ENVIRONMENTAL PRODUCT DECLARATION

Steel Rebar *from*

Raajratna Metal Industries Limited

PROGRAMME
The International EPD® System

PROGRAMME OPERATOR
EPD India

GEOGRAPHICAL SCOPE
Global

EPD REGISTRATION NUMBER
S-P-09225

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2023-07-08

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An EPD should provide current information and may be updated if conditions change. The stated validity is therefore subject to the continued registration and publication at: www.environdec.com

General Information

Programme Information

Programme: The International EPD® System
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Information about verification and reference PCR:
CEN standard EN 15804 serves as the Core Product Category Rules (PCR)

Product category rules (PCR)
Product Category Rules (PCR): <PCR 2019:14 Construction products (EN 15804:2012+A2.2019/AC:2021) Version 1.2.5 and
UN CPC code 412 products of iron or steel

PCR review was conducted by
The Technical Committee of the International EPD® System. See www.environdec.com/TC for a list of members. Review chair: Claudia A. Peña, University of Concepción, Chile. The review panel may be contacted via the Secretariat www.environdec.com/contact.

☐ EPD process verification ☑ EPD verification

Third party verifier	**Approved by**
SIPL Pvt Ltd, New Delhi, India sunil@sipl-sustainability.com	The International EPD® System Technical Committee, supported by the Secretariat

Procedure for follow-up of data during EPD validity involves third party verifier:

☐ Yes ☑ No

LCA Study & EPD Design Conducted by
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Raajratna Metal Industries Limited has the sole ownership, liability, and responsibility for the EPD. EPDs within the same product category but from different programmes may not be comparable. EPDs of construction products may not be comparable if they do not comply with EN 15804. For further information about comparability, see EN 15804 and ISO 14025.

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 characterisation factors); have equivalent content declarations; and be valid at the time of comparison. For further information about comparability, see EN 15804 and ISO 14025.

Company information

Owner of the EPD: Raajratna Metal Industries Limited
909, Sakar- III, Near Income Tax, Ahmedabad 380 014, Gujarat, India

Contact : Chetan Upadhyay, Email: abpagar@raajratna.com, certification@raajratna.com; www.raajratna.com

Description of the organisation: Raajratna Metal Industries Limited is a Manufacturer and Exporter of Stainless Steel & Nickel Alloy Wires, Bright Bars, Reinforcement-bars since 1990 in India. It is ISO 9001:2015 and ISO 14001:2015 certified by TUV Nord, IATF 16949:2016 certified company by TUV SUD and ISO 13485:2016 certified by AQC. It has manufacturing plants based in India and Indonesia and various warehouses worldwide for rapid production and supply chain in order to supply their clients in more than 60 countries in the world. The plant is built in an area of approximately 40 acres of land having construction in about one lakh square meters with more than thousand workers for carrying out the manufacturing activities in various departments viz. Production, Quality Assurance, Planning, Maintenance, Stores, HR. The plant is well equipped with the latest equipment and technologies sourced from overseas and it has installed capacity of 42000MT/Annum.

Name and location of production site(s): Ahmedabad, India

Product information

Product name: Steel Reinforcement bar/ Steel Rebar

Product identification: This study is conducted according to the guidelines of ISO 14040:2006, ISO 14044:2006, ISO 14025:2006 and the requirements given in the General Program Instructions v3.01; PCR Construction products 2019:14, version 1.2.5, by The International EPD® System and EN 15804:2012+A2:2019 as the core PCR.

Product Description: Steel bars are commonly used as reinforcement to impart tensile and shear strength to the structure since concrete is weak in tension/shear. Steel is widely used as reinforcement because its coecient of linear expansion is close to concrete. Steel reinforcing bars (Rebar) are manufactured through a hot rolling process with subsequent treatment (controlled cooling and tempering). Primary application of rebar is to strengthen concrete in end-use applications like buildings, bridges, etc. Steel Rebar is manufactured in various sizes starting from 3mm to 50 mm in Raajratna plant. They are designed and manufactured as per ASTM A 955/ SFS 1259 and UN Standards.

Field of application

- Offshore Constructions.
- Jetty Constructions.
- Bridge Constructions.
- Hospitals.

LIFE CYCLE ASSESSMENT

UN CPC code: 412 products of iron or steel

Geographical scope: India

Functional unit / Declared unit: 1 ton of Steel Rebar.

Reference service life: 50 years

Time representativeness: Primary data from the manufacturing site, suppliers and the electricity mix refer to the financial year 2022-23.

Database(s) and LCA software used: Ecoinvent v3.8 (allocation, cut-off by classification) database and SimaPro v9.4 software have been used for the LCA calculations. LCA methods used are EN 15804:A2 compliant.

Data quality and data collection

According to EN 15804:2012+A2:2019/AC:2021 specific data was used for module A3 (Processes the manufacturer has influence over) and was gathered from the Raajratna's Ahmedabad plant. Specific data includes actual product weights, amounts of raw materials used, product content, energy consumption, transport figures, water consumption and amounts of wastes. For A1 and A2 modules, according to EN 15804:2021+A2:2019/AC:2021, generic data was applied and was obtained from Ecoinvent v3.7.1

Allocation

In this study, allocation has not been applied.

Cut-off rules

Life Cycle Inventory data for a minimum of 99 % of total inflows to the three life cycle stages have been included and a cut-off rule of 1% regarding energy, mass and environmental relevance was applied. Impacts caused by treatment operations have been calculated lower than 1% environmental relevance.

Content Information

Major input materials and their weight in production of one ton of steel bar are given below

Material	Weight
Steel Alloys	900 kgs
Post-consumer Steel scrap	230 kgs
Dolomite	172 kgs

PRODUCT CHARACTERISTICS
MECHANICAL PROPERTIES

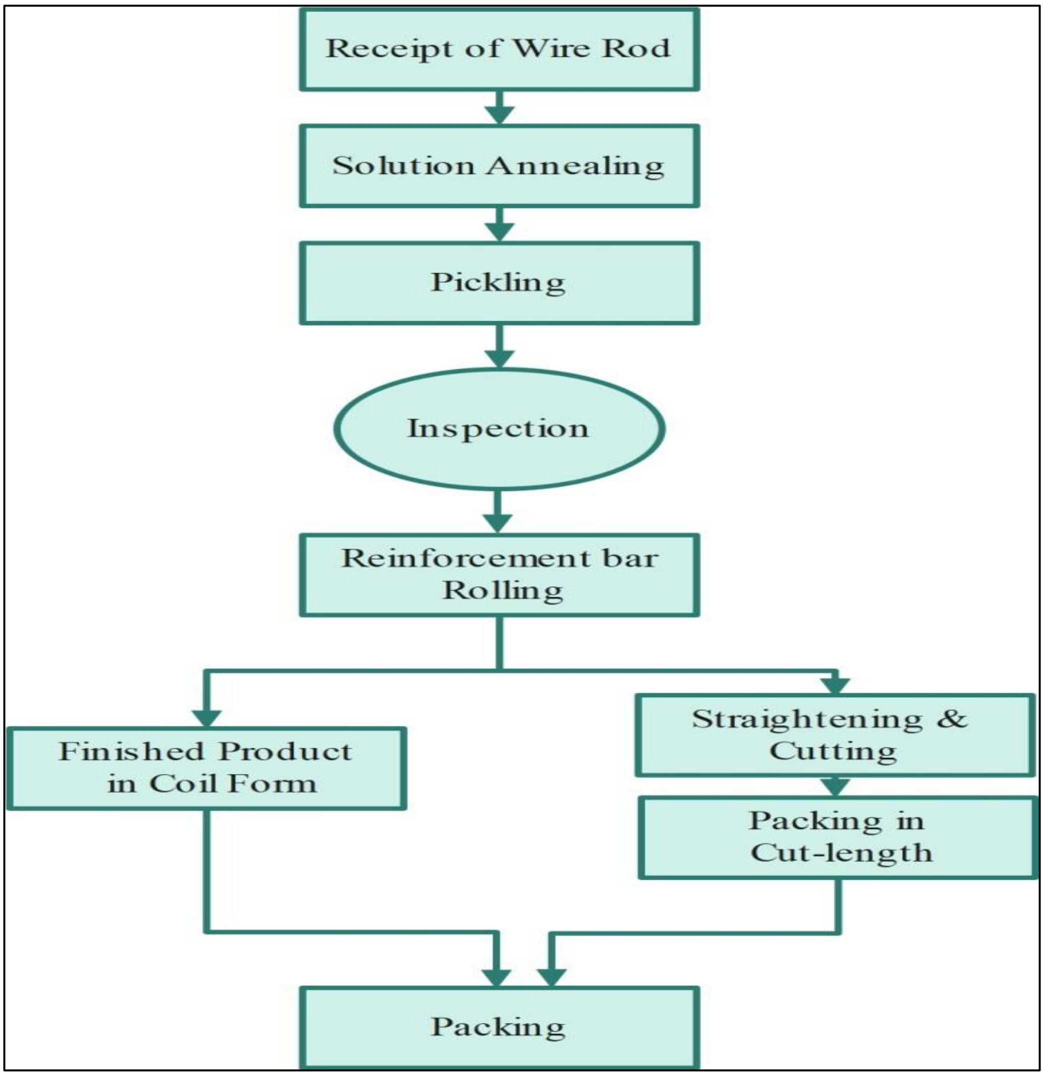
Production Process	Grade	Size in MM	Tensile Strength N/MM^2	Yield Strength N/MM^2	% Elongation A5 ≥	T.S./ 0.2% Yield ≥
Cold Drawn	1.4301-304	3 - 16	≥600	≥500	14	1.08
Cold Drawn	1.4401-316/1.4404-316L	3 - 25	≥600	≥500	14	1.10
Cold Drawn	1.4429-316LN	3 - 20	≥600	≥500	14	1.10
Cold Drawn	1.4436-316	3 - 20	≥600	≥500	14	1.10
Cold Drawn	1.4571-316Ti	3 - 25	≥600	≥500	14	1.10
Cold Drawn	1.4362 [Duplex]	3 - 25	≥600	≥600	14	1.10
Cold Drawn	1.4462 [Duplex] *	3 - 25	≥600	≥600	14	1.10
Cold Drawn	1.4301-304	16 - 25	≥600	≥500	14	1.10
Hot Rolled	1.4301-304	20 - 50	≥600	≥500	14	1.10
Hot Rolled	1.4401-316	20 - 50	≥600	≥500	14	1.10
Hot Rolled	1.4429-316LN	20 - 50	≥600	≥500	14	1.10
Hot Rolled	1.4436-316	20 - 50	≥600	≥500	14	1.10
Hot Rolled	1.4571-316Ti	20 - 50	≥600	≥500	14	1.10
Hot Rolled	1.4362 [Duplex]	20 - 50	≥600	≥500	14	1.10
Hot Rolled	1.4462 [Duplex]	20 - 50	≥600	≥500	14	1.10

CHEMICAL COMPOSITION

Production Process	Grade	C Max %	Mn Max %	P Max %	S Max %	Si Max %	Cr %	Ni %	Cu %	Mo %	N %	Ti Min %
Cold Drawn / Hot Rolled	1.4003-410L	0.030	1.50	0.040	0.030	1.00	10.50-12.50	0.30-1.00	-	-	0.30	-
Cold Drawn / Hot Rolled	1.4301-304	0.080	2.00	0.045	0.030	1.00	18.00-20.00	8.00-10.00	-	-	0.11	-
Cold Drawn / Hot Rolled	1.4401-316/1.4404-316L	0.080	2.00	0.045	0.030	1.00	16.00-18.00	10.00-14.00	-	2.00-3.00	0.11	-
Cold Drawn / Hot Rolled	1.4429-316LN (2.5 Mo)	0.030	2.00	0.045	0.015	1.00	16.50-18.50	11.00-14.00	-	2.50-3.00	0.12-0.22	-
Cold Drawn / Hot Rolled	1.4436-316 (2.5 Mo)	0.050	2.00	0.045	0.030	1.00	16.50-18.50	10.50-13.00	-	2.50-3.00	0.11	-
Cold Drawn / Hot Rolled	1.4571-316Ti	0.080	2.00	0.045	0.030	1.00	16.00-18.00	10.00-14.00	-	2.00-3.00	0.11	5xC
Cold Drawn / Hot Rolled	1.4362-2304 [Duplex]	0.030	2.00	0.030	0.020	1.00	22.00-24.00	3.50-5.50	0.10-0.60	0.10-0.60	0.05-0.20	-
Cold Drawn / Hot Rolled	1.4462-2205 [Duplex]	0.030	2.00	0.030	0.020	1.00	21.00-23.00	4.50-6.50	0.10-0.60	2.50-3.50	0.10-0.22	-

Process Flow diagram:

Process flow chart is shown below. The complete description of manufacturing is also given.



CHOICE OF REINFORCING:

The grade of reinforcement steel will depend upon type of corrosive atmosphere

- For moderate atmosphere high yield reinforcement steel like 1.4301 (304) can be used.
- For more severe corrosive atmospheres 1.4401 (316), 1.4429 (316LN), 1.4436 (316) & 1.457 (316Ti) can be used.
- For high aggressive atmospheres duplex steel 1.4362, 1.4462 (2205) is recommended.

MATERIAL PACKING DETAILS

The following items are needed to pack one ton of steel bar in cut length.

Materials	Amount
Mild Steel Strip	0.7 kg
HDPE	0.2 kg

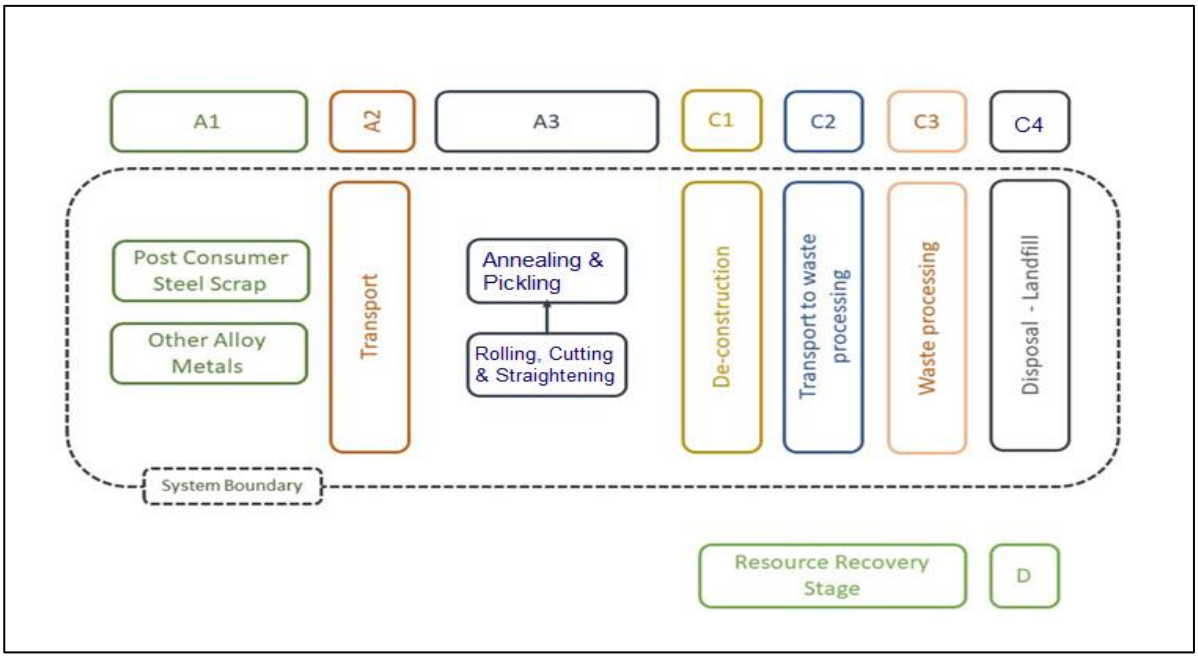
The following items are needed to pack one ton of steel bar in coils.

Materials	Amount
Mild Steel Strip	2 kg
HDPE	0.5 kg
Corrugated Tube	7.7 kg
Wooden palate	13 kg
Mild Steel carrier	17 kg

Additionally, the packing process uses 0.5 kWh of power every ton of packed steel rebar. And, 0.25 kWh of electricity is used for every ton of steel rebar that is inspected using machines.

Description of system boundaries:

System boundary is Cradle to gate with A1–A3, C1-C4 and D modules to be awarded Environmental Product Declarations (EPDs) certified by The International EPD System through third-party verification. The system boundary for one ton steel rebar is shown below.



Modules declared, geographical scope, share of specific data (in GWP-GHG indicator) and data variation:

	Product stage			Construction process stage		Use stage							End of life stage				Resource recovery stage
	Raw material supply	Transport	Manufacturing	Transport	Construction installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal	Recycling potential
Module	**A1**	**A2**	**A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
Modules declared	X	X	X	ND	ND	ND	ND	ND	ND	ND	ND	ND	X	X	X	X	X
Geography	IN/GLO	IN/GLO	IN	-	-	-	-	-	-	-	-	-	IN	IN	IN	IN	IN
Specific data used	Manufacturing Plant data taken.			-	-	-	-	-	-	-	-	-	-	-	-	-	-
Variation – products	Not relevant			-	-	-	-	-	-	-	-	-	-	-	-	-	-
Variation – sites	Not relevant			-	-	-	-	-	-	-	-	-	-	-	-	-	-

X: Declared, ND: Not declared

A1. Raw Material Supply

- Extraction and processing of raw materials
- Generation of electricity and heat from primary energy resources

A2. Transportation

- External transportation to the core processes and internal transport.

A3. Manufacturing

- Manufacturing of the construction product and co-products.
- Production of ancillary materials or pre-products.

C1. De-construction

- The dismantling of Steel Rebar has a very low impact considering the impact throughout the life of the installation.
- It is assumed that, in C1 module, same electricity and diesel is consumed as during the construction installation of steel rebar.

C2. Transport to waste processing

- An average distance of 25 kms has been assumed for the transport to sorting facility. Transport is calculated on the basis of a scenario with the parameters described in the attached table.

Parameters C2 Module	
Transport by road*	Truck >11 metric ton
Distance (km)	25
Database	Ecoinvent v3.8

**Euro 6 emission standard has been used*

C3. Waste processing for reuse, recovery and/or recycling

- The material and energy expenses required for Module C3 are negligible. It is assumed that there is no sorting or processing required for steel pipes.

C4. Final disposal

- 100% of used product after the lifetime will be collected and recycled into the manufacturing system.
- It is assumed that 15% of the product is lost during de-construction and 85% reaches recycling system. The recycling rate of steel products is assumed to be 85% based on World Steel Data.

D. Reuse, recovery or recycling

- Scrap inputs to the production stage are subtracted from scrap to be recycled at end of life in order to obtain the net scrap output from the product system. This remaining net scrap is then sent to recycling. Module D reports the environmental aspects of recycled scrap generated at the end of life minus that used at the production stage.
- This formulation is explained in the PCR section 4.5.3.
  $M_{MR\ in}$:amount of input material to the product system that has been recovered (recycled or reused) from a previous system (determined at the system boundary); in this LCA study post-consumer steel scrap.
  $M_{MR\ out}$:amount of material exiting the system that will be recovered (recycled and reused) in a subsequent system. This amount is determined at end-of-waste point and is therefore equal to the output flow of "materials to recycling [kg]" reported for module C; in this LCA study it is the 85% of the product in the end-of-life section,
- According to the PCR; Y is a process-specific material yield calculated as follows;
  - Y the material yield, between point of end-of-waste (M-EoW) in stage C and point of substitution (M-DoS) in module D (when the material has been upgraded)
  - Y = M-DoS / M-EoW

This LCA and the EPD only cover the Cradle to Gate with options A1-3 and C1-4 and D stages because other stages are very dependent on particular scenarios and are better developed for specific building or construction works.

Environmental Information

The following table shows the environmental impact of 1 ton of Steel Rebar.

Potential environmental impact – mandatory indicators according to EN 15804

Impact category	Unit	A1	A2	A3	Total [A1+A2+A3]	C1	C2	C3	C4	D
Climate change - Total	kg CO2 eq	2508.87	46.58	207.44	2762.88	1.01	2.00	3.82	0.95	-2245.07
Ozone depletion	kg CFC11 eq	5.26E-05	7.77E-06	1.20E-05	0.00	1.41E-06	3.97E-07	2.78E-07	2.64E-08	-5.72E-05
Photochemical ozone formation	kg NMVOC eq	10.05	0.52	0.60	11.17	0.00	0.02	0.01	0.01	-9.82
Acidification	mol H+ eq	32.20	0.40	1.24	33.84	0.01	0.02	0.03	0.01	-28.34
Eutrophication, freshwater	kg P eq	0.70	0.00	0.04	0.74	0.00	0.00	0.01	0.00	-0.59
Eutrophication, marine	kg N eq	2.88	0.20	0.19	3.27	0.00	0.01	0.01	0.00	-2.94
Eutrophication, terrestrial	mol N eq	29.15	2.16	3.28	34.59	0.01	0.09	0.06	0.03	-30.19
Ecotoxicity, freshwater	CTUe	43353.22	218.40	3906.01	47477.63	39.78	5.44	124.40	9.23	-37201
Water use	m3 depriv.	687414	0.71	47672	735087.0	0.13	0.04	721.05	1.00	-584303
Depletion of abiotic resources - fossil fuels	MJ	26232.27	409.24	2164.54	28806.04	74.67	20.79	43.07	22.71	-22955
Depletion of abiotic resources - minerals & metals	kg Sb eq	0.0609	1.33E-06	0.0011	0.06	2.43E-07	6.23E-08	1.19E-05	1.26E-06	-0.0518
Climate change - Fossil	kg CO2 eq	2504.97	46.56	232.56	2784.10	1.00	2.00	3.58	0.95	-2241.73
Climate change - Biogenic	kg CO2 eq	1.41	0.02	-25.45	-24.02	0.00	0.00	-0.99	0.00	-1.22
Climate change - Land use and LU change	kg CO2 eq	2.06	0.00	0.21	2.27	0.00	0.00	1.23	0.00	-1.75

Potential environmental impact – additional mandatory and voluntary indicators

Use of resources

Indicator	Unit	Total	A1	A2	A3	C1	C2	C3	C4	D
Use of non-renewable primary energy resources used as raw materials	MJ	6380.92	27739.96	435.27	2313.30	79.42	22.11	45.51	24.24	-24278.89
Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials	MJ	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
Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials)	MJ	6380.92	27739.96	435.27	2313.30	79.42	22.11	45.51	24.24	-24278.89
Use of renewable primary energy resources used as raw materials	MJ	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
Use of renewable primary energy excluding renewable primary energy resources used as raw materials	MJ	1080.06	4901.87	1.1856	306.075	0.2163	0.0560	38.97	0.1923	-4168.50
Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials)	MJ	1080.06	4901.87	1.1856	306.076	0.2163	0.0560	38.97	0.1923	-4168.50
Net Use of Freshwater	m3	5151.19	23368.29	0.0248	1621.39	0.0045	0.0013	24.55	0.0239	-19863.09

Waste production

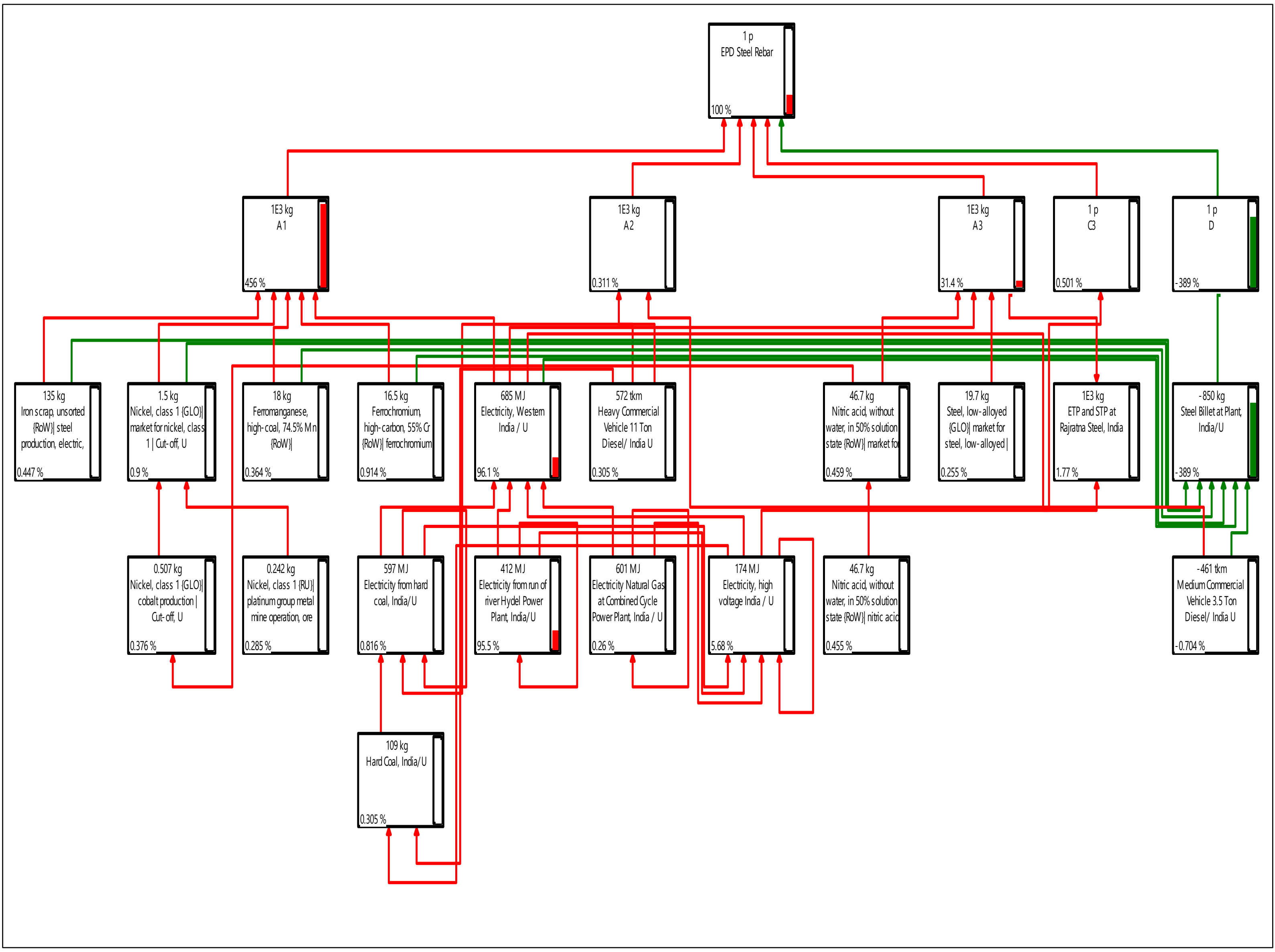
Impact category	Unit	Total	A1	A2	A3	C1	C2	C3	C4	D
Hazardous waste disposed	kg	0.5905	0.8682	0.8676	0.7904	0.158	0.0378	0.0012	0.0001	-2.1332
Non-Hazardous waste disposed	kg	342.35	969.40	0.0669	46.52	0.012	0.0031	0.4799	149.96	-824.09
Radioactive waste disposed	Kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Output flows

Impact category	Unit	Total	A1	A2	A3	C1	C2	C3	C4	D
Components for reuse	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
Exported Energy	MJ	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
Materials for energy recovery	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
Materials for recycling	Kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.50E+02	0.00E+00	0.00E+00

INTERPRETATION

The Network Flow diagram for climate change impact category is shown below.



***Note:** The Red line defines emission concentration of each process flow, based on thickness of the line emission concentrations vary (thicker the line higher the emission concentration).*

Here, the process flow contribution for individual impacts is considered by applying 1% cut-off criteria. In this Interpretation section, SimaPro LCA model is presented for only taking into account GWP-GHG results as kg CO_2 eq. Electricity and natural gas consumed during raw material extraction and manufacturing stage contributes to high GHG emissions (39%) followed by pickling stage during manufacturing of steel rebar (10%) and transportation (A2) module (8%) and steel used (8%).

Impact Category	Interpretation and Hot Spot Analysis
Acidification	The cradle to gate stage (A1 to A3) gives rise to 33.8 kg SO2 eq. of Acidification., while module D (avoided burdens) takes a credit of -28.34 kg SO2 eq. thus giving rise to overall 5.55 kg SO2 eq. emissions. The process flow contribution for individual impacts is considered by applying 1% cut-off criteria. Major contributors for acidification are Nickel during raw material extraction (49%) and Electricity consumed (20%) and transportation (16%).
Eutrophication Potential	The cradle to gate stage (A1 to A3) gives rise to 0.74 kg P eq. of Acidification, while module D takes a credit of -0.59 kg P eq. thus giving rise to overall 0.16 kg P eq. emissions. The process flow contribution for individual impacts is considered by applying 1% cut-off criteria. Major contributors for eutrophication are coal mining raw material extraction (54%) and steel used (12%).
Climate Change	The cradle to gate stage (A1 to A3) gives rise to high GHG emissions (2762 kg CO2 eq.). However, module D (avoided burdens) takes a credit of – 2245 kg CO2 eq., thus reducing the overall impacts (525.59 kg CO2 eq).
Ozone depletion	Manufacturing one ton steel rebar produces 1.73E-05 kg CFC-11 eq. of Ozone depletion potential. Cradle to gate stage (A1 to A3) gives rise to high emissions (7.25E-05 CFC-11 eq.), while module D takes a credit of -5.7E-05 kg CFC-11 eq. The process flow contribution for individual impacts is considered by applying 1% cut-off criteria. High contributors of Ozone depletion are Petroleum used during transportation and manufacturing stage (45%) and Chlorine used and emitted during manufacturing stage (19%).
Photochemical ozone formation	The cradle to gate stage (A1 to A3) gives rise to 11.16 kg NMVOC eq. of while module D takes a credit of -9.82 kg NMVOC eq. thus producing overall 1.39 kg NMVOC eq. emissions. The process flow contribution for individual impacts is considered by applying 1 % cut-off criteria. Major contributors of Photochemical Ozone Formation are Electricity consumed during raw material extraction and manufacturing stage (40%) and transportation (38%).
Depletion of abiotic resources - fossil fuels	The total cradle to gate impact is 28,806 MJ. In A1 – A3, the manufacturing A3 leads to 36% of the total impact. A total credit of -22955 MJ is taken in module D (avoided burdens)

Environmental analysis of one ton steel rebar produced at Raajratna Metal Industries Limited has been carried out for the boundary conditions of cradle to gate (A1 to A3) with options C1, C2, C3, C4 and D using Lifecycle assessment method. From the results it is evident that cradle to gate stage (A1 to A3) produces highest impacts across all impact categories however module D (avoided burdens) plays a major part in reducing the total emissions. Thus, reduction in environmental impacts is mainly due to use of steel scrap as raw material for production of steel rebar instead of virgin material. Also, a major part of environmental impacts are caused due to electricity consumed during raw material extraction and manufacturing stages and transportation of raw materials.

References

General Programme Instructions of the International EPD® System. Version 3.01.

1. ISO 14040: 2006 Environmental management -- Life cycle assessment -- Principles and framework
2. ISO 14044: 2006 Environmental management -- Life cycle assessment -- Requirements and guidelines
3. ISO 14025: 2006 Environmental labels and declarations -- Type III environmental declarations -- Principles and procedures
4. EN 15804:2012+A2:2019 Sustainability of construction works – Environmental product declarations - Core rules for the product category of construction products
5. The International EPD® System / www.environdec.com
6. The International EPD® System / The General Programme Instructions v3.01 / https://www.environdec.com/contentassets/95ee9211a9614f1faa7461ff32cecc91/general-programme-instructions-v3.01.pdf
7. The International EPD® System / PCR 2019:14 Construction products v1.1 (EN 15804:A2) / https://www.environdec.com/PCR/Detail/?Pcr=%2014759
8. Product Environmental Footprint Category Rules Guidance / https://ec.europa.eu/environment/eussd/smgp/pdf/PEFCR_guidance_v6.3.pdf
9. Ecoinvent 3.9.1 / http://www.ecoinvent.org/
10. SimaPro LCA Software / https://simapro.com/

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