Environmental impact indicators	Unit	A1-A3	A4	C1	C2	C3	C4	D
Climate Change - total	[kg CO2 eq.]	2.45E+02	3.63E+00	1.60E+00	1.42E+01	0.00E+00	3.48E+01	0.00E+00
Climate Change, fossil	[kg CO2 eq.]	2.43E+02	3.63E+00	1.60E+00	1.42E+01	0.00E+00	3.58E+01	0.00E+00
Climate Change, biogenic	[kg CO2 eq.]	2.19E+00	-1.95E-03	-1.51E-03	7.02E-03	0.00E+00	-1.06E+00	0.00E+00
Climate Change, land use and land use change	[kg CO2 eq.]	2.94E-02	1.05E-04	4.57E-05	4.10E-04	0.00E+00	6.61E-02	0.00E+00
Ozone depletion	[kg CFC-11 eq.]	2.48E-10	1.99E-13	8.70E-14	7.80E-13	0.00E+00	8.42E-11	0.00E+00
Acidification	[Mole of H+ eq.]	8.17E-01	2.84E-02	8.18E-03	8.39E-02	0.00E+00	2.54E-01	0.00E+00
Eutrophication, freshwater	[kg P eq.]	6.55E-05	7.62E-07	3.33E-07	2.98E-06	0.00E+00	6.07E-05	0.00E+00
Eutrophication, marine	[kg N eq.]	2.04E-01	1.28E-02	3.49E-03	3.74E-02	0.00E+00	6.49E-02	0.00E+00
Eutrophication, terrestrial	[Mole of N eq.]	2.21E+00	1.41E-01	3.82E-02	4.11E-01	0.00E+00	7.13E-01	0.00E+00
Photochemical ozone formation, human health	[kg NMVOC eq.]	5.45E-01	2.44E-02	9.99E-03	7.44E-02	0.00E+00	1.97E-01	0.00E+00
Resource use, mineral and metals	[kg Sb eq.]	4.16E-06	7.27E-08	3.17E-08	2.85E-07	0.00E+00	3.67E-06	0.00E+00
Resource use, fossils	[MJ]	7.13E+02	4.81E+01	2.10E+01	1.88E+02	0.00E+00	4.69E+02	0.00E+00
Water use	[m^3 world equiv.]	7.42E+00	1.15E-02	5.00E-03	4.49E-02	0.00E+00	3.93E+00	0.00E+00

Table 4-20:Resource use Indicators for 1 m^3 of M 30 Grade Concrete

Resource use indicators	Unit	A1-A3	A4	C1	C2	C3	C4	D
Use of renewable primary energy (PERE)	[MJ]	1.20E+02	2.32E-01	1.01E-01	7.18E-01	0.00E+00	7.04E+01	0.00E+00
Use of renewable primary energy as raw materials (PERM)	[MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total use of renewable primary energy resources (PERT)	[MJ]	1.20E+02	2.32E-01	1.01E-01	7.18E-01	0.00E+00	7.04E+01	0.00E+00
Use of non-renewable primary energy (PENRE)	[MJ]	1.66E+03	4.81E+01	2.10E+01	1.88E+02	0.00E+00	4.70E+02	0.00E+00
Use of non-renewable primary energy as raw materials (PENRM)	[MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total use of non-renewable primary energy resources (PENRT)	[MJ]	1.66E+03	4.81E+01	2.10E+01	1.88E+02	0.00E+00	4.70E+02	0.00E+00
Input of secondary material (SM)	[kg]	4.25E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of renewable secondary fuels (RSF)	[m3]	1.06E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of non-renewable secondary fuels (NRSF)	[MJ]	1.64E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of net fresh water (FW)	[m3]	4.32E-01	3.90E-04	1.70E-04	1.53E-03	0.00E+00	1.19E-01	0.00E+00

Table 4-21:Waste Categories and other Indicators for 1 m^3 of M 30 Grade Concrete

Output flows and waste categories	Unit	A1-A3	A4	C1	C2	C3	C4	D
Hazardous waste disposed (HWD)	kg	1.07E-03	1.65E-10	7.20E-11	6.46E-10	0.00E+00	2.41E-08	0.00E+00
Non-hazardous waste disposed (NHWD)	kg	2.27E+01	7.23E-04	3.15E-04	2.83E-03	0.00E+00	2.40E+03	0.00E+00
Radioactive waste disposed (RWD)	kg	1.58E-02	1.09E-05	4.75E-06	4.26E-05	0.00E+00	5.23E-03	0.00E+00
Components for re-use (CRU)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for Recycling (MFR)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for Energy Recovery (MER)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported electrical energy (EEE)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported thermal energy (EET)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 4-22: Additional Parameters for 1 m^3 of M 30 Grade Concrete

Other Indicators	Unit	A1-A3	A4	C1	C2	C3	C4	D
Particulate matter	Disease incidences	9.34E-06	1.66E-07	9.14E-08	3.57E-07	0.00E+00	3.12E-06	0.00E+00
Ionising radiation, human health	kBq U235 eq.	2.43E+00	1.02E-03	4.44E-04	3.98E-03	0.00E+00	5.81E-01	0.00E+00
Ecotoxicity, freshwater	CTUe	4.53E+02	1.75E+01	7.64E+00	6.85E+01	0.00E+00	2.63E+02	0.00E+00
Human toxicity, cancer	CTUh	2.00E-04	3.00E-10	1.29E-10	1.16E-09	0.00E+00	4.01E-08	0.00E+00
Human toxicity, non-cancer	CTUh	4.12E-06	1.28E-08	6.72E-09	4.83E-08	0.00E+00	4.44E-06	0.00E+00
Land Use	Pt	5.83E+01	2.04E-01	8.90E-02	7.99E-01	0.00E+00	9.76E+01	0.00E+00

4.8.5 LCIA and LCI Result for M 35 Concrete

The LCIA results for 1 m^3 of M-35 concrete are given in Table 4-23 to Table 4-26.

Table 4-23:LCIA and LCI Result for 1m^3 of M 35 Concrete

Environmental impact indicators	Unit	A1-A3	A4	C1	C2	C3	C4	D
Climate Change - total	[kg CO2 eq.]	2.57E+02	3.63E+00	1.60E+00	1.42E+01	0.00E+00	3.48E+01	0.00E+00
Climate Change, fossil	[kg CO2 eq.]	2.55E+02	3.63E+00	1.60E+00	1.42E+01	0.00E+00	3.58E+01	0.00E+00
Climate Change, biogenic	[kg CO2 eq.]	2.29E+00	-1.95E-03	-1.51E-03	7.02E-03	0.00E+00	-1.06E+00	0.00E+00
Climate Change, land use and land use change	[kg CO2 eq.]	3.03E-02	1.05E-04	4.57E-05	4.10E-04	0.00E+00	6.61E-02	0.00E+00
Ozone depletion	[kg CFC-11 eq.]	3.27E-10	1.99E-13	8.70E-14	7.80E-13	0.00E+00	8.42E-11	0.00E+00
Acidification	[Mole of H+ eq.]	8.61E-01	2.84E-02	8.18E-03	8.39E-02	0.00E+00	2.54E-01	0.00E+00
Eutrophication, freshwater	[kg P eq.]	6.88E-05	7.62E-07	3.33E-07	2.98E-06	0.00E+00	6.07E-05	0.00E+00
Eutrophication, marine	[kg N eq.]	2.14E-01	1.28E-02	3.49E-03	3.74E-02	0.00E+00	6.49E-02	0.00E+00
Eutrophication, terrestrial	[Mole of N eq.]	2.32E+00	1.41E-01	3.82E-02	4.11E-01	0.00E+00	7.13E-01	0.00E+00
Photochemical ozone formation, human health	[kg NMVOC eq.]	5.71E-01	2.44E-02	9.99E-03	7.44E-02	0.00E+00	1.97E-01	0.00E+00
Resource use, mineral and metals	[kg Sb eq.]	4.25E-06	7.27E-08	3.17E-08	2.85E-07	0.00E+00	3.67E-06	0.00E+00
Resource use, fossils	[MJ]	7.35E+02	4.81E+01	2.10E+01	1.88E+02	0.00E+00	4.69E+02	0.00E+00
Water use	[m^3 world equiv.]	7.06E+00	1.15E-02	5.00E-03	4.49E-02	0.00E+00	3.93E+00	0.00E+00

Table 4-24: Resource use Indicators for 1 m^3 of M 35 Grade Concrete

Resource use indicators	Unit	A1-A3	A4	C1	C2	C3	C4	D
Use of renewable primary energy (PERE)	[MJ]	1.25E+02	2.32E-01	1.01E-01	7.18E-01	0.00E+00	7.04E+01	0.00E+00
Use of renewable primary energy as raw materials (PERM)	[MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total use of renewable primary energy resources (PERT)	[MJ]	1.25E+02	2.32E-01	1.01E-01	7.18E-01	0.00E+00	7.04E+01	0.00E+00
Use of non-renewable primary energy (PENRE)	[MJ]	1.74E+03	4.81E+01	2.10E+01	1.88E+02	0.00E+00	4.70E+02	0.00E+00
Use of non-renewable primary energy as raw materials (PENRM)	[MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total use of non-renewable primary energy resources (PENRT)	[MJ]	1.74E+03	4.81E+01	2.10E+01	1.88E+02	0.00E+00	4.70E+02	0.00E+00
Input of secondary material (SM)	[kg]	4.22E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of renewable secondary fuels (RSF)	[m3]	1.12E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of non-renewable secondary fuels (NRSF)	[MJ]	1.73E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of net fresh water (FW)	[m3]	4.59E-01	3.90E-04	1.70E-04	1.53E-03	0.00E+00	1.19E-01	0.00E+00

Table 4-25: Waste Categories and other Indicators for 1 m^3 of M 35 Grade Concrete

Output flows and waste categories	Unit	A1-A3	A4	C1	C2	C3	C4	D
Hazardous waste disposed (HWD)	kg	2.47E-03	1.65E-10	7.20E-11	6.46E-10	0.00E+00	2.41E-08	0.00E+00
Non-hazardous waste disposed (NHWD)	kg	2.30E+01	7.23E-04	3.15E-04	2.83E-03	0.00E+00	2.40E+03	0.00E+00
Radioactive waste disposed (RWD)	kg	1.63E-02	1.09E-05	4.75E-06	4.26E-05	0.00E+00	5.23E-03	0.00E+00
Components for re-use (CRU)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for Recycling (MFR)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for Energy Recovery (MER)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported electrical energy (EEE)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported thermal energy (EET)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 4-26: Additional Parameters for 1 m^3 of M 35 Grade Concrete

Other Indicators	Unit	A1-A3	A4	C1	C2	C3	C4	D
Particulate matter	Disease incidences	9.94E-06	1.66E-07	9.14E-08	3.57E-07	0.00E+00	3.12E-06	0.00E+00
Ionising radiation, human health	kBq U235 eq.	2.47E+00	1.02E-03	4.44E-04	3.98E-03	0.00E+00	5.81E-01	0.00E+00
Ecotoxicity, freshwater	CTUe	4.76E+02	1.75E+01	7.64E+00	6.85E+01	0.00E+00	2.63E+02	0.00E+00
Human toxicity, cancer	CTUh	2.09E-04	3.00E-10	1.29E-10	1.16E-09	0.00E+00	4.01E-08	0.00E+00
Human toxicity, non-cancer	CTUh	4.32E-06	1.28E-08	6.72E-09	4.83E-08	0.00E+00	4.44E-06	0.00E+00
Land Use	Pt	5.73E+01	2.04E-01	8.90E-02	7.99E-01	0.00E+00	9.76E+01	0.00E+00

4.8.6 LCIA and LCI Result for M 40 Concrete

The LCIA results for 1 m^3 of M-40 concrete are given in Table 4-27 to Table 4-30.

Table 4-27: LCIA and LCI Result for 1 m^3 of M 40 Grade Concrete

Environmental impact indicators	Unit	A1-A3	A4	C1	C2	C3	C4	D
Climate Change - total	[kg CO2 eq.]	2.56E+02	3.63E+00	1.60E+00	1.42E+01	0.00E+00	3.48E+01	0.00E+00
Climate Change, fossil	[kg CO2 eq.]	2.54E+02	3.63E+00	1.60E+00	1.42E+01	0.00E+00	3.58E+01	0.00E+00
Climate Change, biogenic	[kg CO2 eq.]	2.55E+00	-1.95E-03	-1.51E-03	7.02E-03	0.00E+00	-1.06E+00	0.00E+00
Climate Change, land use and land use change	[kg CO2 eq.]	3.27E-02	1.05E-04	4.57E-05	4.10E-04	0.00E+00	6.61E-02	0.00E+00
Ozone depletion	[kg CFC-11 eq.]	6.63E-10	1.99E-13	8.70E-14	7.80E-13	0.00E+00	8.42E-11	0.00E+00
Acidification	[Mole of H+ eq.]	9.02E-01	2.84E-02	8.18E-03	8.39E-02	0.00E+00	2.54E-01	0.00E+00
Eutrophication, freshwater	[kg P eq.]	7.80E-05	7.62E-07	3.33E-07	2.98E-06	0.00E+00	6.07E-05	0.00E+00
Eutrophication, marine	[kg N eq.]	2.27E-01	1.28E-02	3.49E-03	3.74E-02	0.00E+00	6.49E-02	0.00E+00
Eutrophication, terrestrial	[Mole of N eq.]	2.41E+00	1.41E-01	3.82E-02	4.11E-01	0.00E+00	7.13E-01	0.00E+00
Photochemical ozone formation, human health	[kg NMVOC eq.]	5.88E-01	2.44E-02	9.99E-03	7.44E-02	0.00E+00	1.97E-01	0.00E+00
Resource use, mineral and metals	[kg Sb eq.]	4.49E-06	7.27E-08	3.17E-08	2.85E-07	0.00E+00	3.67E-06	0.00E+00
Resource use, fossils	[MJ]	8.53E+02	4.81E+01	2.10E+01	1.88E+02	0.00E+00	4.69E+02	0.00E+00
Water use	[m^3 world equiv.]	6.58E+00	1.15E-02	5.00E-03	4.49E-02	0.00E+00	3.93E+00	0.00E+00

Table 4-28: Resource use Indicators for 1 m^3 of M 40 Grade Concrete

Resource use indicators	Unit	A1-A3	A4	C1	C2	C3	C4	D
Use of renewable primary energy (PERE)	[MJ]	1.29E+02	2.32E-01	1.01E-01	7.18E-01	0.00E+00	7.04E+01	0.00E+00
Use of renewable primary energy as raw materials (PERM)	[MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total use of renewable primary energy resources (PERT)	[MJ]	1.29E+02	2.32E-01	1.01E-01	7.18E-01	0.00E+00	7.04E+01	0.00E+00
Use of non-renewable primary energy (PENRE)	[MJ]	1.82E+03	4.81E+01	2.10E+01	1.88E+02	0.00E+00	4.70E+02	0.00E+00
Use of non-renewable primary energy as raw materials (PENRM)	[MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total use of non-renewable primary energy resources (PENRT)	[MJ]	1.82E+03	4.81E+01	2.10E+01	1.88E+02	0.00E+00	4.70E+02	0.00E+00
Input of secondary material (SM)	[kg]	3.87E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of renewable secondary fuels (RSF)	[m3]	1.05E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of non-renewable secondary fuels (NRSF)	[MJ]	1.63E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of net fresh water (FW)	[m3]	5.31E-01	3.90E-04	1.70E-04	1.53E-03	0.00E+00	1.19E-01	0.00E+00

Table 4-29 Waste Categories and other Indicators for 1 m^3 of M 40 Grade Concrete

Output flows and waste categories	Unit	A1-A3	A4	C1	C2	C3	C4	D
Hazardous waste disposed (HWD)	kg	9.00E-03	1.65E-10	7.20E-11	6.46E-10	0.00E+00	2.41E-08	0.00E+00
Non-hazardous waste disposed (NHWD)	kg	2.85E+01	7.23E-04	3.15E-04	2.83E-03	0.00E+00	2.40E+03	0.00E+00
Radioactive waste disposed (RWD)	kg	1.79E-02	1.09E-05	4.75E-06	4.26E-05	0.00E+00	5.23E-03	0.00E+00
Components for re-use (CRU)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for Recycling (MFR)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for Energy Recovery (MER)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported electrical energy (EEE)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported thermal energy (EET)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 4-30 Additional Parameters for 1 m^3 of M 40 Grade Concrete

Other Indicators	Unit	A1-A3	A4	C1	C2	C3	C4	D
Particulate matter	Disease incidences	1.09E-05	1.66E-07	9.14E-08	3.57E-07	0.00E+00	3.12E-06	0.00E+00
Ionising radiation, human health	kBq U235 eq.	2.57E+00	1.02E-03	4.44E-04	3.98E-03	0.00E+00	5.81E-01	0.00E+00
Ecotoxicity, freshwater	CTUe	5.03E+02	1.75E+01	7.64E+00	6.85E+01	0.00E+00	2.63E+02	0.00E+00
Human toxicity, cancer	CTUh	1.96E-04	3.00E-10	1.29E-10	1.16E-09	0.00E+00	4.01E-08	0.00E+00
Human toxicity, non-cancer	CTUh	4.15E-06	1.28E-08	6.72E-09	4.83E-08	0.00E+00	4.44E-06	0.00E+00
Land Use	Pt	5.24E+01	2.04E-01	8.90E-02	7.99E-01	0.00E+00	9.76E+01	0.00E+00

4.9 Interpretation

The interpretation of the results of 1 m^3 of concrete products (M-7.5, M-10, M-25, M-30, M-35, M-40) are presented in Table 4-31 to Table 4-36.

Table 4-31 Interpretation of most significant contributors to life cycle parameters (1m^3 M-7.5 Grade)

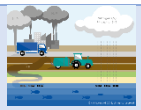
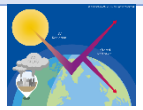
Parameter		Most significant contributor
Abiotic Depletion Potential (ADP) - Elements		The total cradle to gate impact is 2.82E-06 kg Sb eq. In A1 – A3 module. The major contribution is from aggregate (75%).
Acidification Potential (AP)		The total cradle to gate impact is 3.94E-01 Mole of H+ eq. In A1 – A3, the major contribution is from cement (64%), sand (7%), and aggregate (5%)
Eutrophication Potential (EP)		The total cradle to gate impact is 3.84E-05 kg P eq. In A1 – A3, the major contribution is from aggregate (42%), Cement (24%) and sand (16%)
Global Warming Potential (GWP 100 years)		The total cradle to gate impact is 96.798 kg CO_2 eq. The major impact is coming from A1 in which cement is contributing 70% and aggregate is contributing 16% of the GWP value.
Ozone Layer Depletion Potential (ODP, steady state)		The total cradle to gate impact is 9.09E-11 kg CFC-11 eq. In module A1 – A3, the impacts are due to admixture (61%), aggregate and cement contributing (17%).
Photochemical Ozone Creation Potential (POCP)		The total cradle to gate impact is 2.72E-01 kg NMVOC eq. In module A1 – A3, major contribution from cement (61%), aggregate (8%)
Abiotic depletion potential (ADP) - Fossil		The total cradle to gate impact is 6.80E+02 MJ. In A1- A3 module, the major contribution is from aggregate (60%) and from diesel (27%).

Table 4-32: Interpretation of most significant contributors to life cycle parameters (1m^3 M-10 Grade)

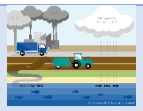
Parameter		Most significant contributor
Abiotic Depletion Potential (ADP) -Elements		The total cradle to gate impact is 1.38E-06kg Sb eq. The major contribution is from aggregate (75%).
Acidification Potential (AP)		The total cradle to gate impact is 4.25E-01 Mole of H+ eq. In A1 – A3, the major contribution is from cement (64%), sand (7%), and aggregate (5%)
Eutrophication Potential (EP)		The total cradle to gate impact is 2.64E-05kg P eq. In A1 – A3, the major contribution is from aggregate (42%), Cement (24%) and sand (16%).
Global Warming Potential (GWP 100 years)		The total cradle to gate impact is 100.200 kg CO2 eq. In A1 – A3, major contribution is from cement (70%), aggregate (16%)
Ozone Layer Depletion Potential (ODP, steady state)		The total cradle to gate impact is 6.62E-11 kg CFC-11 eq. In module A1 – A3, the impacts are due to admixture (61%), aggregate and cement contributing (17%).
Photochemical Ozone Creation Potential (POCP)		The total cradle to gate impact is 2.73E-01 kg NMVOC eq. In module A1 – A3, major contribution from cement (61%), aggregate (8%)
Abiotic depletion potential (ADP) - Fossil		The total cradle to gate impact is 3.85E+02 MJ. In A1- A3 module, the major contribution is from aggregate (60%) and from diesel (27%).

Table 4-33 Interpretation of most significant contributors to life cycle parameters (1m^3 M-25 Grade)

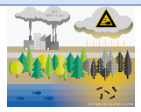
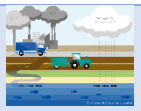
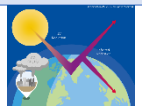
Parameter		Most significant contributor
Abiotic Depletion Potential (ADP) -Elements		The total cradle to gate impact is 3.01E-06 kg Sb eq. In A1 – A3 module. The major contribution is from aggregate (75%), followed by sand (9%).
Acidification Potential (AP)		The total cradle to gate impact is 6.05E-01 Mole of H+ eq. In A1 – A3, the major contribution is from cement (59%), sand (10%), and aggregate (5%).
Eutrophication Potential (EP)		The total cradle to gate impact is 4.96E-05 kg P eq. In A1 – A3, the major contribution is from aggregate (43%), cement (24%) and sand (22%).
Global Warming Potential (GWP 100 years)		The total cradle to gate impact is 170.922 kg CO_2 eq. In A1 – A3, major contribution is from cement (69%), aggregate (16%).
Ozone Layer Depletion Potential (ODP, steady state)		The total cradle to gate impact is 1.41E-10 kg CFC-11 eq. In module A1 – A3, the impacts are due to cement (50%), aggregate (23%) and sand (4%).
Photochemical Ozone Creation Potential (POCP)		The total cradle to gate impact is 4.17E-01 kg NMVOC eq in module A1 – A3, major contribution from cement (56%), aggregate (47%) and sand (8%).
Abiotic depletion potential (ADP) - Fossil		The total cradle to gate impact is 7.49E+02 MJ. In A1- A3 module, the major contribution is from aggregate (58%) and sand (10%).

Table 4-34 Interpretation of most significant contributors to life cycle parameters (1m^3 M-30 Grade)

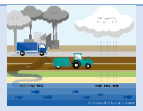
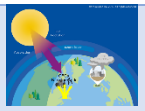
Parameter		Most significant contributor
Abiotic Depletion Potential (ADP) -Elements		The total cradle to gate impact is 4.16E-06 kg Sb eq. The major contribution is from aggregate (54%) and sand (4%)
Acidification Potential (AP)		The total cradle to gate impact is 8.17E-01 Mole of H+ eq. In A1 – A3, the major contribution is from cement (88%), sand (6%), and aggregate (4%).
Eutrophication Potential (EP)		The total cradle to gate impact is 6.55E-05 kg P eq. In A1 – A3, the major contribution is from cement (47%), aggregate (32%) and sand (11%).
Global Warming Potential (GWP 100 years)		The total cradle to gate impact is 245.459 kg CO_2 eq. In A1 – A3, major contribution is from cement (80%), aggregate (11%) and sand (2%).
Ozone Layer Depletion Potential (ODP, steady state)		The total cradle to gate impact is 2.48E-10 kg CFC-11 eq. In module A1 – A3, the impacts are due to cement (48%), aggregate (23%).
Photochemical Ozone Creation Potential (POCP)		The total cradle to gate impact is 5.45E-01 kg NMVOC eq. In module A1 – A3, major contribution from cement (87%), aggregate (7%).
Abiotic depletion potential (ADP) - Fossil		The total cradle to gate impact is 7.13E+02 MJ. In A1- A3 module, the major contribution is from aggregate (81%) and from cement (7%).

Table 4-35 Interpretation of most significant contributors to life cycle parameters (1m^3 M-35 Grade)

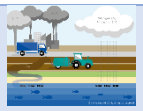
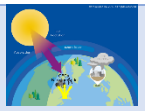
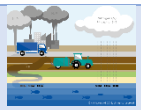
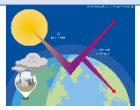
Parameter		Most significant contributor
Abiotic Depletion Potential (ADP) -Elements		The total cradle to gate impact is 4.25E-06 kg Sb eq. The major contribution is from aggregate (53%) and Cement (31%).
Acidification Potential (AP)		The total cradle to gate impact is 8.61E-01 Mole of H+ eq. In A1 – A3, the major contribution is from cement (88%), sand (6%), and aggregate (4%).
Eutrophication Potential (EP)		The total cradle to gate impact is 6.88E-05 kg P eq. In A1 – A3, the major contribution is from aggregate (31%), cement (47%) and sand (11%).
Global Warming Potential (GWP 100 years)		The total cradle to gate impact is 257.254 kg CO_2 eq. In A1 – A3, major contribution is from cement (80%), aggregate (12%).
Ozone Layer Depletion Potential (ODP, steady state)		The total cradle to gate impact is 3.27E-10 kg CFC-11 eq. In module A1 – A3, the impacts are due to cement (50%), aggregate (23%).
Photochemical Ozone Creation Potential (POCP)		The total cradle to gate impact is 5.71E-01 kg NMVOC eq. In module A1 – A3, major contribution from cement (87%), aggregate (7%).
Abiotic depletion potential (ADP) - Fossil		The total cradle to gate impact is 7.35E+02 MJ. In A1- A3 module, the major contribution is from aggregate (81%) and from cement (7%).

Table 4-36 Interpretation of most significant contributors to life cycle parameters (1m^3 M-40 Grade)

Parameter		Most significant contributor
Abiotic Depletion Potential (ADP) -Elements		The total cradle to gate impact is 4.49E-06 kg Sb eq. The major contribution is from aggregate (49%) and cement (28%).
Acidification Potential (AP)		The total cradle to gate impact is 9.02E-01 Mole of H+ eq. In A1 – A3, the major contribution is from cement (65%), aggregate (28%).
Eutrophication Potential (EP)		The total cradle to gate impact is 7.80E-05 kg P eq. In A1 – A3, the major contribution is from cement (51%), aggregate (4%) and sand (6%).
Global Warming Potential (GWP 100 years)		The total cradle to gate impact is 256.089 kg CO2 eq. In A1 – A3, major contribution is from cement (86%), aggregate (12%).
Ozone Layer Depletion Potential (ODP, steady state)		The total cradle to gate impact is 6.63E-10 kg CFC-11 eq. In module A1 – A3, the impacts are due to cement (50%), aggregate (23%).
Photochemical Ozone Creation Potential (POCP)		The total cradle to gate impact is 5.88E-01 kg NMVOC eq. In module A1 – A3, major contribution from cement (87%), aggregate (7%).
Abiotic depletion potential (ADP) - Fossil		The total cradle to gate impact is 8.53E+02 MJ. In A1- A3 module, the major contribution is from aggregate (81%) and from cement (7%).

Concluding, the study provides fair understanding of environmental impacts during the various life cycle stages of concrete production. It also identifies the hot spots in the value chain where improvement activities can be prioritised and accordingly investment can be planned. The scope covers the ecological information to be divided into raw material production (A1), transportation (A2) and Manufacturing (A3).

5. LCA Terminology

Cradle to Gate	Scope of study extends from mining of natural resources to the completed product ready for shipping from the manufacturing dispatch "gate", known as Modules A1-A3.
Cradle to Grave	Scope of study extends from mining of natural resources to manufacture, use and disposal of products at End of Life, including all Modules A-D.
End of life	Post-use phase life cycle stages involving collection and processing of materials (e.g., scrap) and recycling or disposal, known as Modules C and D.

6. Other Environmental Information

The constituent materials used within our products are responsibly sourced and we apply the principles of Sustainable Development and of Environmental Stewardship as a standard business practice in our operations. Protecting the environment by preserving non-renewable natural resources, increasing energy efficiency, reducing the environmental emissions, limiting the impact of materials transportation to and from our operations is part of our way in doing business.

Products do not contain any substances that can be included in "Candidate List of Substances of Very High Concern for Authorization" and raw materials used are not part of the EU REACH regulation.

7. References

- GaBi 10.5_2021: Dokumentation der GaBi-Datensätze der Datenbank zur Ganzheitlichen Bilanzierung. LBP, Universität Stuttgart und Sphera Solutions Pvt Ltd GmbH
- GaBi 10_2021: Software und Datenbank zur Ganzheitlichen Bilanzierung. LBP, Universität Stuttgart und Sphera Solutions Pvt Ltd GmbH
- ISO 14020:2000 Environmental labels and declarations - General principles
- ISO 14025:2006 Environmental labels and declarations - Type III environmental declarations - Principles and procedures
- ISO 14040:2006 Environmental management- Life cycle assessment - Principles and framework
- ISO 14044:2006 Environmental management - Life cycle assessment - Requirements and guidelines.
- PCR 2019:14, Product Category Rules (PCR) for 'CONSTRUCTION PRODUCT' Version 1.11

Annexure

LCIAs Resource use, Waste categories, optional indicators

LCIA and LCI Result for M-20 Concrete

Environmental impact indicators	Unit	A1-A3	A4	C1	C2	C3	C4	D
Climate Change - total	[kg CO2 eq.]	1.66E+02	3.63E+00	1.60E+00	1.42E+01	0.00E+00	3.48E+01	0.00E+00
Climate Change, fossil	[kg CO2 eq.]	1.64E+02	3.63E+00	1.60E+00	1.42E+01	0.00E+00	3.58E+01	0.00E+00
Climate Change, biogenic	[kg CO2 eq.]	2.23E+00	-1.95E-03	-1.51E-03	7.02E-03	0.00E+00	-1.06E+00	0.00E+00
Climate Change, land use and land use change	[kg CO2 eq.]	2.66E-02	1.05E-04	4.57E-05	4.10E-04	0.00E+00	6.61E-02	0.00E+00
Ozone depletion	[kg CFC-11 eq.]	3.15E-10	1.99E-13	8.70E-14	7.80E-13	0.00E+00	8.42E-11	0.00E+00
Acidification	[Mole of H+ eq.]	6.05E-01	2.84E-02	8.18E-03	8.39E-02	0.00E+00	2.54E-01	0.00E+00
Eutrophication, freshwater	[kg P eq.]	4.87E-05	7.62E-07	3.33E-07	2.98E-06	0.00E+00	6.07E-05	0.00E+00
Eutrophication, marine	[kg N eq.]	1.50E-01	1.28E-02	3.49E-03	3.74E-02	0.00E+00	6.49E-02	0.00E+00
Eutrophication, terrestrial	[Mole of N eq.]	1.60E+00	1.41E-01	3.82E-02	4.11E-01	0.00E+00	7.13E-01	0.00E+00
Photochemical ozone formation, human health	[kg NMVOC eq.]	3.82E-01	2.44E-02	9.99E-03	7.44E-02	0.00E+00	1.97E-01	0.00E+00
Resource use, mineral and metals	[kg Sb eq.]	2.92E-06	7.27E-08	3.17E-08	2.85E-07	0.00E+00	3.67E-06	0.00E+00
Resource use, fossils	[MJ]	6.98E+02	4.81E+01	2.10E+01	1.88E+02	0.00E+00	4.69E+02	0.00E+00
Water use	[m^3 world equiv.]	7.32E+00	1.15E-02	5.00E-03	4.49E-02	0.00E+00	3.93E+00	0.00E+00

Resource use Indicators for M-20 Grade Concrete

Resource use indicators	Unit	A1-A3	A4	C1	C2	C3	C4	D
Use of renewable primary energy (PERE)	[MJ]	8.95E+01	2.32E-01	1.01E-01	7.18E-01	0.00E+00	7.04E+01	0.00E+00
Use of renewable primary energy as raw materials (PERM)	[MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total use of renewable primary energy resources (PERT)	[MJ]	8.95E+01	2.32E-01	1.01E-01	7.18E-01	0.00E+00	7.04E+01	0.00E+00
Use of non-renewable primary energy (PENRE)	[MJ]	1.34E+03	4.81E+01	2.10E+01	1.88E+02	0.00E+00	4.70E+02	0.00E+00
Use of non-renewable primary energy as raw materials (PENRM)	[MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total use of non-renewable primary energy resources (PENRT)	[MJ]	1.34E+03	4.81E+01	2.10E+01	1.88E+02	0.00E+00	4.70E+02	0.00E+00
Input of secondary material (SM)	[kg]	5.07E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of renewable secondary fuels (RSF)	[m3]	8.48E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of non-renewable secondary fuels (NRSF)	[MJ]	1.27E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of net fresh water (FW)	[m3]	3.86E-01	3.90E-04	1.70E-04	1.53E-03	0.00E+00	1.19E-01	0.00E+00

Waste Categories and other Indicators for M-20 Grade Concrete

Output flows and waste categories	Unit	A1-A3	A4	C1	C2	C3	C4	D
Hazardous waste disposed (HWD)	kg	3.73E-03	1.65E-10	7.20E-11	6.46E-10	0.00E+00	2.41E-08	0.00E+00
Non-hazardous waste disposed (NHWD)	kg	2.30E+01	7.23E-04	3.15E-04	2.83E-03	0.00E+00	2.40E+03	0.00E+00
Radioactive waste disposed (RWD)	kg	1.28E-02	1.09E-05	4.75E-06	4.26E-05	0.00E+00	5.23E-03	0.00E+00
Components for re-use (CRU)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for Recycling (MFR)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for Energy Recovery (MER)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported electrical energy (EEE)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported thermal energy (EET)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Additional Indicators	Unit	A1-A3	A4	C1	C2	C3	C4	D
Particulate matter	Disease incidences	7.31E-06	1.66E-07	9.14E-08	3.57E-07	0.00E+00	3.12E-06	0.00E+00
Ionising radiation, human health	kBq U235 eq.	2.11E+00	1.02E-03	4.44E-04	3.98E-03	0.00E+00	5.81E-01	0.00E+00
Ecotoxicity, freshwater	CTUe	3.32E+02	1.75E+01	7.64E+00	6.85E+01	0.00E+00	2.63E+02	0.00E+00
Human toxicity, cancer	CTUh	1.11E-04	3.00E-10	1.29E-10	1.16E-09	0.00E+00	4.01E-08	0.00E+00
Human toxicity, non-cancer	CTUh	2.50E-06	1.28E-08	6.72E-09	4.83E-08	0.00E+00	4.44E-06	0.00E+00
Land Use	Pt	4.11E+01	2.04E-01	8.90E-02	7.99E-01	0.00E+00	9.76E+01	0.00E+00

LCIA and LCI Result for M-45 Concrete

Environmental impact indicators	Unit	A1-A3	A4	C1	C2	C3	C4	D
Climate Change - total	[kg CO2 eq.]	3.17E+02	3.63E+00	1.60E+00	1.42E+01	0.00E+00	3.48E+01	0.00E+00
Climate Change, fossil	[kg CO2 eq.]	3.15E+02	3.63E+00	1.60E+00	1.42E+01	0.00E+00	3.58E+01	0.00E+00
Climate Change, biogenic	[kg CO2 eq.]	2.76E+00	-1.95E-03	-1.51E-03	7.02E-03	0.00E+00	-1.06E+00	0.00E+00
Climate Change, land use and land use change	[kg CO2 eq.]	3.15E-02	1.05E-04	4.57E-05	4.10E-04	0.00E+00	6.61E-02	0.00E+00
Ozone depletion	[kg CFC-11 eq.]	3.59E-10	1.99E-13	8.70E-14	7.80E-13	0.00E+00	8.42E-11	0.00E+00
Acidification	[Mole of H+ eq.]	1.07E+00	2.84E-02	8.18E-03	8.39E-02	0.00E+00	2.54E-01	0.00E+00
Eutrophication, freshwater	[kg P eq.]	8.49E-05	7.62E-07	3.33E-07	2.98E-06	0.00E+00	6.07E-05	0.00E+00
Eutrophication, marine	[kg N eq.]	2.73E-01	1.28E-02	3.49E-03	3.74E-02	0.00E+00	6.49E-02	0.00E+00
Eutrophication, terrestrial	[Mole of N eq.]	2.97E+00	1.41E-01	3.82E-02	4.11E-01	0.00E+00	7.13E-01	0.00E+00
Photochemical ozone formation, human health	[kg NMVOC eq.]	7.27E-01	2.44E-02	9.99E-03	7.44E-02	0.00E+00	1.97E-01	0.00E+00
Resource use, mineral and metals	[kg Sb eq.]	5.28E-06	7.27E-08	3.17E-08	2.85E-07	0.00E+00	3.67E-06	0.00E+00
Resource use, fossils	[MJ]	8.53E+02	4.81E+01	2.10E+01	1.88E+02	0.00E+00	4.69E+02	0.00E+00
Water use	[m³ world equiv.]	9.15E+00	1.15E-02	5.00E-03	4.49E-02	0.00E+00	3.93E+00	0.00E+00

Resource use Indicators for M-45 Grade Concrete

Resource use indicators	Unit	A1-A3	A4	C1	C2	C3	C4	D
Use of renewable primary energy (PERE)	[MJ]	1.45E+02	2.32E-01	1.01E-01	7.18E-01	0.00E+00	7.04E+01	0.00E+00
Use of renewable primary energy as raw materials (PERM)	[MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total use of renewable primary energy resources (PERT)	[MJ]	1.45E+02	2.32E-01	1.01E-01	7.18E-01	0.00E+00	7.04E+01	0.00E+00
Use of non-renewable primary energy (PENRE)	[MJ]	2.03E+03	4.81E+01	2.10E+01	1.88E+02	0.00E+00	4.70E+02	0.00E+00
Use of non-renewable primary energy as raw materials (PENRM)	[MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total use of non-renewable primary energy resources (PENRT)	[MJ]	2.03E+03	4.81E+01	2.10E+01	1.88E+02	0.00E+00	4.70E+02	0.00E+00
Input of secondary material (SM)	[kg]	2.88E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of renewable secondary fuels (RSF)	[m3]	1.22E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of non-renewable secondary fuels (NRSF)	[MJ]	1.93E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of net fresh water (FW)	[m3]	4.81E-01	3.90E-04	1.70E-04	1.53E-03	0.00E+00	1.19E-01	0.00E+00

Waste Categories and other Indicators for M-45 Grade Concrete

Output flows and waste categories	Unit	A1-A3	A4	C1	C2	C3	C4	D
Hazardous waste disposed (HWD)	kg	2.20E-03	1.65E-10	7.20E-11	6.46E-10	0.00E+00	2.41E-08	0.00E+00
Non-hazardous waste disposed (NHWD)	kg	3.41E+01	7.23E-04	3.15E-04	2.83E-03	0.00E+00	2.40E+03	0.00E+00
Radioactive waste disposed (RWD)	kg	1.83E-02	1.09E-05	4.75E-06	4.26E-05	0.00E+00	5.23E-03	0.00E+00
Components for re-use (CRU)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for Recycling (MFR)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for Energy Recovery (MER)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported electrical energy (EEE)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported thermal energy (EET)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Other Indicators	Unit	A1-A3	A4	C1	C2	C3	C4	D
Particulate matter	Disease incidences	1.27E-05	1.66E-07	9.14E-08	3.57E-07	0.00E+00	3.12E-06	0.00E+00
Ionising radiation, human health	kBq U235 eq.	2.62E+00	1.02E-03	4.44E-04	3.98E-03	0.00E+00	5.81E-01	0.00E+00
Ecotoxicity, freshwater	CTUe	5.90E+02	1.75E+01	7.64E+00	6.85E+01	0.00E+00	2.63E+02	0.00E+00
Human toxicity, cancer	CTUh	2.68E-04	3.00E-10	1.29E-10	1.16E-09	0.00E+00	4.01E-08	0.00E+00
Human toxicity, non-cancer	CTUh	5.44E-06	1.28E-08	6.72E-09	4.83E-08	0.00E+00	4.44E-06	0.00E+00
Land Use	Pt	7.24E+01	2.04E-01	8.90E-02	7.99E-01	0.00E+00	9.76E+01	0.00E+00

LCIA and LCI Result for M-50 Concrete

Environmental impact indicators	Unit	A1-A3	A4	C1	C2	C3	C4	D
Climate Change - total	[kg CO2 eq.]	4.51E+02	3.63E+00	1.60E+00	1.42E+01	0.00E+00	3.48E+01	0.00E+00
Climate Change, fossil	[kg CO2 eq.]	4.49E+02	3.63E+00	1.60E+00	1.42E+01	0.00E+00	3.58E+01	0.00E+00
Climate Change, biogenic	[kg CO2 eq.]	2.40E+00	-1.95E-03	-1.51E-03	7.02E-03	0.00E+00	-1.06E+00	0.00E+00
Climate Change, land use and land use change	[kg CO2 eq.]	3.95E-02	1.05E-04	4.57E-05	4.10E-04	0.00E+00	6.61E-02	0.00E+00
Ozone depletion	[kg CFC-11 eq.]	1.33E-09	1.99E-13	8.70E-14	7.80E-13	0.00E+00	8.42E-11	0.00E+00
Acidification	[Mole of H+ eq.]	1.41E+00	2.84E-02	8.18E-03	8.39E-02	0.00E+00	2.54E-01	0.00E+00
Eutrophication, freshwater	[kg P eq.]	1.43E-04	7.62E-07	3.33E-07	2.98E-06	0.00E+00	6.07E-05	0.00E+00
Eutrophication, marine	[kg N eq.]	3.74E-01	1.28E-02	3.49E-03	3.74E-02	0.00E+00	6.49E-02	0.00E+00
Eutrophication, terrestrial	[Mole of N eq.]	3.98E+00	1.41E-01	3.82E-02	4.11E-01	0.00E+00	7.13E-01	0.00E+00
Photochemical ozone formation, human health	[kg NMVOC eq.]	9.96E-01	2.44E-02	9.99E-03	7.44E-02	0.00E+00	1.97E-01	0.00E+00
Resource use, mineral and metals	[kg Sb eq.]	8.78E-06	7.27E-08	3.17E-08	2.85E-07	0.00E+00	3.67E-06	0.00E+00
Resource use, fossils	[MJ]	1.11E+03	4.81E+01	2.10E+01	1.88E+02	0.00E+00	4.69E+02	0.00E+00
Water use	[m³ world equiv.]	6.52E+00	1.15E-02	5.00E-03	4.49E-02	0.00E+00	3.93E+00	0.00E+00

Resource use Indicators for M-50 Grade Concrete

Resource use indicators	Unit	A1-A3	A4	C1	C2	C3	C4	D
Use of renewable primary energy (PERE)	[MJ]	1.45E+02	2.32E-01	1.01E-01	7.18E-01	0.00E+00	7.04E+01	0.00E+00
Use of renewable primary energy as raw materials (PERM)	[MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total use of renewable primary energy resources (PERT)	[MJ]	1.45E+02	2.32E-01	1.01E-01	7.18E-01	0.00E+00	7.04E+01	0.00E+00
Use of non-renewable primary energy (PENRE)	[MJ]	2.03E+03	4.81E+01	2.10E+01	1.88E+02	0.00E+00	4.70E+02	0.00E+00
Use of non-renewable primary energy as raw materials (PENRM)	[MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total use of non-renewable primary energy resources (PENRT)	[MJ]	2.03E+03	4.81E+01	2.10E+01	1.88E+02	0.00E+00	4.70E+02	0.00E+00
Input of secondary material (SM)	[kg]	2.88E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of renewable secondary fuels (RSF)	[m3]	1.22E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of non-renewable secondary fuels (NRSF)	[MJ]	1.93E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of net fresh water (FW)	[m3]	4.81E-01	3.90E-04	1.70E-04	1.53E-03	0.00E+00	1.19E-01	0.00E+00

Waste Categories and other Indicators for M-50 Grade Concrete

Output flows and waste categories	Unit	A1-A3	A4	C1	C2	C3	C4	D
Hazardous waste disposed (HWD)	kg	1.84E-02	1.65E-10	7.20E-11	6.46E-10	0.00E+00	2.41E-08	0.00E+00
Non-hazardous waste disposed (NHWD)	kg	3.30E+01	7.23E-04	3.15E-04	2.83E-03	0.00E+00	2.40E+03	0.00E+00
Radioactive waste disposed (RWD)	kg	3.05E-02	1.09E-05	4.75E-06	4.26E-05	0.00E+00	5.23E-03	0.00E+00
Components for re-use (CRU)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for Recycling (MFR)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for Energy Recovery (MER)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported electrical energy (EEE)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported thermal energy (EET)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Other Indicators	Unit	A1-A3	A4	C1	C2	C3	C4	D
Particulate matter	Disease incidences	1.59E-05	1.66E-07	9.14E-08	3.57E-07	0.00E+00	3.12E-06	0.00E+00
Ionising radiation, human health	kBq U235 eq.	3.67E+00	1.02E-03	4.44E-04	3.98E-03	0.00E+00	5.81E-01	0.00E+00
Ecotoxicity, freshwater	CTUe	8.55E+02	1.75E+01	7.64E+00	6.85E+01	0.00E+00	2.63E+02	0.00E+00
Human toxicity, cancer	CTUh	4.06E-04	3.00E-10	1.29E-10	1.16E-09	0.00E+00	4.01E-08	0.00E+00
Human toxicity, non-cancer	CTUh	7.99E-06	1.28E-08	6.72E-09	4.83E-08	0.00E+00	4.44E-06	0.00E+00
Land Use	Pt	1.04E+02	2.04E-01	8.90E-02	7.99E-01	0.00E+00	9.76E+01	0.00E+00

LCIA and LCI Result for M-60 Concrete

Environmental impact indicators	Unit	A1-A3	A4	C1	C2	C3	C4	D
Climate Change - total	[kg CO2 eq.]	4.80E+02	3.63E+00	1.60E+00	1.42E+01	0.00E+00	3.48E+01	0.00E+00
Climate Change, fossil	[kg CO2 eq.]	4.79E+02	3.63E+00	1.60E+00	1.42E+01	0.00E+00	3.58E+01	0.00E+00
Climate Change, biogenic	[kg CO2 eq.]	1.68E+00	-1.95E-03	-1.51E-03	7.02E-03	0.00E+00	-1.06E+00	0.00E+00
Climate Change, land use and land use change	[kg CO2 eq.]	5.87E-02	1.05E-04	4.57E-05	4.10E-04	0.00E+00	6.61E-02	0.00E+00
Ozone depletion	[kg CFC-11 eq.]	2.67E-08	1.99E-13	8.70E-14	7.80E-13	0.00E+00	8.42E-11	0.00E+00
Acidification	[Mole of H+ eq.]	1.52E+00	2.84E-02	8.18E-03	8.39E-02	0.00E+00	2.54E-01	0.00E+00
Eutrophication, freshwater	[kg P eq.]	1.76E-04	7.62E-07	3.33E-07	2.98E-06	0.00E+00	6.07E-05	0.00E+00
Eutrophication, marine	[kg N eq.]	3.98E-01	1.28E-02	3.49E-03	3.74E-02	0.00E+00	6.49E-02	0.00E+00
Eutrophication, terrestrial	[Mole of N eq.]	4.22E+00	1.41E-01	3.82E-02	4.11E-01	0.00E+00	7.13E-01	0.00E+00
Photochemical ozone formation, human health	[kg NMVOC eq.]	1.06E+00	2.44E-02	9.99E-03	7.44E-02	0.00E+00	1.97E-01	0.00E+00
Resource use, mineral and metals	[kg Sb eq.]	1.10E-05	7.27E-08	3.17E-08	2.85E-07	0.00E+00	3.67E-06	0.00E+00
Resource use, fossils	[MJ]	1.31E+03	4.81E+01	2.10E+01	1.88E+02	0.00E+00	4.69E+02	0.00E+00
Water use	[m³ world equiv.]	8.32E+00	1.15E-02	5.00E-03	4.49E-02	0.00E+00	3.93E+00	0.00E+00

Resource use Indicators for M-60 Grade Concrete

Resource use indicators	Unit	A1-A3	A4	C1	C2	C3	C4	D
Use of renewable primary energy (PERE)	[MJ]	3.08E+02	2.32E-01	1.01E-01	7.18E-01	0.00E+00	7.04E+01	0.00E+00
Use of renewable primary energy as raw materials (PERM)	[MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total use of renewable primary energy resources (PERT)	[MJ]	3.08E+02	2.32E-01	1.01E-01	7.18E-01	0.00E+00	7.04E+01	0.00E+00
Use of non-renewable primary energy (PENRE)	[MJ]	3.69E+03	4.81E+01	2.10E+01	1.88E+02	0.00E+00	4.70E+02	0.00E+00
Use of non-renewable primary energy as raw materials (PENRM)	[MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total use of non-renewable primary energy resources (PENRT)	[MJ]	3.69E+03	4.81E+01	2.10E+01	1.88E+02	0.00E+00	4.70E+02	0.00E+00
Input of secondary material (SM)	[kg]	3.26E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of renewable secondary fuels (RSF)	[m3]	1.32E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of non-renewable secondary fuels (NRSF)	[MJ]	2.20E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of net fresh water (FW)	[m3]	7.79E-01	3.90E-04	1.70E-04	1.53E-03	0.00E+00	1.19E-01	0.00E+00

Waste Categories and other Indicators for M-60 Grade Concrete

Output flows and waste categories	Unit	A1-A3	A4	C1	C2	C3	C4	D
Hazardous waste disposed (HWD)	kg	2.07E-02	1.65E-10	7.20E-11	6.46E-10	0.00E+00	2.41E-08	0.00E+00
Non-hazardous waste disposed (NHWD)	kg	3.20E+01	7.23E-04	3.15E-04	2.83E-03	0.00E+00	2.40E+03	0.00E+00
Radioactive waste disposed (RWD)	kg	3.69E-02	1.09E-05	4.75E-06	4.26E-05	0.00E+00	5.23E-03	0.00E+00
Components for re-use (CRU)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for Recycling (MFR)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for Energy Recovery (MER)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported electrical energy (EEE)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported thermal energy (EET)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Other Indicators	**Unit**	**A1-A3**	**A4**	**C1**	**C2**	**C3**	**C4**	**D**
Particulate matter	Disease incidences	4.57E-05	1.66E-07	9.14E-08	3.57E-07	0.00E+00	3.12E-06	0.00E+00
Ionising radiation, human health	kBq U235 eq.	4.71E+00	1.02E-03	4.44E-04	3.98E-03	0.00E+00	5.81E-01	0.00E+00
Ecotoxicity, freshwater	CTUe	9.67E+02	1.75E+01	7.64E+00	6.85E+01	0.00E+00	2.63E+02	0.00E+00
Human toxicity, cancer	CTUh	4.20E-04	3.00E-10	1.29E-10	1.16E-09	0.00E+00	4.01E-08	0.00E+00
Human toxicity, non-cancer	CTUh	9.01E-06	1.28E-08	6.72E-09	4.83E-08	0.00E+00	4.44E-06	0.00E+00
Land Use	Pt	1.11E+02	2.04E-01	8.90E-02	7.99E-01	0.00E+00	9.76E+01	0.00E+00