ENVIRONMENTAL PRODUCT DECLARATION

as per ISO 14025 and EN 15804

Owner of the Declaration	**JSW Steel Limited**
Programme holder	Institut Bauen und Umwelt e.V. (IBU)
Publisher	Institut Bauen und Umwelt e.V. (IBU)
Declaration number	EPD-JSW-20160053-IBC1-EN
Issue date	01.11.2016
Valid to	31.10.2021
Date of withdrawal	02.08.2017

Hot Rolled Steel Strip

JSW Steel Limited

Institut Bauen und Umwelt e.V.

www.bau-umwelt.com / https://epd-online.com

1. General Information

JSW Steel Limited	Hot Rolled Steel Strip
Programme holder IBU - Institut Bauen und Umwelt e.V. Panoramastr. 1 10178 Berlin Germany	**Owner of the Declaration** JSW Steel Limited,Vijayanagar Works, Bellary – 583275, India
Declaration number EPD-JSW-20160053-IBC1-EN	**Declared product / Declared unit** Hot rolled steel strip / 1 tonne
This Declaration is based on the Product Category Rules: Structural steels, 07.2014 (PCR tested and approved by the SVR)	**Scope:** This declaration and its LCA are relevant for hot rolled steel strip product manufactured by JSW Steel Limited, Vijayanagar Works, Bellary – 583275, India. The owner of the declaration shall be liable for the underlying information and evidence; the IBU shall not be liable with respect to manufacturer information, life cycle assessment data and evidences.
Issue date 01.11.2016	
Valid to 31.10.2021	
Date of withdrawal 02.08.2017	
	Verification The CEN Norm /EN 15804/ serves as the core PCR Independent verification of the declaration according to /ISO 14025/ ☐ internally ☒ externally
Prof. Dr.-Ing. Horst J. Bossenmayer (President of Institut Bauen und Umwelt e.V.)	
Dr. Burkhart Lehmann (Managing Director IBU)	Manfred Russ (Independent verifier appointed by SVR)

VOID

2. Product

2.1 Product description

Hot Rolled Steel Strip is a Steel Sheet product with a maximum thickness of 25.4 mm.

2.2 Application

Hot rolled steel strip product is used in load-bearing applications within buildings. The application of various products types of HRC is as follows:

- **Structural Steel** - Structural steels are intended for welded, bolted or riveted structures
- **Drawing and Forming Steel** - Hot-rolled steel for cold forming is used for bending and deep drawing and is suitable for welding
- **High Strength Low Alloy Steel** - High-strength steel with enhanced properties for forming and welding with combine high strength with good formability. Hot-rolled DP600 is advanced high-strength steel for the automotive industry.
- **Medium Carbon Steel** - Hot-rolled medium-carbon steel, supplied in the 'as rolled' condition, often heat treated to give the final mechanical properties required for the intended application.
- **Re Rolling Steel -** Hot-rolled steel, supplied in the 'as rolled' condition is feed stock for cold-rolled, galvanised and packaging steels.
- **Weather Resistance Steel** - Also referred to as Atmospheric Corrosion Resistant Steel, this product is seen as an inexpensive and highly effective material to be used in structural applications which are exposed to the atmospheric elements.

2.3 Technical Data

Types of steel:
Hot rolled products (as specified in /EN 10025-1:2005/).

The technology description is given in the table below:

Name	Value	Unit
Density	7850	kg/m^3
Modulus of elasticity	210000	N/mm^2
Grade of material according to the	The	-

delivery standards	various grades of materials accordingly to the delivery standards are detailed below this table	
Coefficient of thermal expansion	12	$10^{-6}K^{-1}$
Thermal conductivity at 20°C	48	W/(mK)
Melting point depending on the alloy proportions	1536	°C
Shear Modulus	81000	N/mm2

The various grades of materials accordingly to the delivery standards are S235 to S460, E250 to E450, Fe 330 to Fe 590, SS330 to SS540, A36, A53, A572, A1011, A1018, SAE 1008 to SAE 1018, DD 11 to DD 14, HR 1 to HR4, SPHC to SPHD, S315, S600, HR5 (DP 600), SAPH 310 to SAPH 440, SPFH490 to SPFH590, 5L GrB to X80, C22 to C60, 20MnB5 to 30MnB5, SAE 1020 to SAE 2060, SAE 1527 to SAE 1541, SAE 1006 to SAE 1012, CR0 to CR6, IRSM 41 IRSM 97, Corten A, SPAH

2.4 Placing on the market / Application rules

For the placing on the market in the EU/EFTA (with the exception of Switzerland) the Regulation (EU) No. 305/2011 applies. The products need a Declaration Performance taking into consideration /EN 10025-1:2004 Hot rolled products of structural steels — Part 1:General technical delivery conditions/ and the CE marking.

For the application and use the respective national provisions apply.
The assessed hot rolled steel strip also meets the following standard:

EN 10025-2, IS 2062, IS 5986, JIS G3101, ASTM, SAE, EN 10111, IS 1079, IS G3131, EN 10149, IS 1079, IS G 3113, JIS G 3134, API, EN10083, IS 11513, IRSM, JIS G 3125.

For more details on above standards, please refer Section 8: References.

2.5 Delivery status

The dimensions of the declared products may vary according the intended application. It varies in thickness upto 25.4mm, width upto 2050mm, lenth upto 13000 mm and weight upto 36 metric tons

2.6 Base materials / Ancillary materials

Hot Rolled Steel Strip product's carbon content is between 0 and 0.64%. Iron is the main component of steel strip. The content of other elements is significantly less. The exact chemical composition varies depending on the steel grade and is characterized in the product standards listed in 2.4

Auxiliary materials:
A. For the production route “blast furnace with basic oxygen furnace”: coking coal, lime
B. For the production route “COREX with basic oxygen furnace”: non-coking coal, lime
For both production routes:
Ferrosilicon, Ferro manganese, Metallic manganese, Silico manganese, Ferro Aluminium, Aluminium Ingot/Bar/Wire/Cubes, Ferrochromium, Ferro vanadium, Ferro niobium, ferro titanium, Nickel, Copper, Ferro Boron, Ferro Molybdenum, Ferro Phosphorus, CaSi (Ferro Silicon Calcium Cored) Wire, CaFe (Ferro Calcium Silicide Cored) Wire
The rates of these additives depend on the steel grade.

2.7 Manufacture

In the integrated steel production route iron ore (a typical mix is based on ferro-oxides Fe2O3) and other additives are mixed and sintered for being fed into the blast furnace together with coking coke, which is used as the reducing agent. (For COREX the reducing agent is non-coking coal). Also pellets and / or lump may be used.

The pig iron produced in the blast furnace & COREX is transferred into the basic oxygen furnace. In this vessel the iron is converted into steel by lowering the carbon content of the iron by blowing oxygen into the melt (exothermic reaction). For temperature control, scrap (up to 10%) is added to the melt.

Refining (lowering of sulphur, phosphorous and other tramp elements) and alloying with micro alloying elements is applied according to steel grade to give the required characteristics for the steel.

Treatment on special requirement for internal cleanliness, new steel products are processed through the VD (RH-Stahl-Heraeus) Degassing unit.

At the end of the steelmaking process, the liquid steel is transformed into a semi-finished product in a continuously cast steel slab. The semi-finished slab is then rolled and Hot Rolled Steel Strip as a finished product is produced.

Quality control: /ISO 9001/ Monitoring according to the product standards.

2.8 Environment and health during manufacturing

JSW Steel Limited has ISO 14001 and OHSAS 18001 management systems for environment, health and safety of permanent and contractual employees during product manufacturing. All the statutory limits of environmental pollution and Factory’s Act for Labour Laws are under compliance

2.9 Product processing/Installation

Processing recommendations:
Planning, processing, implementing and intended use of hot rolled steel strip have to be carried out depending on the respective applications according to the generally recognized rules of engineering and manufacturer’s recommendations.
Regarding transport and storage of coils, the generally accepted requirements for securing loads have to be observed.

Residual material:
During processing residual pieces are to be separately collected. This scrap steel is entirely recycled by melting and producing new steel products

2.10 Packaging
Products are delivered with steel strap packing.

2.11 Condition of use
During usage no changes in material composition shall occur except, steel can corrode in the presence of oxygen in the water (slow oxidation) and requires adequate maintenance.

2.12 Environment and health during use
The intended use of product does not hazard health or environment in any known way.

2.13 Reference service life
A reference service life for product is not declared. As the product has many different applications, the parameters decisive for service life estimation are the purpose, possible corrosion protection and adequate maintenance.

2.14 Extraordinary effects

Fire
Hot rolled steel strip meets the requirements of building material safety class A1 (i.e. non-flammable according to /EN 13501–1/) and do not emit fumes or fire-gases.

Water
Steel is stable to water, insoluble and does not emit substances in water. In case of flooding no impacts are to be expected. Steel can corrode in the presence of oxygen in the water (slow oxidation).

Mechanical destruction
Thanks to the ductility of steel, steel-structures react resilient in the event of unforeseeable mechanical destruction: In case of tensile load necking will occur before cracking. In case of lasting high compression load, components of steel may buckle or bulge. No splintering or breaking edges shall result.

2.15 Re-use phase
Hot rolled steel strips are not generally reused at end of life but can be recycled to the same quality of steel (or higher or lower quality) depending upon the metallurgy and processing of the recycling route. Hot rolled steel strip can be recycled without any problems after dismantling. Currently, around 85% of the products are used for closed-loop recycling (World Steel Association, 2011)

2.16 Disposal
Due to its high value as a resource, significant efforts are made to recycle steel scrap rather than disposing of it at the end of life.

In case of disposal, i.e. landfill as inert matter, minimal environmental impacts like global warming potential, primary energy and abiotic depletion (fossil) occur.

2.17 Further information
For further information on these products please refer to www.jsw.in/steel

3. LCA: Calculation rules

3.1 Declared Unit
The declared unit is 1 tonne of hot rolled steel strip having the technical characteristics declared in 2. This is calculated based on the yearly data of hot rolled steel strip products produced at the manufacturing during the assessed period.

Declared unit

Name	Value	Unit
Declared unit	1000	kg
Thickness (des Bleches)	0 - 25.4	mm
Density	7850	kg/m^3
Conversion factor to 1 kg	0.001	-

3.2 System boundary
Type of the EPD: cradle-to-gate (modules A1-A3), module C3 and module D.

The “Product stage” (modules A1-A3) accounts for:
- production and processing of raw materials and the processing of secondary material input;
- transport of these inputs to the manufacturing site; and
- manufacture of hot rolled strip, product, onsite power generation, and waste processing/treatment.

The End of Life stage (module C3) accounts for:
- Waste Processing
- Landfilling

In module D, it is assumed that 85% of the hot rolled steel strip used in the structure is recovered for recycling, while the remainder is landfilled (/worldsteel/) as an inert matter.

Transport impacts have been included for all mass inputs and outputs across the modules considered in this study. This has been based on information supplied by JSW Steel Limited.

3.3 Estimates and assumptions
Key assumptions are outlined in 3.2.In addition, the following estimates and assumptions are used in this declaration:
- For impacts related to background data, databases of GaBi software are used
- Site specific factors for net calorific value, and contents of C, Ash, Sulphur, H2 are used for fuel and process gases
- An electricity mix comprising of import from national grid, captive generation from coal, captive generation from gases and waste recovery boilers is used
- Bye products i.e. slag, fly ash, tar etc are allocated as per the PCR
- Packaging of product is not included
- Waste water and effluent treatment plants are modelled based on primary data from manufacturing site

3.4 Cut-off criteria

On the input side all flows entering the system and comprising more than 1% in total mass or contributing more than 1% to primary energy consumption are considered. All inputs used as well as all process-specific waste and process emissions were assessed including emissions to air and effluent discharges as per the consent requirements from the statutory bodies in India. For this reason, material streams which were below 1 % (by mass) were captured as well. In this manner the cut-off criteria according to the IBU guideline are fulfilled.

Respective cut-off criteria (system boundaries) for the background data are given in the documentation of the data sets (/GaBi 6 2014/).

3.5 Background data

Background data are sourced from GaBi 6 Databases (/GaBi 6 2014/).

3.6 Data quality

The data quality can be described as good. Background data are consistently sourced from thinkstep databases with no data older than 8 years. The primary data collection was thorough, considering all relevant flows.

3.7 Period under review

The review period is April 2013- March 2014

3.8 Allocation

Basic oxygen furnace (BOF) and Blast Furnace (BF) slag is produced as a co-product in the steel manufacturing process. Impacts are allocated between the hot metal, steel and the BF/BOF slag on a physical allocation according to the co-product methodology developed by the steel industry (/worldsteel & EUROFER 2014/). The sold slag is given credit with alternative systems which are consistent with actual practice

The coke oven co-products are mainly energy-based products and so the inputs and outputs related to the production of these co-products are partitioned based on the ratios of the total energy content (net calorific value, NCV) of each of them

System expansion is used to account for the excess BF and BOF gases that leave the product system boundary, either for use to make other steel products in upstream or downstream processes (replacing the need for other fuels), or exported off site (replacing the need for other fuels or contributing to the national electricity grid). The avoided burden of the relevant fuel or electricity grid mix is applied to the data. This process of system expansion occurs after partitioning of the metal and slag in the BF and BOF process
Production losses of steel during the production process are recycled in a closed loop offsetting the requirement for external scrap.

Hot rolled products produced by the BOF route are net producers of scrap over the life cycle (less scrap is used to make the product than is generated at the end-of-life). The resulting scrap credit is calculated based on a global "value of scrap" approach (/worldsteel 2011/) and reported in module D.

For more detailed and specific allocation for various processes of steel making, please refer to Appendix C of the co-product methodology developed by the steel industry (/worldsteel & EUROFER 2014/)

Specific information on allocation within the background data is given in the GaBi datasets documentation (/GaBi 6 2012/).

3.9 Comparability

Basically, a comparison or an evaluation of EPD data is only possible if all the data sets to be compared were created according to /EN 15804/ and the building context, respectively the product-specific characteristics of performance, are taken into account.

4. LCA: Scenarios and additional technical information

Out of the end of life stage i.e. module C, only C3 is declared. 15% of the hot rolled steel strip is landfilled (/worldsteel/) as an inert matter.

For module D, 85% of the hot rolled steel strip used in the structure is recovered for recycling (/worldsteel/). There are no external scrap utilized by JSW Steel Limited, only 10% of scrap which is being used as a secondary material in the steel production is internal scrap generated from the production process.

Landfilling	150	kg

End of life (C1 - C4)

Name	Value	Unit
Collected separately Abfalltyp	0	kg
Collected as mixed construction waste	0	kg
Reuse	0	kg
Recycling	0	kg
Energy recovery	0	kg

5. LCA: Results

DESCRIPTION OF THE SYSTEM BOUNDARY (X = INCLUDED IN LCA; MND = MODULE NOT DECLARED)

PRODUCT STAGE			CONSTRUCTION PROCESS STAGE		USE STAGE							END OF LIFE STAGE				BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARIES
Raw material supply	Transport	Manufacturing	Transport from the gate to the site	Assembly	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal	Reuse-Recovery-Recycling-potential
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
X	X	X	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	X	MND	X

RESULTS OF THE LCA - ENVIRONMENTAL IMPACT: 1 tonne of hot rolled steel strip

Parameter	Unit	A1-A3	C3	D
Global warming potential	[kg CO_2-Eq.]	2799.11	2.42	-1285.24
Depletion potential of the stratospheric ozone layer	[kg CFC11-Eq.]	2.98E-6	2.86E-9	4.11E-5
Acidification potential of land and water	[kg SO_2-Eq.]	27.56	0.01	-3.07
Eutrophication potential	[kg $(PO_4)^{3-}$-Eq.]	1.77E+0	2.01E-3	-8.00E-2
Formation potential of tropospheric ozone photochemical oxidants	[kg ethene-Eq.]	1.10E+0	1.39E-3	-6.90E-1
Abiotic depletion potential for non-fossil resources	[kg Sb-Eq.]	7.73E-3	8.89E-5	-2.88E-3
Abiotic depletion potential for fossil resources	[MJ]	35541.59	31.57	-13563.28

RESULTS OF THE LCA - RESOURCE USE: 1 tonne of hot rolled steel strip

Parameter	Unit	A1-A3	C3	D
Renewable primary energy as energy carrier	[MJ]	275.01		699.24
Renewable primary energy resources as material utilization	[MJ]	0.00		0.00
Total use of renewable primary energy resources	[MJ]	275.01		699.24
Non-renewable primary energy as energy carrier	[MJ]	35741.59		-12094.83
Non-renewable primary energy as material utilization	[MJ]	0.00	0.00	0.00
Total use of non-renewable primary energy resources	[MJ]	35741.59	31.89	-12094.83
Use of secondary material	[kg]	0.00	IND	0.00
Use of renewable secondary fuels	[MJ]	0.00	IND	0.00
Use of non-renewable secondary fuels	[MJ]	0.00	IND	0.00
Use of net fresh water	[m³]	3.39	0.02	0.40

RESULTS OF THE LCA – OUTPUT FLOWS AND WASTE CATEGORIES: 1 tonne of hot rolled steel strip

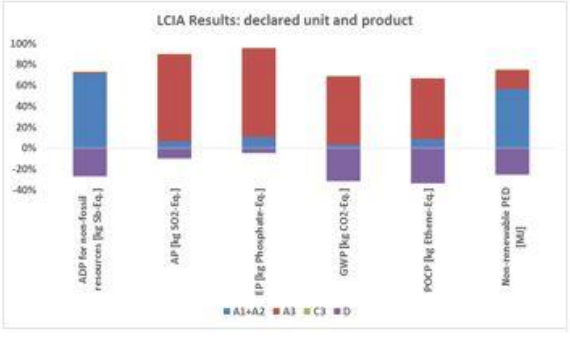
Parameter	Unit	A1-A3	C3	D
Hazardous waste disposed	[kg]	8.89	0.43	-0.68
Non-hazardous waste disposed	[kg]	3.88	0.00	32.15
Radioactive waste disposed	[kg]	5.31E-2	5.23E-4	4.40E-1
Components for re-use	[kg]	0.00	0.00	0.00
Materials for recycling	[kg]	0.00	850.00	0.00
Materials for energy recovery	[kg]	0.00	0.00	0.00
Exported electrical energy	[MJ]	0.00	0.00	0.00
Exported thermal energy	[MJ]	0.00	0.00	0.00

6. LCA: Interpretation

This chapter contains an interpretation of the Life Cycle Impact Assessment categories with regards to the functional unit. It focuses on the dominant contributions during the production process

For acidification potential (AP), manufacturing has an impact share of around 88% while for global warming potential, (GWP), the impact share is around 77%, with other categories between these two values. The outliers are ODP where the manufacturing stage has a share of 5% and abiotic depletion (fossil), where the manufacturing stage has a share of 20%.

For all the considered, impact categories, besides ODP, a credit is given for the end-of-life phase.



GWP is dominated by on-site emissions associated with steel making processes and the production of

ancillary materials/pre-products. The overall share for these processes is about 77%.

Formation potential of tropospheric ozone photochemical oxidants (POCP) is also dominated by on-site emissions and the production of ancillary materials/pre-products with a share of about 82%

Acidification potential (AP) is strongly dominated by the generation of electricity, steam and heat from primary energy resources, with module A3 having a total share of about 88.6%

Similarly, **Eutrophication Potential (EP)** is also strongly dominated by the generation of electricity, steam and heat from primary energy resources, (Module A3) with a share of about 81.80%

Abiotic depletion potential for non-fossil resources (ADP elements) is dominated by the provision of auxiliary material e.g. ferro molybdenum, ferro chrome, and copper used in the basic oxygen furnace.

Abiotic depletion potential for fossil resources (ADP fossil) is strongly dominated by the extraction and processing of raw materials and the generation of electricity, steam and heat from primary energy resources, including extraction, refining and transport (Module A1).

Total use of renewable primary energy resources (PERT) and **Total use of nonrenewable primary energy resources (PENRT)** are dominated by the extraction and processing of raw materials and the generation of electricity, steam and heat from primary energy resources, including extraction, refining and transport (Module A1). In general, the main contribution to primary energy in the BF/BOF route comes from the use of coal/coke as an energy and carbon source.

The most significant emissions for **Acidification potential** and **Eutrophication potential** in the BF/BOF-Route steel making process are NOx and SOx emissions. The most significant source of emissions contributing to **formation potential of tropospheric ozone photochemical oxidants (POCP)** is the Basic oxygen furnace steel making process (BF/BOF-Route).

BF/BOF route is mostly primary materials based steel production route. Radioactive waste comes from the provision of electrical energy, especially from the share of nuclear power in the grid mix. Non-hazardous wastes include overburden, tailings and sludges. Hazardous waste for deposition is produced in small amounts during production.

7. Requisite evidence

This EPD covers semi-finished hot rolled steel product. Further processing and fabrication depends on the intended application. Therefore further documentation is not applicable.

8. References

Institut Bauen und Umwelt
Institut Bauen und Umwelt e.V., Berlin(p... Generation of Environmental Product Declarations (EPDs);

General principles
for the EPD range of Institut Bauen und Umwelt e.V. (IBU), 2013/04
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ISO 14025
DIN EN ISO 14025:2011-10: Environmental labels and declarations — Type III environmental declarations — Principles and procedures

EN 15804
EN 15804:2012-04+A1 2013: Sustainability of construction works — Environmental Product Declarations — Core rules for the product category of construction products

ISO 14001
DIN EN ISO 14001:2004: Environmental Management Systems

API 5L
Specification for pipe grades

ASTM A36
ASTM A 36:2008: Standard specification for carbon structural steel

ASTM A1011
Standard Specification for steel, sheet and strip, hot-rolled, carbon, structural, high-strength low-alloy, high-strength low-alloy with improved formability, and ultra-high strength

ASTM A1018
Standard specification for steel, sheet and strip, heavy-thickness coils, hot-rolled, carbon, commercial, drawing, structural, high-strength low-alloy, high-strength low-alloy with improved formability, and ultra-high strength

ASTM A53
Standard Specification for pipe, steel, black and hot-dipped, zinc-coated, welded and seamless

ASTM A572
ASTM A572:2012: Standard specification for high-strength low-alloy columbium-vanadium structural steel

ASTM Corten A
Standard for weathering steel specifications

PCR 2011, Part A

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EN 10025-2
EN 10025-2:2005: Hot rolled products of structural steels- Part 2

EN 10083
EN 10083 C22 to C60: Specifications for Steels for quenching and tempering

EN 10111
EN 10111 DD11 to DD14:2008: Continuously hot rolled low carbon steel sheet and strip for cold forming

EN 10149
EN 10149 S315 to S600:Specification for hot-rolled flat products made of high yield strength steels for cold forming

EN 1090
EN 1090:2009: Execution of steel structures and aluminium structures

EN 13501
EN 13501:2010-1: Fire classification of construction products and building elements

EN 1993:2010-12/ Eurocode 3
Design of steel structures

EN 1994:2010-12 / Eurocode 4
Design of composite steel and concrete structures

European Waste Index code
Waste code according to European Waste Catalogue (EWC)

IRSM 41/97
Corrosion Resistance steel Indian grade for weather resistant steel

IS 1079
Specification for hot rolled carbon steel sheet and strip

IS 11513
IS 11513 CR0 to CR6: Standard for hot-rolled carbon steel strip for cold rolling purposes

IS 2062
IS 2062 E250 to E450:Standard specification for hot rolled medium and high tensile structural steel

IS 5986
IS 5986 Fe 330 to Fe 590: Standard specification for hot rolled steel flat products for structural forming and flanging purposes

ISO 9001
Quality Management Systems

JIS G3101
JIS G3101 SS330 to SS540: Japanese standard for Common Structural Steel

JIS G3113
JIS G3113 SAPH310 to SAPH440: Japanese material standard for Hot Rolled steel plates, sheets, strips for automobile structural usage.

JIS G3125
JIS G3125 SPAH: Japanese material standard hot rolled steel for superior atmospheric corrosion resistance steel plates, sheets, strips

JIS G3131
JIS G3131 SPHC to SPHD: Japanese material standard for hot rolled steel

JIS G3134
JIS G3134 SPFH490 to SPFH590: Japanese material standard for hot rolled high strength steel sheets with improved formability for automobile.

SAE 1006 to 1012: Standard for carbon steel material properties

SAE 1008 to 1018: Standard specifications for carbon steel

SAE 1020 to 1060, 1527 to 1541: Specification for steel grades

20MnB5 to 30MnB5: Standard specifications for alloyed steel

GaBi 6 Software
GaBi 6. Software and Databasis for Life Cycle Engineering. LBP, University of Stuttgart und PE International, 2014

GaBi 6 2014
GaBi 6 dataset documentation, PE INTERNATIONAL AG, Leinfelden-Echterdingen, 2014
http://database-documentation.gabi-software.com/

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Life Cycle Assessment Methodology Report, World Steel Association, 2011.

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OHSAS 18001
BS OHSAS 18001 Occupational Health and Safety Management

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