Environmental Product Declaration

In Accordance with ISO 14025:2006 and EN 15804:2012+A2:2019

Grey & Ductile Iron Manhole with Cover

EPD registration number	Publication date	Validity date	Geographical scope
SP-06475	2023-02-26	2028-02-25	India

1 .Introduction

RBA Ferro Industries Private Limited, founded in 1986, is one of the largest manufacturers and exporters of Iron Castings in India. RBA Ferro Industries Private Limited is one of the largest manufacturer-exporter of Iron Castings in India. RBA Ferro Industries Private Limited has been manufacturing and exporting diverse range of Iron Castings, Industrial Valves, Trench Gratings, Manholes & Covers and various OEM products in both Grey & Ductile Iron offering end to end engineering solutions from Design to Delivery, RBA Ferro is having its industrial infrastructure spread across multiple locations in Eastern India (Headquartered in Kolkata), has an installed capacity of over 20,000 MT of Grey Iron and 21,000 MT of Ductile Iron Castings. Apart from being a leading exporter in North America, Africa, Western Europe and Middle East, RBA Ferro is also emerging as a dominant supplying partner in the Indian domestic market.

Thinkstep Sustainability Solutions Pvt. Ltd, a Sphera Company (formerly thinkstep AG), has been entrusted to conduct Life Cycle Assessment for RBA Ferro Industries Private Limited as per the ISO 14040/44. The LCA model was created using the GaBi ts Software system for life cycle engineering, developed by Sphera (formerly thinkstep AG).

Life Cycle Assessment approach is one of the key tools for evaluating and assessing the environmental burdens associated with resource consumption, energy consumption, emissions, effluent and solid waste generation during the life span of the product. It means the study helps in identifying the “hot-spots” with respect to various environment parameters at various stages of production process value chain.

The LCA study has been performed in accordance with the requirements of EN 15804 and Product Category Rules for ‘CONSTRUCTION PRODUCTS' Version 1.2.5, 2019:14 for preparation of Environmental Product Declaration (EPD) of construction products. The EPD is in accordance with ISO 14025 and EN 15804+A2. EPD of construction products may not be comparable if they do not comply with EN 15804+A2.

This assessment is based on credible scientific approach and will provide reliable information to various stakeholders. The audience for the LCA can be internal or external. Internal reports can be intended for sustainable product development or benchmarking the products. The target group of LCA report are Green Building Certification Program holders and Consultants, Customers, Project Developers, Statutory Agencies and Government.

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. info@environdec.com	Indian Regional Hub www.envirodecindia.com
Declaration holder[1]	Name: Harshvardhan Agarwal RBA Ferro Industries Private Limited 2/6, Sarat Bose Road, Central Plaza, Suite#808, Kolkata-700 020, [WB], India Email: harsh@rbaferro.com	
Product	Grey & Ductile Iron Manhole Cover	
CPC Code	412	
EPD registration number	S-P-06475	
Reference standards	IS0 14020:2001, ISO 14025:2006, EN 15804:2012+A2:2019	

Table 2. PCR Information

Reference PCR	'Construction Products'2019:14, Version 1.2.5
Date of Issue	2022-11-01 (VALID UNTIL: 2024-12-20)

Table 3. Verification Information

Demonstration of verification	External, independent verification
Third party verifier	Mr. Prabodha Acharya Independent verifier Mumbai, India Email: prabodha.acharya@gmail.com

Table 4. LCA Information

Title	Environmental Product Declaration of Manhole with cover
Author	Dr. Rajesh Kumar Singh Thinkstep Sustainability Solutions Pvt. Ltd., a Sphera Company 707, Meadows, Sahar Plaza, Andheri Kurla Road, Andheri East, Mumbai, India - 400059 Email: rsingh@sphera.com
Reference standards	ISO 14040/44 standard

[1] EPD owner has the sole ownership, liability, and responsibility for the EPD.

2.2. Reference Period of EPD Data

The reference period for the primary data (foreground data) used within this EPD is 1st April 2021 to 31st March 2022.The background data used in the study have been applied through GaBi datasets which are less than 5 years old.

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 for 1 piece of Grey & Ductile Iron Manhole with cover (142 kg) manufactured by RBA Ferro Industries Private Limited at its Kolkata plant in India. The EPD is in accordance with ISO 14025 and EN 15804+A2. EPD of construction products may not be comparable if they do not comply with EN 15804+A2. The Life Cycle Assessment (LCA) study carried out for developing this EPD for steel products is done as per ISO 14040 and ISO 14044 requirements.

Product Category Rules (PCR) for the assessment of the environmental performance of steel products is PCR for 'Construction Products' 2019:14, Version 1.2.5.

This PCR is applicable to the Grey & Ductile Iron Manhole with cover (142 kg) complying with the standard EN 15804+A2 (Sustainability of construction works - Environmental Product Declarations - Core rules for the product category of construction products).

3 .Product Description and System Boundaries

3.1. Product Description

The base and cover are sometimes called "castings" because they are usually made by a casting process, typically sand-casting techniques. Material required for manufacturing are a Mold and Molten metal which are casted to manufacture Manhole Product. Metal is molted in the furnace and a Mold of sand is prepared, later the molten metal is casted into the Mold and the Manhole Product is manufactured. A manhole cover or maintenance hole cover is a removable plate forming the lid over the opening of a manhole. After finishing the Manhole Product is packed and transported for the use.

The product under this study is 1 piece of Grey & Ductile Iron Manhole with cover (142 kg weight) manufactured by RBA Ferro Industries Private Limited at Kolkata, India.

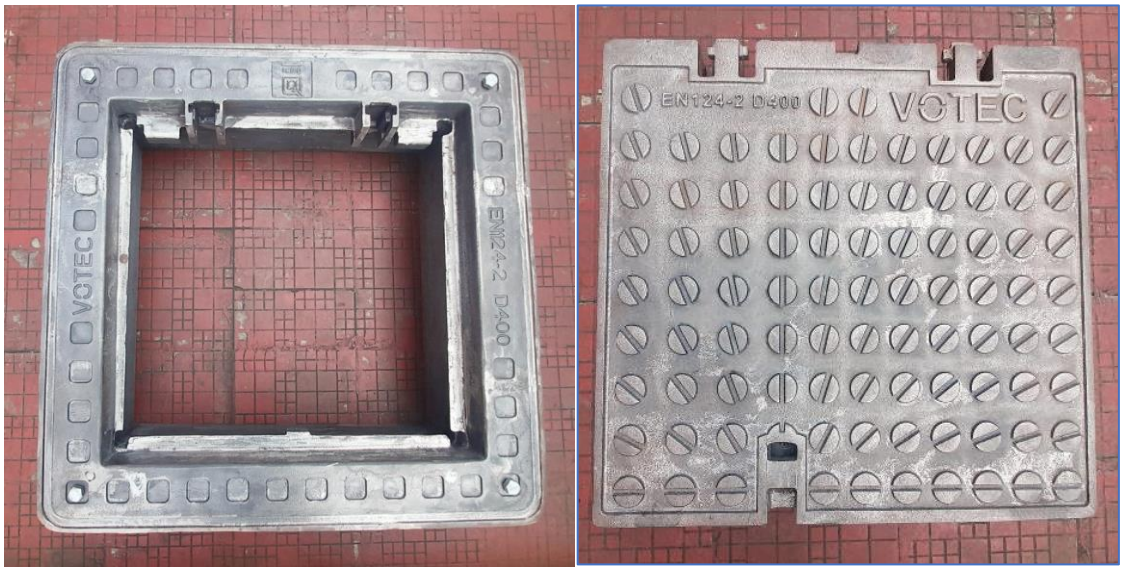


Figure 1: Manhole and its cover from RBA Ferro Industries Pvt Ltd

Dimension of RBA Ferro Manhole cover:

Width (in mm): 150 to 900.

Length (in mm): 500 to 1000.

Load Rating: BS EN 124–D400, E600 and F900.

Above product do not contain any substances that can be included in “Candidate List of Substances of Very High Concern for Authorization".

3.2. System boundary

Figure 2 given below represents system boundary diagram of the study.

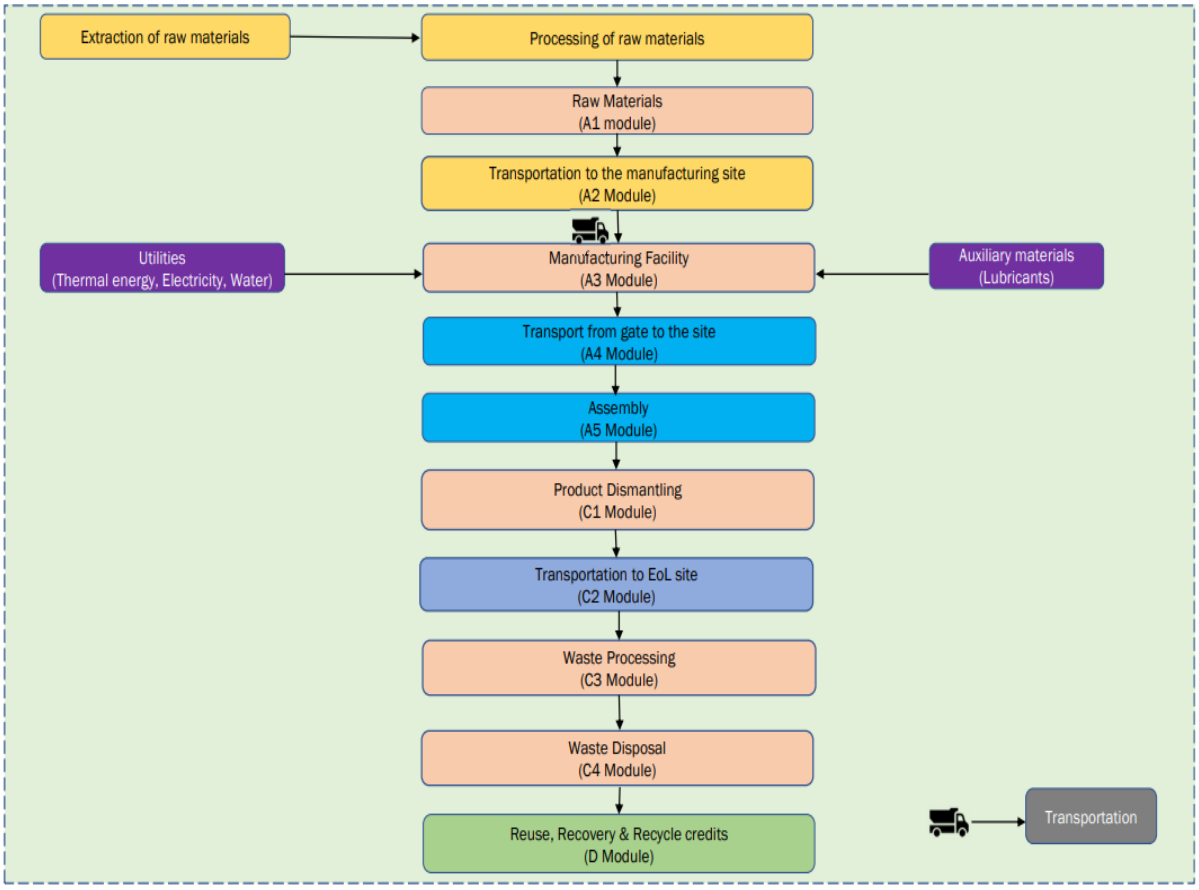


Figure 2 System boundary diagram (Cradle to grave)

3.3. Process Description

The Life Cycle of a Manhole Product begins from the mold making and metal melting in furnace, which undergoes casting process where the product is manufactured, this step is followed by finishing stage, use stage, and end of life phase (disposal).

4 .Life Cycle Assessment

4.1. Information Sources and Data Quality

It is important that data quality is in accordance with the requirements of the LCA's goal and scope. This is essential to the reliability of LCA and achievement of the intended application. The quality of the LCI data for modelling the life cycle stages have been assessed according to ISO 14040:2006. Data quality is judged by its precision (measured, calculated or estimated), completeness (e.g., are there unreported emissions?), consistency (degree of uniformity of the methodology applied on an LCA serving as a data source) and representativeness (geographical, time period, technology). Primary data collected using data collection questionnaires was used for the study and for upstream processes GaBi 10.6 professional database 2022 was used.

4.2. Methodological Details

4.2.1. Co-Product Allocation

With any multi-product system, allocation rules are defined to relate the system inputs and outputs to each of the products. Several methods are documented in ISO 14040:2006 and ISO Technical Report 14049.

4.2.2. End-of-life phase

As per net scrap (product is mainly produced from scrap) approach the recycling of the steel has not been considered in EOL. So, we have considered 100% land fill of the product in the module C4.

4.2.3. Declared unit

The declared unit for the EPD is 1 piece of Grey & Ductile iron manhole with cover (142 kg weight) manufactured by RBA Ferro Industries Private Limited at its Kolkata Plant, India.

4.2.4. Selection of application of LCIA categories

A list of relevant impact categories and category indicators is defined and associated with the inventory data. The environmental impact per declared unit for the following environmental impact categories were reported in the EPD according with EN15804+A2:2019 (Table 5), and divided into core, upstream (and downstream, if included) module.

Table 5. 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 eq.

The consumption of natural resources per declared or function unit is reported in the EPD. Input parameters, according with EN15804+A2, describing resource use are shown in Table 6.

Table 6. Natural 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 7. 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 8. 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

Criteria were set out in the original study for the recording of material flows and to avoid the need to pursue trivial inputs/outputs in the system. These are outlined below:

1. All energetic inputs to the process stages are to be recorded, including fuels, electricity, steam, and compressed air.
2. Each excluded material flow must not exceed 1% of mass, energy, or environmental relevance, for each unit process.
3. The sum of the excluded material flows in the system must not exceed 5% of mass, energy, or environmental relevance.

4.4. System Boundaries

The study is a cradle-to-grave LCA study. It covers the stages from production of raw materials to the End of Life of the product, excluding the use phase of the product. The scope covers raw material production (A1), inbound transportation (A2), manufacturing (A3), outbound transportation (A4), installation (A5), product dismantling (C1), transport of dismantled product to EoL site (C2), waste processing (C3), disposal (C4) as well as the end of life stage recycling (D) considerations. The scenarios included are currently in use and are representatives for one of the most likely scenario alternatives.

Table 9. Details of system boundary included in the study

EPD Module	Life Cycle Stages	Life Cycle Sub-Stages	Definitions
A1	Materials	Primary raw materials Production	Extraction, production of the raw materials.
A2	Upstream Transport	-	Transport of raw materials to the manufacturing unit
A3	Manufacturing	Utilities and packaging materials	Manufacturing of Grey & Ductile Manhole with cover
A4	Downstream Transport	-	Transport of finished product to the customer
A5	Installation		Treatment of packaging materials
C1	Product Dismantling	-	Dismantling of the Iron Manhole with cover
C2	Transport to EoL site	-	Transport of the dismantled product to the EoL site
C3	Waste Processing	-	Waste processing of the dismantled product
C4	Disposal	-	Disposal of the dismantled products (i.e., landfill) Net scrap method applied where in scrap generated from product end use is looped to input scrap and remaining goes to landfill
D	EoL Credit	-	The potential benefits from packaging material in module A5 are declared in module D

4.4.1. Geographic System Boundaries

The geographical coverage of this study covers the production of 1 piece of Grey & Ductile iron manhole with cover (142 kg weight) by RBA Ferro Industries Private Limited, Kolkata, India. Indian specific datasets wherever possible have been adapted and other datasets were chosen from EU if no Indian datasets were available. In addition, imported raw materials are considered along with transport. All the primary data have been collected from RBA Ferro Industries Private Limited in co-operation with experts from Sphera (formerly Thinkstep AG).

4.4.2. 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 data was derived for FY 2021-22. It is believed to be representative of production of the manhole with cover during this time frame.

4.4.3. Technology coverage

In the present study, steel scrap and pig iron are the major raw material in the production of the manhole with cover.

4.5. Software and database

The LCA model was created using the GaBi 10.6 Software system for life cycle engineering, developed by Sphera Solutions Inc. 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: https://sphera.com/product-sustainability-gabi-data-search/.

4.6. 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.

"EPDs within the same product category but registered in different EPD programmes, or not compliant with EN 15804, may not be comparable. For two EPDs to be comparable, they must be based on the same PCR (including the same version number) or be based on fully-aligned PCRs or versions of PCRs; cover products with identical functions, technical performances and use (e.g. identical declared/functional units); have equivalent system boundaries and descriptions of data; apply equivalent data quality requirements, methods of data collection, and allocation methods; apply identical cut-off rules and impact assessment methods (including the same version of characterization factors); have equivalent content declarations; and be valid at the time of comparison. For further information about comparability, see EN 15804 and ISO 14025."

4.7. Results

Modules of the life cycle included as per PCR is given in Table 10.

Table 10. Modules of the production life cycle included (X = declared module; MND = module not declared)

Production			Installation		Use stage							End-of-Life				Credits & charges outside system boundary
Raw material supply	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, recovery, recycle	Disposal	Reuse, recovery, or recycling potential
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
X	X	X	X	X	MND	MND	MND	MND	MND	MND	MND	X	X	X	X	X

4.7.1. LCIA results for 1 piece of Grey & Ductile iron manhole with cover (142 kg weight)

The LCIA results for 1 piece of Grey & Ductile iron manhole with cover (142 kg weight) is given in Table 11 to Table 15. The estimated results are only relative statements which do not indicate the end points of the impact categories, exceeding threshold values, safety margins or risks.

Table 11: Environmental impacts for 1 piece of Grey & Ductile iron manhole with cover (142 kg weight)

Parameter	Unit	A1	A2	A3	A4	A5	C1	C2	C3	C4	D
Climate Change - total	kg CO_2 eq.	1.35E+02	1.34E+00	2.48E+02	1.16E+00	2.07E-01	0.00E+00	5.83E-01	0.00E+00	2.13E+00	-9.42E-01
Climate Change, fossil	kg CO_2 eq.	1.34E+02	1.34E+00	2.48E+02	1.16E+00	1.53E-01	0.00E+00	5.82E-01	0.00E+00	2.12E+00	-9.43E-01
Climate Change, biogenic	kg CO_2 eq.	5.32E-01	-7.20E-04	-7.65E-02	1.32E-04	5.48E-02	0.00E+00	4.44E-04	0.00E+00	7.13E-03	4.13E-04
Climate Change, land use and land use change	kg CO_2 eq.	3.29E-02	3.86E-05	2.64E-01	3.35E-05	4.10E-06	0.00E+00	1.68E-05	0.00E+00	3.91E-03	-1.33E-04
Ozone depletion	kg CFC -11 eq.	3.49E-10	7.34E-14	5.99E-10	6.37E-14	3.38E-14	0.00E+00	3.19E-14	0.00E+00	4.98E-12	-2.66E-13
Acidification	Mole of H+ eq.	3.43E-01	7.79E-03	3.34E+00	6.76E-03	3.51E-05	0.00E+00	3.38E-03	0.00E+00	1.50E-02	-3.25E-03
Eutrophication, freshwater	kg P eq.	1.15E-04	2.81E-07	2.01E-04	2.44E-07	9.79E-09	0.00E+00	1.22E-07	0.00E+00	3.59E-06	-2.32E-07
Eutrophication, marine	kg N eq.	7.72E-02	3.47E-03	3.48E-01	3.01E-03	9.77E-06	0.00E+00	1.51E-03	0.00E+00	3.84E-03	-4.94E-04
Eutrophication, terrestrial	Mole of N eq.	8.38E-01	3.81E-02	3.82E+00	3.31E-02	1.46E-04	0.00E+00	1.65E-02	0.00E+00	4.22E-02	-4.77E-03
Photochemical ozone formation, human health	kg NMVOC eq.	2.47E-01	6.90E-03	1.07E+00	5.99E-03	2.81E-05	0.00E+00	2.99E-03	0.00E+00	1.17E-02	-1.80E-03
Resource use, mineral and metals	kg Sb eq.	9.71E-06	2.68E-08	1.31E-05	2.32E-08	8.79E-10	0.00E+00	1.16E-08	0.00E+00	2.17E-07	-1.97E-06
Resource use, fossils	MJ	1.61E+03	1.77E+01	2.59E+03	1.54E+01	8.27E-02	0.00E+00	7.69E+00	0.00E+00	2.78E+01	-9.07E+00
Water use	m^3 world equiv.	1.05E+01	4.22E-03	2.93E+01	3.66E-03	2.02E-02	0.00E+00	1.83E-03	0.00E+00	2.32E-01	-1.59E-01
Caption		GWP - total = global warming potential; GWP - fossil = global warming potential (fossil fuel only); GWP - biogenic = global warming potential (biogenic); GWP - luluc = global warming potential (land use only); ODP = ozone depletion; AP = acidification terrestrial and freshwater; EP - freshwater = eutrophication potential (freshwater); EP - marine = eutrophication potential (marine); EP- terrestric = eutrophication potential (terrestrial); POCP = photochemical ozone formation; ADPE = abiotic depletion potential (element), ADPF = abiotic depletion potential (fossil) WDP = water scarcity.									

Table 12. Resource use for 1 piece of Grey & Ductile iron manhole with cover (142 kg weight)

Parameter	Unit	A1	A2	A3	A4	A5	C1	C2	C3	C4	D
PERE	MJ	2.56E+02	8.56E-02	5.27E+02	7.43E-02	5.40E-01	0.00E+00	3.72E-02	0.00E+00	4.16E+00	2.23E-01
PERM	MJ	0.00E+00	0.00E+00	5.20E-01	0.00E+00	-5.20E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	2.56E+02	8.56E-02	5.27E+02	7.43E-02	1.93E-02	0.00E+00	3.72E-02	0.00E+00	4.16E+00	2.23E-01
PENRE	MJ	1.61E+03	1.77E+01	2.59E+03	1.54E+01	2.61E+00	0.00E+00	7.69E+00	0.00E+00	2.78E+01	-9.07E+00
PENRM	MJ	0.00E+00	0.00E+00	2.53E+00	0.00E+00	-2.53E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	1.61E+03	1.77E+01	2.60E+03	1.54E+01	8.28E-02	0.00E+00	7.69E+00	0.00E+00	2.78E+01	-9.07E+00
SM	kg	3.89E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m^3	3.91E-01	1.44E-04	1.01E+00	1.25E-04	4.78E-04	0.00E+00	6.24E-05	0.00E+00	7.05E-03	-3.73E-03
Caption	PERE = Use of renewable primary energy as energy; PERM = Use of renewable primary energy as raw materials; PERT = Total use of renewable primary energy resources; PENRE = Use of non-renewable primary energy as raw materials; PENRM = Use of non-renewable primary energy d as raw materials; PENRT = Total use of non-renewable primary energy resources; SM = Use of secondary material; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels; FW = Use of net fresh water										

Table 13: Output flows and waste categories for 1 piece of Grey & Ductile iron manhole with cover (142 kg weight)

Parameter	Unit	A1	A2	A3	A4	A5	C1	C2	C3	C4	D
HWD	kg	6.59E-08	6.08E-11	4.93E-07	5.28E-11	6.55E-12	0.00E+00	2.64E-11	0.00E+00	1.43E-09	-3.20E-10
NHWD	kg	9.44E-01	2.66E-04	2.69E+01	2.31E-04	9.43E-02	0.00E+00	1.16E-04	0.00E+00	1.42E+02	1.09E-01
RWD	kg	6.11E-02	4.01E-06	2.69E-02	3.48E-06	3.17E-06	0.00E+00	1.74E-06	0.00E+00	3.09E-04	-1.10E-05
CRU	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MER	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EEE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.53E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EET	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.33E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Caption	HWD = Hazardous waste disposed; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed; CRU = Components for re-use; MFR = Materials for recycling; MER = Materials for energy recovery; EEE = Exported electrical energy; EET = Exported thermal energy										

Table 14: Biogenic carbon content of product and packaging for 1 piece of Grey & Ductile iron manhole with cover (142 kg weight)

Parameter	A1	A2	A3	A4	A5	C1	C2	C3	C4	D
Biog. C in packaging (kg)	0.00E+00	0.00E+00	1.10E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Caption	Biog. C in packaging = Biogenic carbon content in packaging; Biog. C in product = Biogenic carbon content in product									

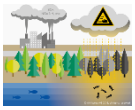
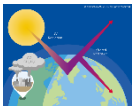
Table 15: Additional Environmental parameters for 1 piece of Grey & Ductile iron manhole with cover (142 kg weight)

Para-meter	Unit	A1	A2	A3	A4	A5	C1	C2	C3	C4	D
PM	Disease incidences	4.00E-06	3.26E-08	5.41E-05	2.83E-08	3.72E-10	0.00E+00	1.41E-08	0.00E+00	1.85E-07	-4.84E-08
IR	kBq U235 eq.	9.44E+00	3.75E-04	2.50E+00	3.25E-04	4.48E-04	0.00E+00	1.63E-04	0.00E+00	3.43E-02	1.66E-02
ETF-fw	CTUe	4.49E+02	6.45E+00	4.11E+02	5.59E+00	5.37E-02	0.00E+00	2.80E+00	0.00E+00	1.57E+01	-6.33E-01
HTP-c	CTUh	2.68E-08	1.09E-10	3.42E-08	9.50E-11	3.92E-12	0.00E+00	4.75E-11	0.00E+00	2.37E-09	-3.46E-10
HTP-nc	CTUh	1.14E-06	4.43E-09	2.14E-06	3.85E-09	3.86E-10	0.00E+00	1.92E-09	0.00E+00	2.63E-07	-1.16E-08
SQP	Pt	1.65E+02	7.52E-02	5.81E+02	6.52E-02	2.09E-02	0.00E+00	3.26E-02	0.00E+00	5.77E+00	-1.67E-01
Caption	PM = Particulate matter emissions; IR = Ionising radiation, human health; ETF= Eco-toxicity (freshwater); HTP-c = Human toxicity, cancer effects; HTP-nc = Human toxicity, non-cancer effects; SQP = Soil quality potential/Land use related impacts										

4.8 Interpretation

The interpretation of the results for 1 piece of Grey & Ductile Iron Manhole with Cover (142 kg) are presented in Table 16.

Table 16. Interpretation of most significant contributors to life cycle parameters (Manhole with cover)

Parameter		Most significant contributor
Abiotic Depletion Potential (ADP) - Elements		The total cradle to gate impact is 2.11E-05 kg Sb eq. In A1 – A3 module the electricity (~48%) followed by graphite (~16%) has the highest impacts. A total credit of 1.97E-06 kg Sb eq is taken in module D.
Acidification Potential (AP)		The total cradle to gate impact is 3.71E+00 Mole of H+ eq. In A1 – A3, the electricity (~72%) followed by Pig iron (~5%) has the highest impacts. A total credit of 3.25E-03 Mole of H+ eq is taken in module D.
Eutrophication Potential (EP)		The total cradle to gate impact is 3.20E-04 kg P eq. In A1 – A3, the electricity (~50%) followed by graphite (~19%) has the highest impacts. A total credit of 2.32E-07 kg P eq is taken in module D.
Global Warming Potential (GWP 100 years)		The total cradle to gate impact is 3.87E+02 kg CO2 eq. In A1 – A3, the electricity (~51%) followed by pig iron (~16%) has the highest impacts. A total credit of 9.42E-01 kg CO2 eq is taken in the module D.
Ozone Layer Depletion Potential (ODP, steady state)		The total cradle to gate impact is 9.53E-10 kg CFC eq. In module A1 – A3, the electricity (~50%) followed by graphite (~27%) has the highest impacts. A total credit of 2.66E-13 kg CFC-11 eq is taken in module D.
Photochemical Ozone Creation Potential (POCP)		The total cradle to gate impact is 1.35E+00 kg NMVOC eq In A1 – A3, the electricity (~63%) followed by pig iron (~10%) has the highest impacts. A total credit of 1.80E-03 kg NMVOC eq is taken in module D.
Abiotic Depletion Potential (ADP) -fossil		The total cradle to gate impact is 4.26E+03 MJ. In A1 – A3 module the electricity (~48%) followed by graphite (~15%) has the highest impacts. A total credit of 9.07E+00 MJ is taken in module D.

Concluding, the study provides fair understanding of environmental impacts during the various life cycle stages in the production of Manhole with cover. It also identifies the hotspots 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), manufacturing (A3), product dismantling (C1), transport of dismantled product to EoL site (C2), waste processing (C3), waste disposal (C4) as well as the end of life stage recycling (D) considerations.

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.

7 . References

- EN 15804: 2012+A2:2019, Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products.
- GaBi 10.6 2022: Dokumentation der GaBi-Datensätze der Datenbank zur Ganzheitlichen Bilanzierung. LBP, Universität Stuttgart und PE International, 2012
- GaBi 10.6 2022: Software und Datenbank zur Ganzheitlichen Bilanzierung. LBP, Universität Stuttgart und PE International, 2012
- 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.
- ISO/TR 14049:2012 Environmental management — Life cycle assessment — Illustrative examples on how to apply ISO 14044 to goal and scope definition and inventory analysis.
- PCR 2019:14, Product Category Rules (PCR) for 'CONSTRUCTION PRODUCT’ Version 1.2.5