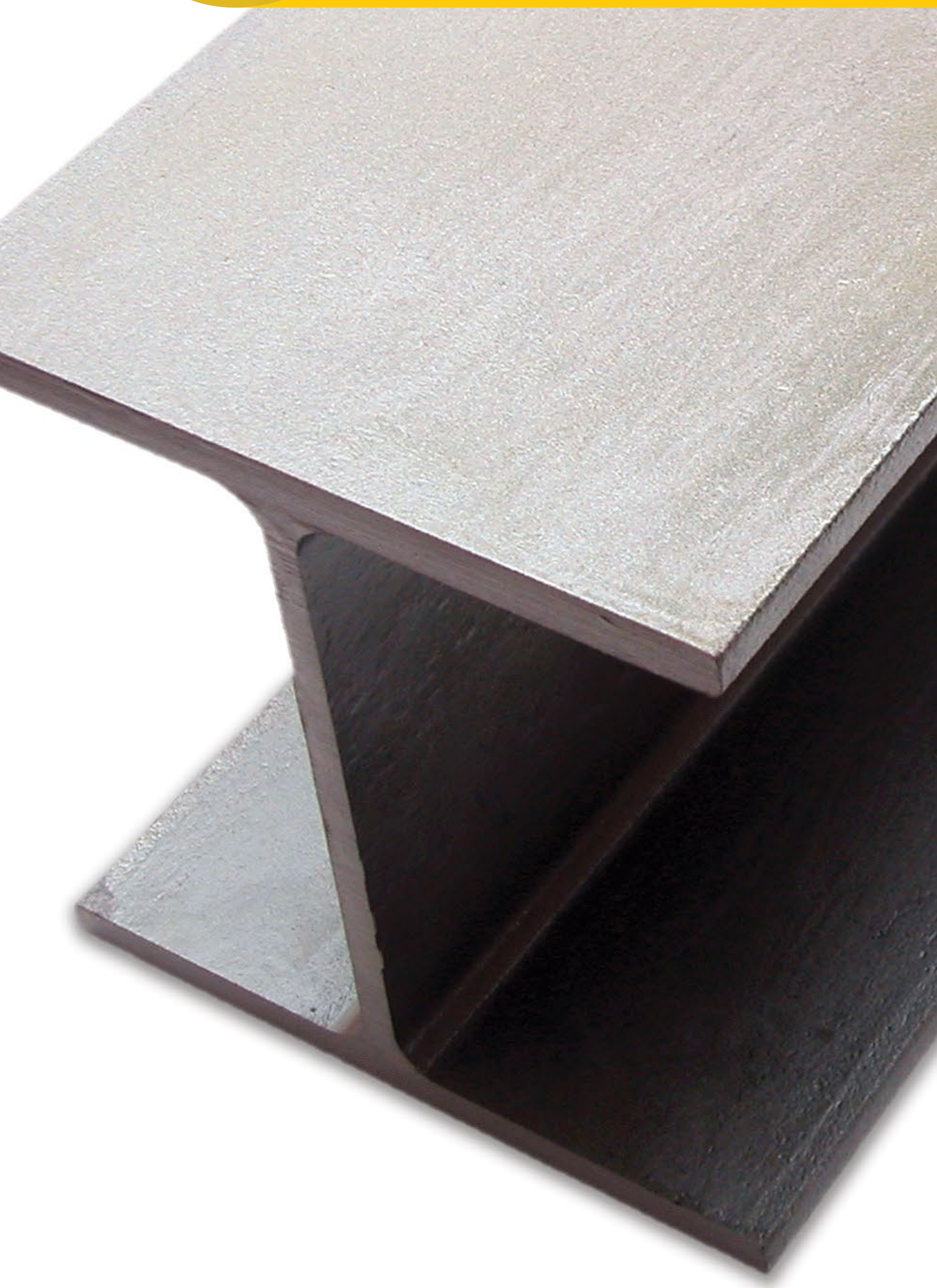
GERDAU

Environmental Product Declaration

Structural Steel, Midlothian Steel Mill



Gerdau

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Declaration Owner:

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Facility:

Gerdau Midlothian Steel Mill
300 Ward Road,
Midlothian, TX 76065

This EPD has been prepared using data from 228 fabrication shops located throughout the US. For simplicity, the addresses have not been included here.

Declared Unit

The declared unit is one metric ton of fabricated Structural steel produced in a Gerdau facility, as used to provide structural support to buildings, foundations and other structures. Results are reported using SI units.

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EPD Number and Period of Validity

SCS-EPD-04281

Approved: December 15, 2016 – Valid until: December 14, 2021

Product Category Rule

North American Product Category Rule for Designated Steel Construction Products, v1.0

PCR review, was conducted by	Thomas P. Gloria, Ph.D., Industrial Ecology Consultants t.gloria@industrial-ecology.com
Approved Date: December 15, 2016 - End Date: December 14, 2021	
Independent verification of the declaration and data, according to ISO 14025:2006 and ISO 21930:2007.	☐ internal ☑ external
Third party verifier	Jeremie Hakian, SCS Global Services

About Gerdau

Gerdau is a leading producer of long steel in the Americas and one of the largest suppliers of special steel in the world. It is the largest recycler in Latin America and one of the largest recyclers in North America, transforming millions of tons of scrap into steel each year and reinforcing its commitment to sustainable development in the regions where it operates.

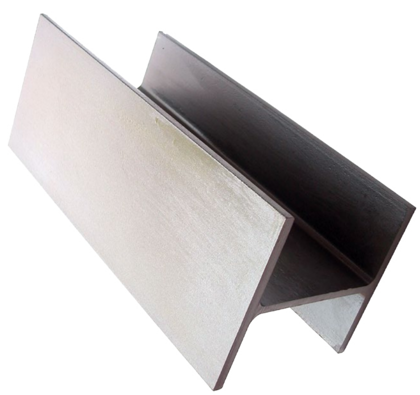
Gerdau's North American business division focus on long steel and special steel products including beams and piling, merchant bar quality, rebar, special bar quality and wire rod products. The company serves the construction, automotive, agricultural, service center and energy markets through its vertically integrated network of steel mills, recycling and downstream processing facilities.

PRODUCT

Gerdau is a global leader in the production of hot-rolled structural products. Gerdau Structural steel is manufactured from recycled steel – both pre-consumer and post-consumer scrap, demonstrating the company's commitment to environmentally-responsible steel production. From commercial buildings in Montreal to hospitals in Texas, and from the Panama Canal to the bays of Alaska, Gerdau beams and piling products have proven the company's commitment to consistently high production standards.

Gerdau produces four distinct beam shapes in North America, providing a range of geometries to suit applications from construction to manufacturing. Gerdau also produces three primary categories of piling, typically used in deep foundation and geo-technical construction projects, such as foundations, marine, environmental and transportation. The Midlothian Steel Mill in Texas produces Wide Flange Beams, Bantam Beams, Standard I-Beams, H-Piling, and PS Flat Sheet Piling.

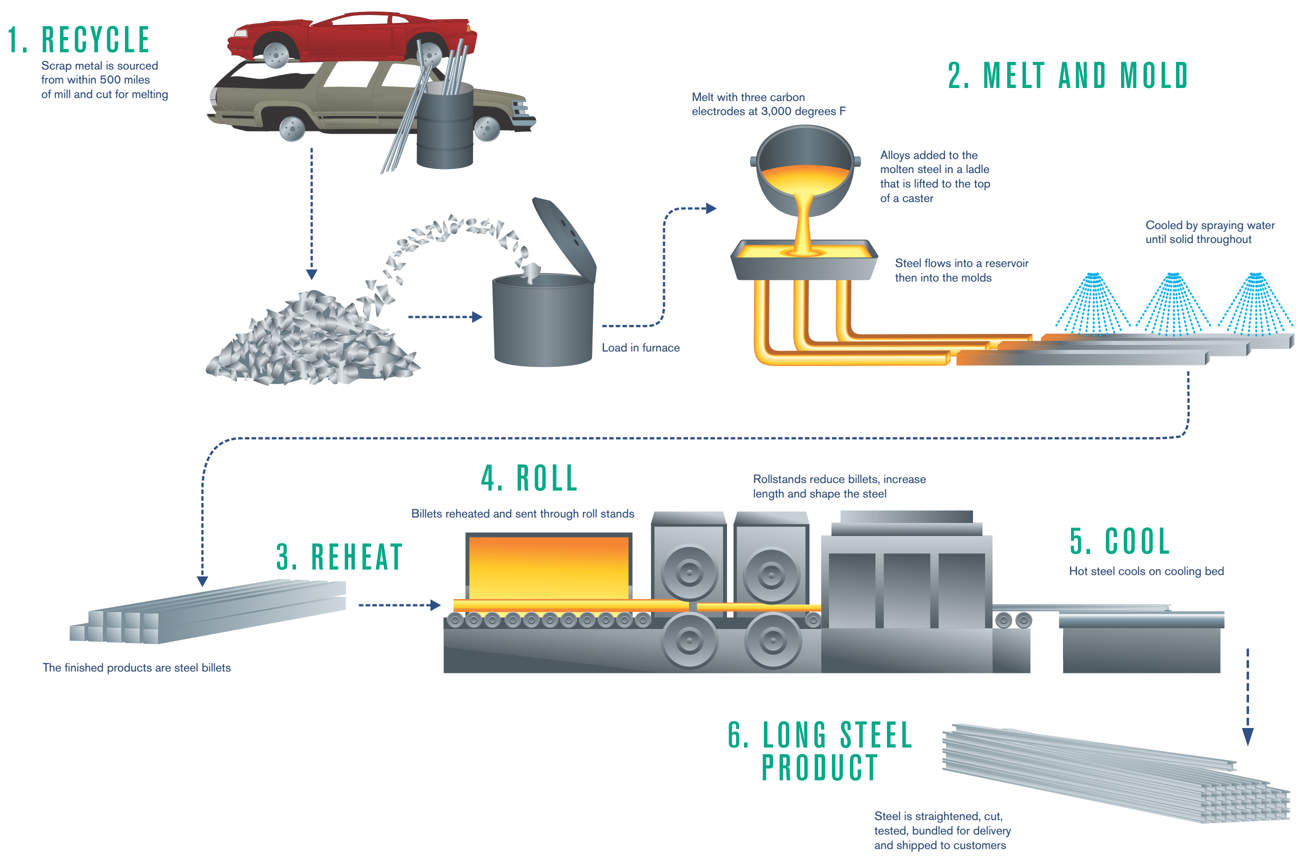
This Environmental Product Declaration is for 1 metric ton of fabricated Structural steel produced by Gerdau in the Midlothian Steel Mill. Structural steel is manufactured from steel scrap, melted in an Electric Arc Furnace (EAF) followed by hot rolling, and by transport to external fabrication shops and fabrication.



PRODUCT SCOPE

This EPD is for Structural steel that is obtained from steel scrap that does not contain virgin material. Scrap metal, together with alloying additions, are melted in an Electric Arc Furnace (EAF) to obtain liquid steel and casted into steel billets. The billets are sent to the rolling mill where they are rolled and shaped to the required dimensions for the finished steel products. The Structural steel is then fabricated in external fabrication shops.

This EPD includes Structural steel produced in the Gerdau mill located in Midlothian, TX. The process flow diagram for this EPD is shown below:



According to the applicable PCR, the declared unit of this study is one metric ton of fabricated Structural steel produced in a Gerdau facility up to the gate. In this EPD, the gate is an external fabrication shop. More information on the declared unit is shown in Table 1 and specifications for the products are shown in Table 2.

Table 1. *Declared unit for fabricated Structural steel and the approximate density.*

Parameter	Value, SI Units	Value, US Customary Units
Declared Unit	1 metric ton	1 short ton
Density	7,850 kg/m^3	490 lb/ft^3

Table 2. *Technical Information for fabricated Structural steel.*

Parameters	Structural Steel	Units
Specific gravity	7.85	N/A
Boiling point	3,000	°C
Melting point	1,540	°C

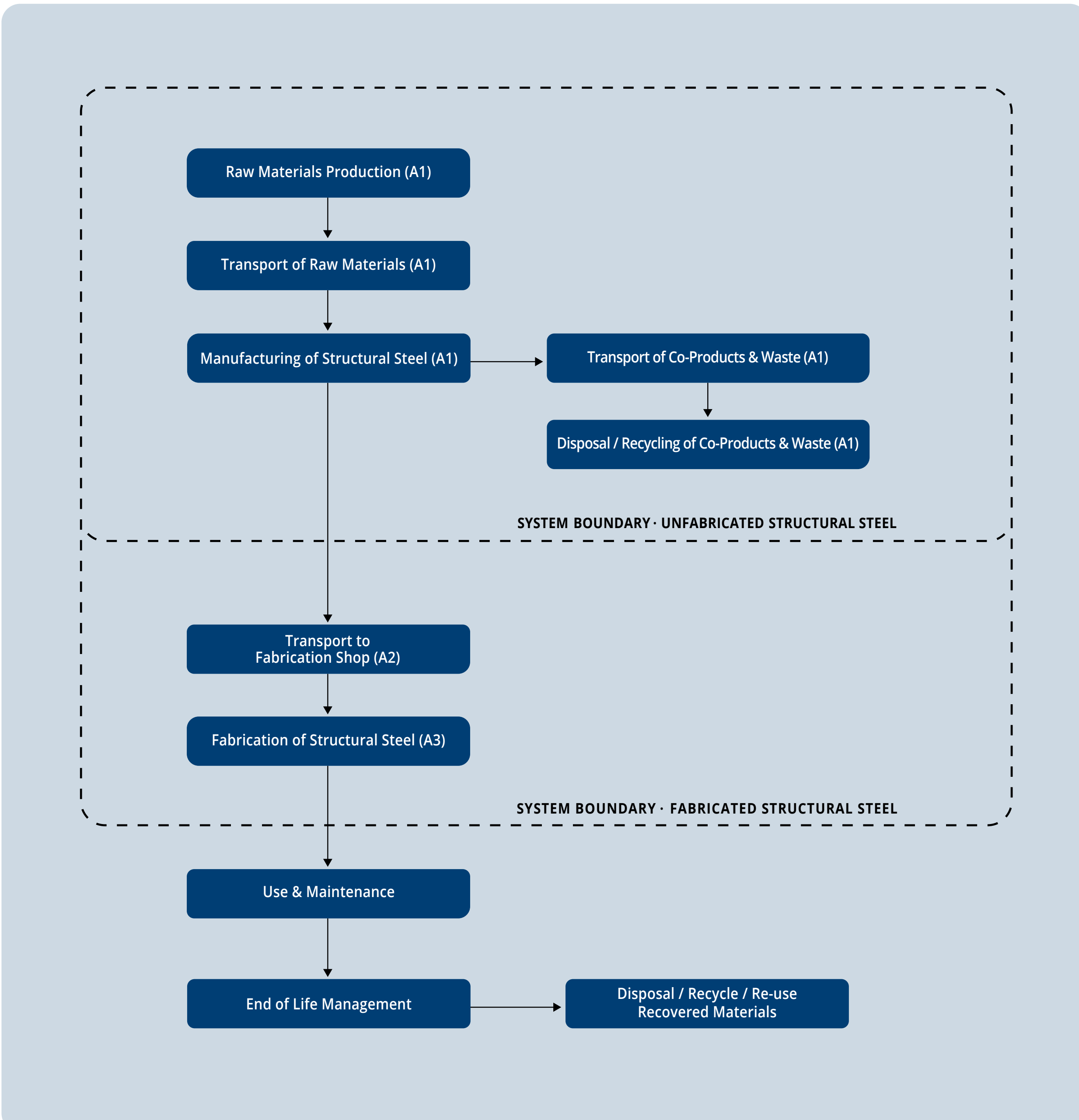
This study is a cradle-to-gate study, which addresses the environmental aspects and potential environmental impacts from raw material acquisition to the point at which the product leaves the gate of the fabrication shop.

MATERIAL CONTENT

The approximate material content of Structural steel will vary slightly from batch to batch. In general, the steel will contain < 97% recycled iron, < 2% Manganese, <1.5% Copper, <0.9% Carbon, and a total of 1.5% or less of Nickel, Silicon, Sulfur, Tin, Phosphorus, and Vanadium. Steel products used inside the building envelope (e.g., used in load-bearing applications present inside wall structures) do not include materials or substances which have any potential route of exposure to humans or flora/fauna in the environment.

PRODUCT LIFE CYCLE FLOW DIAGRAM

The diagram below is a representation of the most significant contributions to the production of Structural steel. This includes resource extraction, steelmaking, transport to fabrication shops, and product fabrication. The cradle-to-gate (A1-A3) system boundaries are shown in the diagram. Waste flows are treated within the module they occur via system expansion.



LIFE CYCLE ASSESSMENT STAGES AND REPORTED INFORMATION

In accordance with the PCR, the life cycle stages included in this EPD are as shown below (× = included, MND = module not declared):

Product			Construction Process		Use							End-of-life				Benefits & loads beyond the system boundary
A1	A2	A3	A4	A5	B1	B1	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
Raw material extraction and processing	Transport to manufacturer	Manufacturing	Transport	Construction – installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Deconstruction demolition	Transport	Waste processing	Disposal	Reuse, recovery and/or recycling potential
×	×	×	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND

× = included, MND = module not declared

The following life cycle stages are included in the EPD:

- **Raw materials:** The primary raw material used for the manufacture of Structural steel is steel scrap, together with various alloys. The raw materials are included in the A1 product stage.
- **Transport:** Inbound transportation includes transportation of all materials from suppliers to the Gerdau facility, and is included in A1 product stage. The outbound transportation includes the transportation of the unfabricated Structural steel to the external fabrication shops, and is included in the A2 product stage.

- **Manufacturing of Structural Steel:** Scrap metal and alloys are mixed in a vessel in the Melt Shop and an electric arc furnace heats up the raw materials by use of electrodes, causing them to melt. Successively the molten steel is cast into billets, which will be reheated in a reheat furnace. From there, billets enter the Rolling Mill where they are rolled into Structural steel. The manufacturing of Structural steel is included in the A1 product stage.
- **Waste disposal:** The Structural steel manufacturing process generates waste either used for energy recovery, recycling or disposal as municipal solid waste. Additionally, wastewater is generated at the plant from showers and sinks. The waste disposal is included in the A1 product stage.
- **Fabrication:** The Structural steel is fabricated in external fabrication shops where it is detailed, cut, drilled, bolted, welded, and otherwise processed per customer request. Industry-wide data collected at 288 fabrication shops by the American Institute of Steel Construction (AISC) was used for modeling of the fabrication stage. The fabrication is included in the A3 product stage.

The Reference Service Life (RSL) of the products is not specified.

The construction process stage, use stage, end-of-life stage and Module D of the product are excluded from the system boundaries of this study. Additional elements that are excluded from the study are:

- Production, transportation and disposal of the packaging used for raw materials
- Construction activities, capital equipment and infrastructure
- Maintenance and operation of support equipment
- Human labor, employee commute and business travel
- Chemicals for water treatment and purification

The deletion of these inputs or outputs is permitted since it is not expected to significantly change the overall conclusions of the study.

LIFE CYCLE IMPACT ASSESSMENT

Results are reported in Table 3 according to the LCIA methodologies of Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI version 2.1) and CML-IA version 4.1.

Table 3. *Results for the declared unit for Structural steel produced at the Midlothian mill, TX.*

				PRODUCT STAGE		
				Unfabricated Structural Steel Production	Transport to the Fabricator	Fabrication
Impact Category	Category Indicator	Indicator Description	Unit	A1	A2	A3
Global warming [a]	Global Warming Potential	Global Warming Potential (GWP)	Metric ton CO_2 eq	1.12	1.93×10^{-2}	1.16×10^{-1}
Ozone Depletion [a]	Ozone Depletion Potential	Depletion potential of the stratospheric ozone layer (ODP)	Metric ton CFC-11 eq	1.85×10^{-9}	8.26×10^{-13}	1.37×10^{-10}
Acidification of land and water [a]	Acid Emissions	Acidification Potential of soil and water (AP)	Metric ton SO_2 eq	3.57×10^{-3}	1.07×10^{-4}	3.43×10^{-4}
Eutrophication (freshwater) [a]	Phosphorus and nitrogen emissions	Eutrophication potential (EP)	Metric ton N eq	5.85×10^{-4}	5.98×10^{-6}	5.52×10^{-5}
Photochemical Ozone Creation [a]	Max. Pot. for Ozone Formation	Formation potential of tropospheric ozone (POCP)	Metric ton O_3 eq	3.79×10^{-2}	2.86×10^{-3}	3.95×10^{-3}
Depletion of abiotic resources (elements) [b,c]	Aggregated Depletion of Extracted Resources	Abiotic depletion potential (ADP-elements) for non-fossil resources	Metric ton Sb eq	-1.36×10^{-5}	9.01×10^{-12}	2.23×10^{-8}
Depletion of abiotic resources (fossil) [b]	Fossil fuel consumption	Abiotic depletion potential (ADP-fossil fuels) for fossil resources	MJ	1.41×10^{4}	2.74×10^{2}	1.41×10^{3}

[a] Calculated using TRACI v2.1.

[b] Calculated using CML-IA v4.1.

[c] This indicator is based on assumptions regarding current reserves estimates. Users should use caution when interpreting results because there is insufficient information on which indicator is best for assessing the depletion of abiotic resources.

A second set of results is reported in Table 4 according to the World Steel methodology, which excludes calcium carbide, fluorspar, ferro-niobium, and silico-manganese alloys, and no upstream burdens were assigned for these alloys. These results are reported here for comparability against EPDs that follow this methodology.

Table 4. *Results for the declared unit for Structural steel produced at the Midlothian mill, TX, using World Steel methodology.*

				PRODUCT STAGE		
				Unfabricated Structural Steel Production	Transport to the Fabricator	Fabrication
Impact Category	**Category Indicator**	**Indicator Description**	**Unit**	**A1**	**A2**	**A3**
Global warming [a]	Global Warming Potential	Global Warming Potential (GWP)	Metric ton CO_2 eq	1.05	1.93×10^{-2}	1.16×10^{-1}
Ozone Depletion [a]	Ozone Depletion Potential	Depletion potential of the stratospheric ozone layer (ODP)	Metric ton CFC-11 eq	1.79×10^{-9}	8.26×10^{-13}	1.37×10^{-10}
Acidification of land and water [a]	Acid Emissions	Acidification Potential of soil and water (AP)	Metric ton SO_2 eq	3.03×10^{-3}	1.07×10^{-4}	3.43×10^{-4}
Eutrophication (freshwater) [a]	Phosphorus and nitrogen emissions	Eutrophication potential (EP)	Metric ton N eq	5.72×10^{-4}	5.98×10^{-6}	5.52×10^{-5}
Photochemical Ozone Creation [a]	Max. Pot. for Ozone Formation	Formation potential of tropospheric ozone (POCP)	Metric ton O_3 eq	3.22×10^{-2}	2.86×10^{-3}	3.95×10^{-3}
Depletion of abiotic resources (elements) [b,c]	Aggregated Depletion of Extracted Resources	Abiotic depletion potential (ADP-elements) for non-fossil resources	Metric ton Sb eq	-1.37×10^{-5}	9.01×10^{-12}	2.23×10^{-8}
Depletion of abiotic resources (fossil) [b]	Fossil fuel consumption	Abiotic depletion potential (ADP-fossil fuels) for fossil resources	MJ	1.33×10^{4}	2.74×10^{2}	1.41×10^{3}

[a] Calculated using TRACI v2.1.

[b] Calculated using CML-IA v4.1.

[c] This indicator is based on assumptions regarding current reserves estimates. Users should use caution when interpreting results because there is insufficient information on which indicator is best for assessing the depletion of abiotic resources.

RESOURCE USE

The PCR requires that several parameters be reported in the EPD, including resource use, waste categories and output flows, and other environmental information. The results for these parameters per declared unit are shown in Table 5.

Table 5. *Resource use results for one ton of Structural steel produced at the Midlothian mill, TX.*

		PRODUCT STAGE		
		Unfabricated Structural steel Production	Transport to the Fabricator	Fabrication
Impact Category	Unit	A1	A2	A3
Use of renewable primary energy excluding renewable primary energy resources used as raw materials	MJ	$9.68x10^{2}$	0.00	$1.04x10^{2}$
Use of renewable primary energy resources used as raw materials	MJ	0.00	0.00	0.00
Total use of renewable primary energy resources	MJ	$9.68x10^{2}$	0.00	$1.04x10^{2}$
Use of nonrenewable primary energy excluding nonrenewable primary energy resources used as raw materials	MJ	$1.48x10^{4}$	$2.76x10^{2}$	$1.70x10^{3}$
Use of nonrenewable primary energy resources used as raw materials	MJ	$3.80x10^{2}$	0.00	0.00
Total use of nonrenewable primary energy resources (primary energy and primary energy resources used as raw materials)	MJ	$1.51x10^{4}$	$2.76x10^{2}$	$1.70x10^{3}$
Use of secondary materials	Metric ton	1.27	0.00	0.00
Use of renewable secondary fuels	MJ	0.00	0.00	0.00
Use of nonrenewable secondary fuels	MJ	0.00	0.00	0.00
Net use of fresh water	m^3	2.04	0.00	$6.59x10^{-1}$
Nonhazardous waste disposed	Metric ton	$6.42x10^{-4}$	0.00	0.00
Hazardous waste disposed	Metric ton	$1.82x10^{-5}$	0.00	0.00
Radioactive Waste disposed	Metric ton	0.00	0.00	0.00
Components for re-use	Metric ton	0.00	0.00	0.00
Materials for recycling	Metric ton	$1.67x10^{-1}$	0.00	$7.00x10^{-2}$
Materials for energy recovery	Metric ton	$8.56x10^{-6}$	0.00	0.00
Exported energy	MJ	0.00	0.00	0.00

A second set of resource use results is reported in Table 6 according to the World Steel methodology, which excludes calcium carbide, fluorspar, ferro-niobium, and silico-manganese alloys, and no upstream burdens were assigned for these alloys. These results are reported here for comparability against EPDs that follow this methodology.

Table 6. *Resource use results for one ton of Structural steel produced at the Midlothian mill, GA, using World Steel methodology.*

		PRODUCT STAGE		
		Unfabricated Structural steel Production	Transport to the Fabricator	Fabrication
Impact Category	Unit	A1	A2	A3
Use of renewable primary energy excluding renewable primary energy resources used as raw materials	MJ	8.52×10^{2}	0.00	1.04×10^{2}
Use of renewable primary energy resources used as raw materials	MJ	0.00	0.00	0.00
Total use of renewable primary energy resources	MJ	8.52×10^{2}	0.00	1.04×10^{2}
Use of nonrenewable primary energy excluding nonrenewable primary energy resources used as raw materials	MJ	1.40×10^{4}	2.76×10^{2}	1.70×10^{3}
Use of nonrenewable primary energy resources used as raw materials	MJ	3.80×10^{2}	0.00	0.00
Total use of nonrenewable primary energy resources (primary energy and primary energy resources used as raw materials)	MJ	1.43×10^{4}	2.76×10^{2}	1.70×10^{3}
Use of secondary materials	Metric ton	1.27	0.00	0.00
Use of renewable secondary fuels	MJ	0.00	0.00	0.00
Use of nonrenewable secondary fuels	MJ	0.00	0.00	0.00
Net use of fresh water	m^3	1.72	0.00	6.59×10^{-1}
Nonhazardous waste disposed	Metric ton	6.42×10^{-4}	0.00	0.00
Hazardous waste disposed	Metric ton	1.82×10^{-5}	0.00	0.00
Radioactive Waste disposed	Metric ton	0.00	0.00	0.00
Components for re-use	Metric ton	0.00	0.00	0.00
Materials for recycling	Metric ton	1.67×10^{-1}	0.00	7.00×10^{-2}
Materials for energy recovery	Metric ton	8.56×10^{-6}	0.00	0.00
Exported energy	MJ	0.00	0.00	0.00

Disclaimer: This Environmental Product Declaration (EPD) conforms to ISO 14025, 14040, ISO 14044, and ISO 21930.

Scope of Results Reported: The PCR requires the reporting of a limited set of LCA metrics; therefore, there may be relevant environmental impacts beyond those disclosed by this EPD. The EPD does not indicate that any environmental or social performance benchmarks are met nor thresholds exceeded.

Accuracy of Results: This EPD has been developed in accordance with the PCR applicable for the identified product following the principles, requirements and guidelines of the ISO 14040, ISO 14044, ISO 14025 and ISO 21930 standards. The results in this EPD are estimations of potential impacts. The accuracy of results in different EPDs may vary as a result of value choices, background data assumptions and quality of data collected.

Comparability: EPDs are not comparative assertions and are either not comparable or have limited comparability when they cover different life cycle stages, are based on different product category rules or are missing relevant environmental impacts. Such comparisons can be inaccurate, and could lead to the erroneous selection of materials or products which are higher impact, at least in some impact categories. Any comparison of EPDs shall be subject to the requirements of ISO 21930. For comparison of EPDs which report different module scopes, such that one EPD includes Module D and the other does not, the comparison shall only be made on the basis of Modules A1, A2, and A3. Additionally, when Module D is included in the EPDs being compared, all EPDs must use the same methodology for calculation of Module D values.

SUPPORTING TECHNICAL INFORMATION

Data Sources:

All primary data for Gerdau's manufacturing processes was collected at the Midlothian mill for the calendar year 2014. See Table 7 for a description of data sources used for the LCA.

Table 7. *Data sources used for the LCA.*

Module	Scope	Technology Source	Data Source	Region	Year
A1	Yes	GaBi 6	Gerdau	North America	2014
A2	Yes	GaBi 6	Gerdau	North America	2014
A3	Yes	GaBi 6	AISC	US	2014
D	No	N/A	N/A	N/A	N/A
Other Processes	Yes	GaBi 6	Thinkstep, ecoinvent, USLCI or ELCD inventories	US or acceptable surrogate	2012–2015

Table 8. *Data quality assessment of Life Cycle Inventory.*

Data Quality Parameter	Data Quality Discussion
Time-Related Coverage: Age of data and the minimum length of time over which data should be collected	All primary data were gathered for reference year 2014. Secondary data was sourced from GaBi 6 databases and is representative for 2012-2015. The electricity inventory was updated to match the specific 2014 energy mixes at the facility more closely.
Geographical Coverage: Geographical area from which data for unit processes should be collected to satisfy the goal of the study	All primary data is specific to the facility. The electricity inventory is updated to match the 2014 energy mixes at the facility. The remainders of the secondary inventories are either representative of the US or can be used as an acceptable surrogate for this geography.
Technology Coverage: Specific technology or technology mix	All primary and secondary data were modeled to be specific to the technologies under study. Where technology-specific data were unavailable, suitable proxy data were used.
Precision: Measure of the variability of the data values for each data expressed.	All relevant manufacturing data were primary and obtained from Gerdau's internal management systems. Most data were modeled based on primary information sources, and very limited assumptions were done to fill data gaps.
Completeness: Percentage of flow that is measured or estimated	All relevant process steps were considered and modeled, and the process chain is considered sufficiently complete to fulfill the goal and scope of this study, according to the cut-off rules.
Representativeness: Qualitative assessment of the degree to which the data set reflects the true population of interest.	The key foreground inventories used are the electricity inventory, which was chosen to be representative of the grid mix specific to the local electric company; and the alloy inventories, which were selected to match the materials used.
Consistency: Qualitative assessment of whether the study methodology is applied uniformly to the various components of the analysis.	To ensure consistency, all manufacturing data was gathered with the same level of detail, and allocation was conducted similarly for all data categories and life cycle stages. All background data was sourced from the GaBi 6 databases selecting the most appropriate geography; either Thinkstep, ecoinvent or USLCI inventories were used.
Reproducibility: Qualitative assessment of the extent to which information about the methodology and data values would allow an independent practitioner to reproduce the results reported in the study.	Reproducibility is warranted as much as possible through the disclosure of input-output data, dataset choices from life cycle inventory databases, and modeling approaches in the LCA report. Based on this information, any third party should be able to reproduce the results using the same data and modeling methodology.
Sources of the data: Description of all primary and secondary sources of data.	All primary data was collected at the Midlothian facility in 2015 and 2016 by one key project contact at Gerdau. Data was reviewed for completeness and accuracy through mass balancing and benchmarking. Gaps, outliers, or other inconsistencies were resolved with the key data providers. The secondary data used were obtained from databases contained within the GaBi 6 software, which have been used worldwide in LCA models of many critically-reviewed studies in industrial and scientific applications.
Uncertainty of the information: E.g. data, models, and assumptions	Few assumptions were made about the client operations since primary data was available for all life cycle stages. Proxies were used for some of the alloys since appropriate datasets were missing in the GaBi databases. A sensitivity analysis was done to evaluate the significance of these proxies which showed the effect to be not significant.

Allocation

The production process of Structural steel generates co-products for which the avoided burden method is applied, in accordance with the PCR. Allocation rules are avoided by allocating all system inputs and outputs to the main product but credits are given to the production of co-products since their production replaces production of similar products. The Gerdau mill produces three valuable co-products; slag, baghouse dust and mill scale. In Table 9 the systems expansion assumptions for these co-products are shown.

Table 9. *System expansion assumptions for co-products.*

Product	Co-product Function	Avoided Production
Slag	9% Cement	0.9 ton slag/ton cement
	91% Gravel	Gravel production
Baghouse dust	Zinc production	Zinc production, 0.25 ton zinc/ton dust
Millscale	Metallurgical input to steelmaking	Iron ore production

Limitations

Since it is not feasible to collect primary data for each of the many processes and materials in an LCA, it is normal and necessary to use publicly available or secondary data for some processes. The necessary secondary data may not always be available to exactly represent the temporal, geographical, and technological profile of the supply chain for the specific system being studied, resulting in some factor of error (usually unquantifiable given the hundreds of processes linked together in a life cycle system).

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