

STEEL

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1. Definition and Classification of grades of steel
Designation of steels:

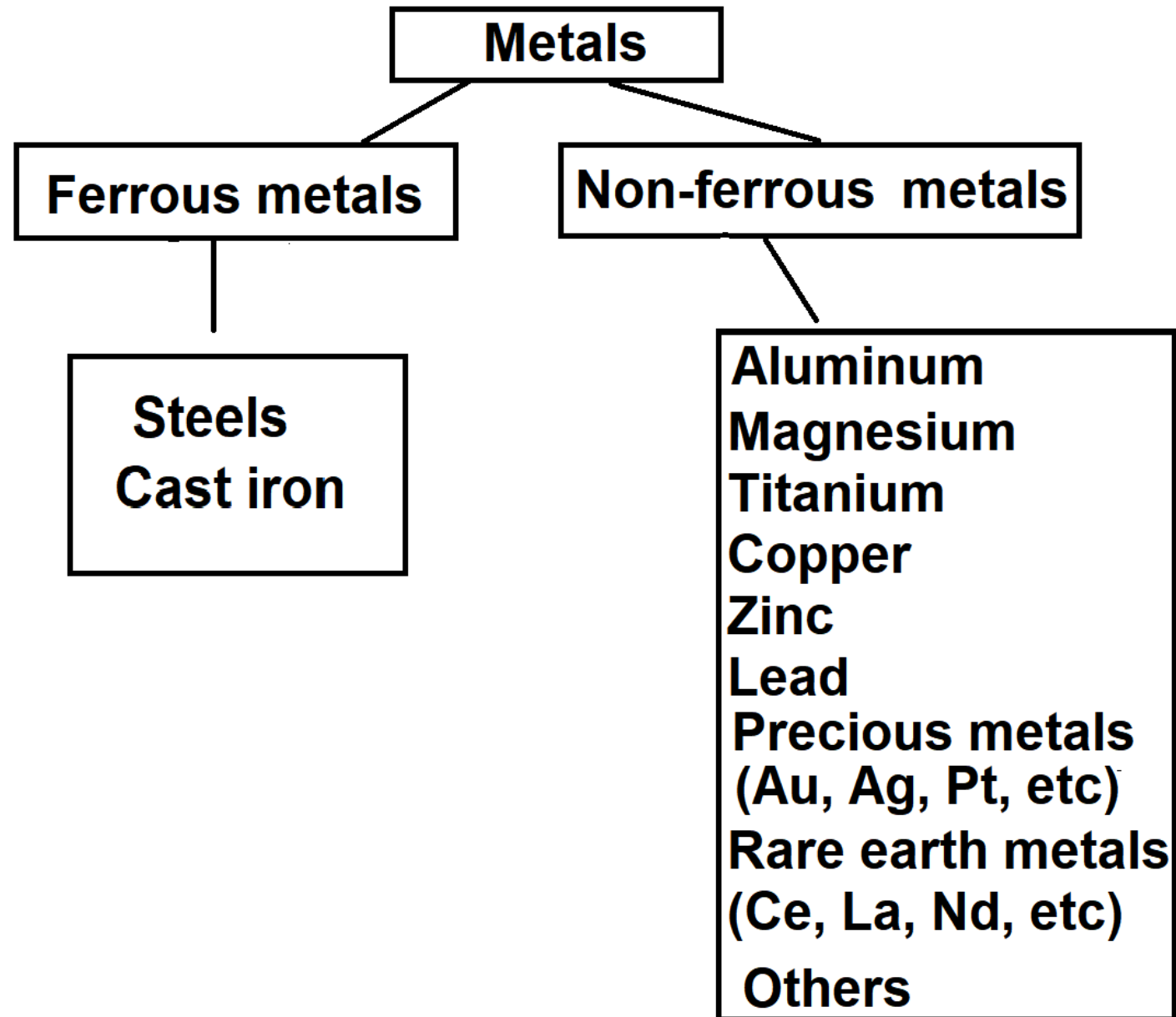
2. Classification of steels based on uses

3. Production and Recycling of steel

4. Steel scrap

Definition and classification of grades of steel

European standard EN 10020



European standard EN 10020 defines the term "steel" and establishes:

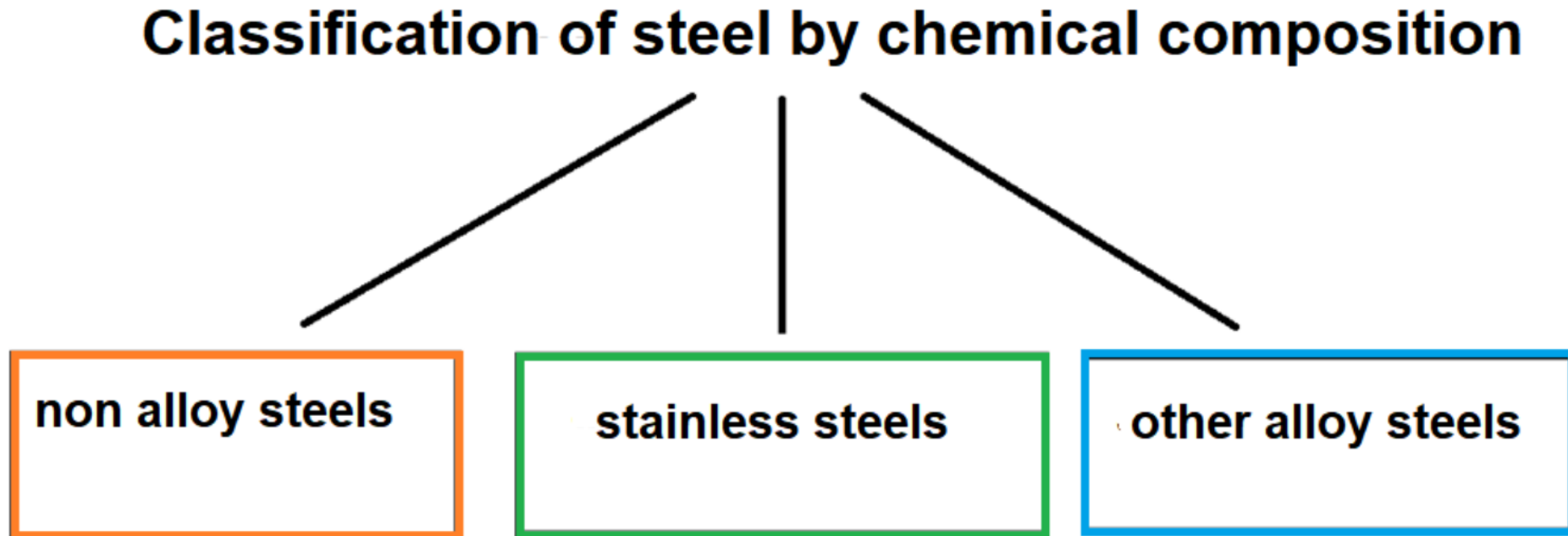
- The classification into unalloyed, stainless steels and other alloyed steels based **on chemical composition**.
- The classification of steels according to the **main quality classes**, defined on the main characteristics regarding their properties and their respective uses.

Steel: Material whose iron content is greater than that of each of the other elements and whose carbon content is generally less than 2%, and which contains other elements. A limited number of chromium steels may have a carbon content greater than 2%, but this value of 2% is the current limiting content that separates the steel from the cast iron.

The classification into unalloyed, stainless steels and other alloyed steels based on **chemical composition**.

Classification based on chemical composition

- **Non alloy steels**
- **Stainless steels (Cr > 10.5%, C < 1.2%)**
- **Other alloy steels**



Classification based on chemical composition

Non alloy steels

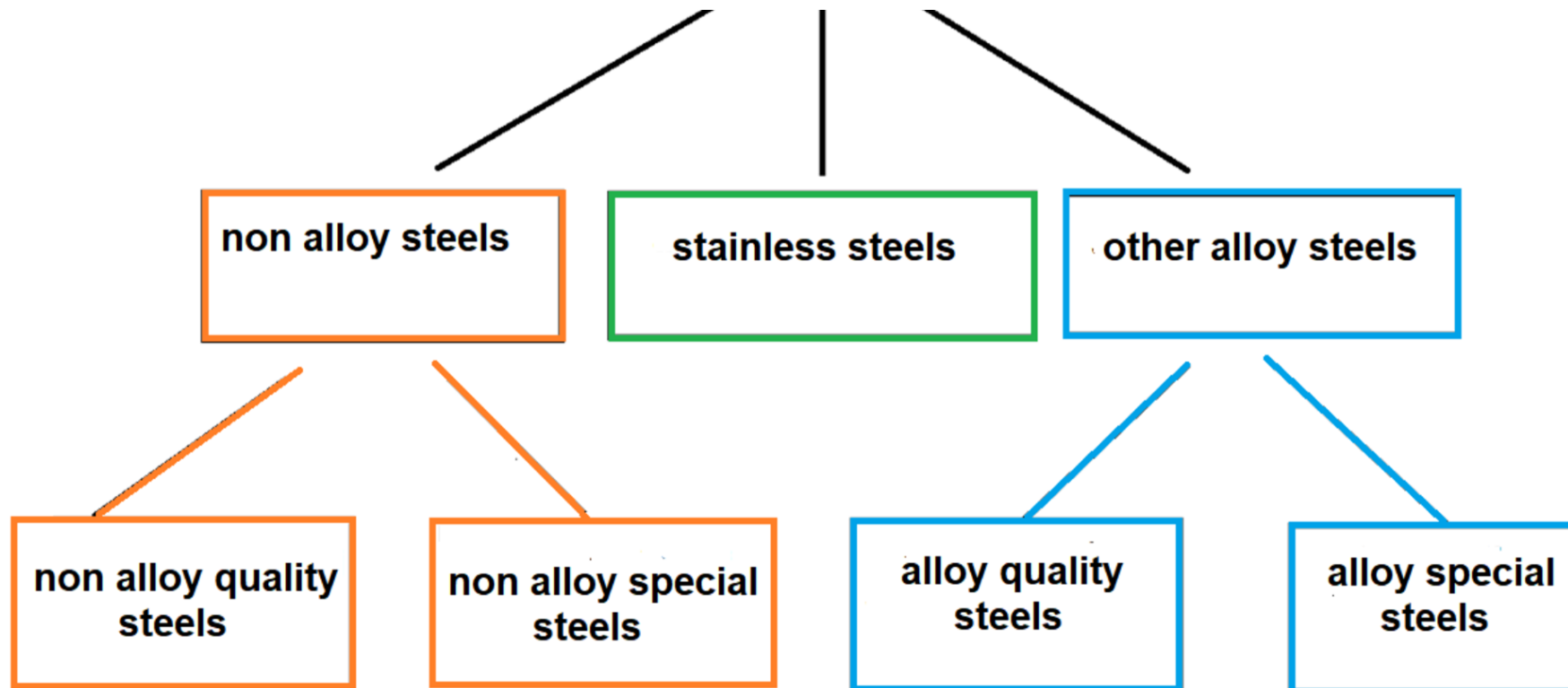
In non alloy steels, the percentages of chemical elements present (obviously excluding carbon) are lower than those indicated in following table:

Table 1 – Boundary between non alloy and alloy steels

Specified element		Limit value % by mass
Al	Aluminium	0,30
B	Boron	0,0008
Bi	Bismuth	0,10
Co	Cobalt	0,30
Cr	Chromium	0,30
Cu	Copper	0,40
La	Lanthanides (each)	0,10
Mn	Manganese	1,80
Mo	Molybdenum	0,08
Nb	Niobium	0,06
Ni	Nickel	0,30
Pb	Lead	0,40
Se	Selenium	0,10
Si	Silicon	0,60
Te	Tellurium	0,10
Ti	Titanium	0,05
V	Vanadium	0,10
W	Tungsten	0,30
Zr	Zirconium	0,05

The classification of steels according to the **main quality classes**, defined on the main characteristics regarding their properties and their respective uses.

European standard EN 10020



Classification according to the main quality classes

Non alloy steels

Non alloy **quality** steels

- There are requirements regarding specific characteristics (toughness, grain size, formability).
- Magnetic sheets and tapes have maximum values of specific total losses or minimum values of magnetic induction, polarization or permeability.

Classification according to the main quality classes

Non alloy steels

Non alloy **special** steels

- There are requirements regarding higher purity in particular towards non-metallic inclusions.
- Generally from reclamation or surface hardening (regular response to treatments).
- High and controlled values of yield strength or hardenability associated with cold forming, weldability or toughness.

Classification according to the main quality classes

Non alloy steels

Non alloy special steels

- They have a minimum resilience value in the reclaimed state.
- They have a set hardening penetration or surface hardness value in the quenched, tempered or surface hardened state.
- Reduced levels of non-metallic inclusions are prescribed.
- With a maximum content of S and P ($\leq 0.02\%$ on casting and $\leq 0.025\%$ on product) (e.g. wire rod for springs, wires for electrodes or tires).
- With minimum impact strength of 16 J at -50°C on the crosspiece and 27 J on the long one (V-tube).
- Steels for nuclear reactors ($\text{Cu} \leq 0.10\%$, $\text{V} \leq 0.05\%$ $\text{Co} \leq 0.05\%$).
- They have electrical conductivity greater than 9 Sm / mm².
- Precipitation hardeners (HSLA with niobium or vanadium).

Classification according to the main quality classes

Stainless steels

With Cr value > 10.5% and C value < 1.2%

Nickel content

- Ni < 2.5%
- Ni ≥ 2.5%

Particular characteristics:

- Corrosion resistance.
- Resistance to hot oxidation.
- Creep resistance.

Classification according to the main quality classes

Other alloy steels

Alloy quality steels

- They are generally not intended for quenching and tempering treatments or surface hardening treatment.
- Fine grain weldable steels for structural uses, including for pressure equipment and pipes.
- Minimum unit yield strength 380 N / mm² for thicknesses $\leq$ 16 mm.
- minimum impact strength less than 16 J at -50 ° C on the crosspiece and less than 27 J on long (V-tube).

Classification according to the main quality classes

Other alloy steels

Alloy quality steels

- Alloy steels for rails, sheet piles and armor for mines.
- Alloy steels for products for cold or severe hot rolling and containing refiners such as B, Zr, V, Nb, Ti or "biphasic" (ferritic structures with max. 30% of isolated martensite).
- Alloy steels for which Cu is the only required element.
- Unalloyed magnetic sheets and tapes produced with steels containing Si or Si and Al with prescribed magnetic characteristics.

Classification according to the main quality classes

Other alloy steels

Alloy special steels

- Steels other than stainless steel, characterized by a precise regulation of the chemical composition and by particular production conditions (improved characteristics):
 - Steels for mechanical constructions and for pressure equipment.
 - Bearing steels.
 - Tool steels.
 - Rapid steels.
 - Steels with particular characteristics (or particular electrical resistances).

Designation of the steels

European Standard UNI EN 10027-1/06

European Standard UNI EN 10027-1/06 for Designation of the steels

It establishes the rules for the designation of steels by means of literal and numerical symbols that express the intended use and the main characteristics, *e.g.* mechanical, physical or chemical, in such a way as to provide abbreviated identification of the steels themselves.

European Standard UNI EN 10027-1/06 for Designation of the steels

Category 1: Steels designated based on their use and their mechanical or physical characteristics.

Category 2: Steels designated according to their chemical composition, in turn divided into 4 subgroups.

Designation of the steels

Category 1: Steels designated according to their application and mechanical or physical properties.

The designation must include:

- The initial symbol that determines its use
- The main feature (mechanics, physics, etc.)

These steels are generally used in the rolling state (or other hot working), and only in exceptional cases in the normalized state.

Designation of the steels

Category 1

Table 1: The Classification of steels in accordance with their designated use

Designation	Meaning	Examples
S	Steels for structural steel engineering	S235JR; S355J0
P	Steels for pressure vessel construction	P265GH; P355M
L	Steels for pipeline construction	L360A; L360QB
E	Engineering steels	E295; E360
B	Reinforcing steels	B500A; B500B
Y	Prestressing steels	Y1770C; Y1230H
R	Steel for rails	R350GHT
H	Cold rolled flat rolled steels with higher-strength drawing quality	H400LA
D	Flat products made of soft steels for cold reforming	DC04; DD14

INITIAL
SYMBOL
THAT
DETERMINES
ITS USE



MAIN
FEATURE



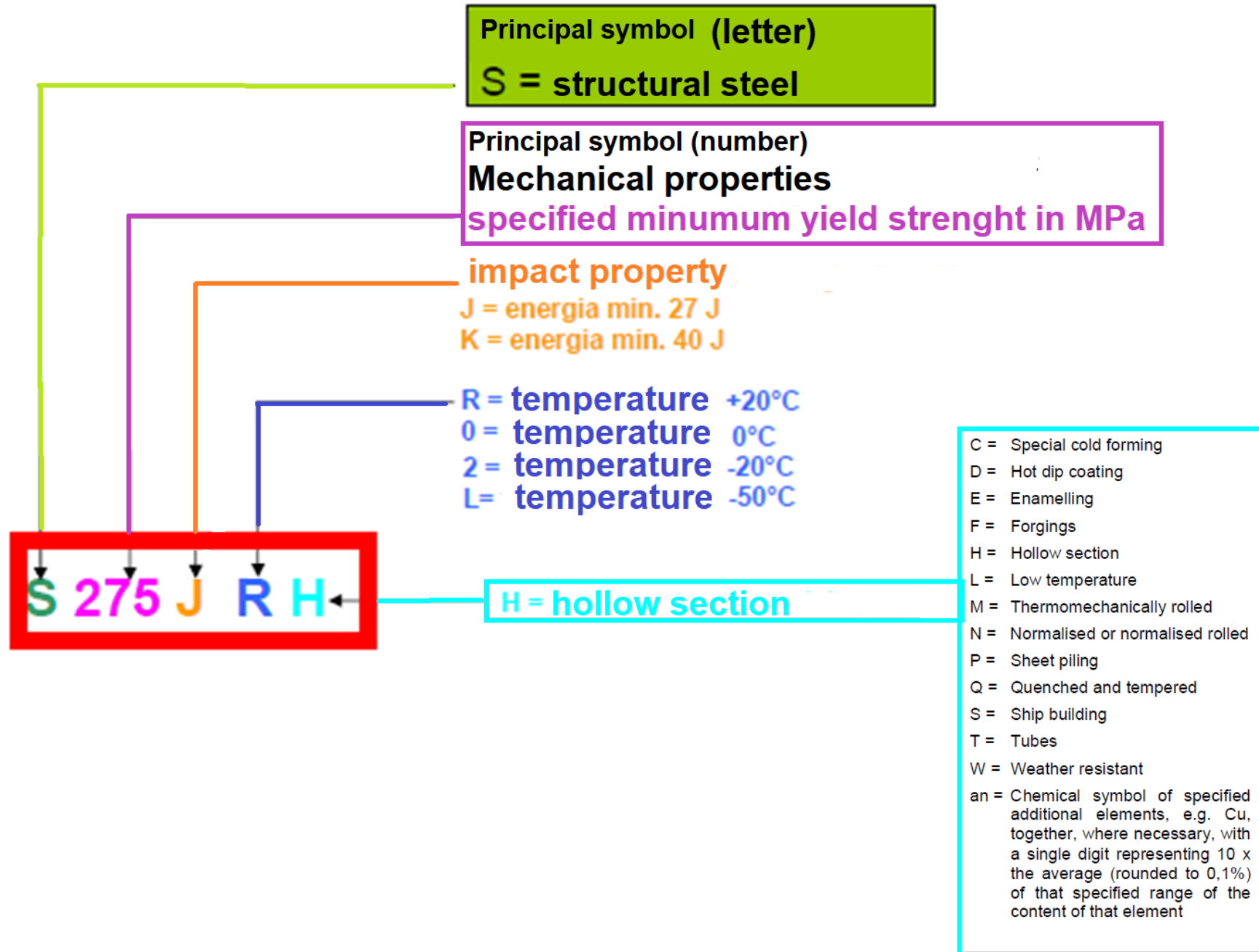
Designation of the steels

Category 1

Principal symbols EN 10027-1:2005		
Symbol	Application	
Snnna	Structural steel	nnn indicates specified minimum yield strength (R_e) in MPa for smallest thickness range. Additional symbols (a) indicate other material properties, process route, product form or type etc.
Pnnna	Steel for pressure purposes	
Lnnna	Steel line pipe	
Ennna	Engineering steels	

Designation of the steels

Category 1



Designation of the steels

Category 1

EU Grade	C%	Mn%	P%	S%	Si%
S235	0.22 max	1.60 max	0.05 max	0.05 max	0.05 max
S275	0.25 max	1.60 max	0.04 max	0.05 max	0.05 max
S355	0.23 max	1.60 max	0.05 max	0.05 max	0.05 max

Designation of the steels

Category 1

Structural Steel Grade at 16mm	Minimum Yield Strength at nominal thickness 16mm			
	psi		N/mm ² (MPa)	
S235	33 000		235 N/mm ²	
S275	36 000		275 N/mm ²	
S355	50 000		355 N/mm ²	

Designation of the steels

Category 2: Steels designated according to their chemical composition. 4 different groups:

Group 1: Non alloy steel with an average of Mn content $< 1\%$.

Group 2: Non alloy steel with an average of Mn content $> 1\%$; Non alloy cutting steels; alloy steels where the content by weight of every average alloying element is $< 5\%$.

Group 3: Stainless steels and other alloy steels (except high speed steels) where the average content by weight of at least of one alloying element is $> 5\%$

Group 4: High speed steels

These steels, with only a few exceptions, are always subjected to heat treatment.

Designation of the steels

Category 2

Group 1: Non alloy steel with an average of Mn content $< 1\%$.

The designation must include the following symbols in the order indicated:

- The letter **C**.
 - A number equal to 100 times the prescribed average percentage of carbon
-
- Example: C 35
 - Non alloys steel with average percentage of carbon of 0.35%

Designation of the steels

Category 2

Group 2: Non alloy steel with an average of Mn content $> 1\%$; Non alloy cutting steels; alloy steels where the content by weight of every average alloying element is $< 5\%$.

The designation must include the following symbols in the order indicated:

- A number equal to 100 times the prescribed average percentage of carbon
- The chemical symbols that indicate the alloying elements characterizing the steel in descending order with respect to the value of their respective contents. (if the contents are the same, the symbols are indicated in alphabetical order)
- The numbers indicating the content of the alloying elements. Each number represents the average content of the element multiplied by a factor and rounded to the nearest integer.

Designation of the steels

Category 2

Group 2: Non alloy steel with an average of Mn content $> 1\%$; Non alloy cutting steels; alloy steels where the content by weight of every average alloying element is $< 5\%$.

Element	Factor
Cr, Co, Mn, Ni, Si, W	4
Al, Be, Cu, Mo, Nb, Pb, Ta, Ti, V, Zr	10
Ce, N, P, S	100
B	1 000

Example: 36 CrNiMo 4

Low alloy steel with average carbon content $C = 0.36\%$, chromium $Cr = 1$, and Ni and Mo content not specified.

Designation of the steels

Category 2

Group 3: Stainless steels and other alloy steels (except high speed steels) where the average content by weight of at least of one alloying element is $>5\%$.

The designation must include the following symbols in the order indicated:

- The letter **X**
- A number equal to 100 times the prescribed average percentage of carbon.
- The chemical symbols that indicate the alloying elements characterizing the steel in descending order with respect to the value of their respective contents (if the contents are the same, the symbols are indicated in alphabetical order).
- The numbers indicating the content of the alloying elements. Each number represents the average content of the element rounded to the nearest integer.

Example: X 10 Cr 13

Chromium stainless steel, with average contents of C = 0.10% and Cr = 13%

Designation of the steels

Category 2

Group 4: High speed steels

The designation must include the following symbols in the order indicated:

- The letters HS
- The numbers indicating the content of the alloying elements reported in the following order:
 - W
 - Mo
 - V
 - Co

Example: HS 18-0-1

High speed steel for tools with medium contents $W = 18\%$, $V = 1\%$.

Designation of the steels

Category 2

Unalloyed steels (Mn content < 1%)



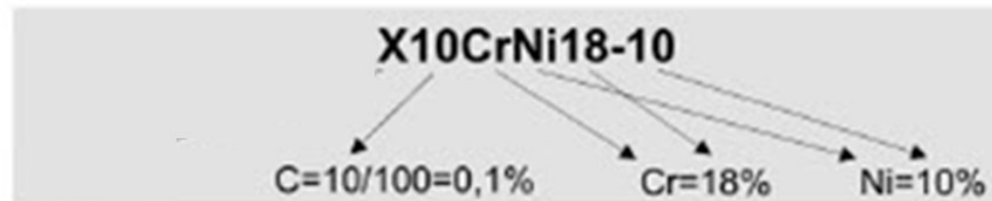
Group 1

Alloyed steels (individual alloying element contents < 5 %)



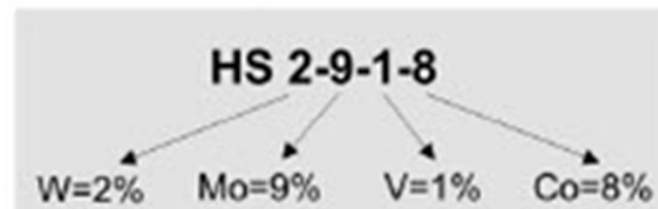
Group 2

Alloyed steels (individual alloying element contents ≥ 5 %)



Group 3

High-speed steels



Group 4

Designation of the steels

Designation	Indicatory analysis	Strength	Character	Application
S 355 J2 (St 52-3)	C ≤ 0.22 Si ≤ 0.55 Mn ≤ 1.60	≈ 550 N/mm ²	Structural steel unalloyed, with good weldability	For common applications in mould and die making and machine and jig construction
C 45	C 0.45 Si 0.30 Mn 0.70	≈ 640 N/mm ²	Tool steel unalloyed, suitable for flame hardening	Unhardened parts for mould, die and jig construction or plates and frames for mould bases and die sets
X 40 Cr 14	C 0.40 Si 0.40 Mn 0.30 Cr 13.00	≈ 720 N/mm ²	Steel for through hardening low corrosion, high-alloy	Cavity plates and inserts for the processing of plastics, mainly for the processing of corrosive plastics
X 40 Cr 14	C 0.40 Si 0.40 Mn 0.30 Cr 13.00	≈ 720 N/mm ²	Steel for through hardening low corrosion, suitable for mirror polishing, electro-slag remelted, high-alloy	Cavity plates and inserts for the processing of plastics, mainly for the processing of corrosive plastics
X 33 CrS 16	C 0.33 Si 0.30 Mn 0.80 Cr 16.00 S 0.06 Ni 0.30	≈ 1080 N/mm ²	Tool steel pre-toughened, corrosion resistant, with good machinability, high-alloyed	Plates for corrosion resistant mould bases and die sets; moulds for corrosive plastics
21 MnCr 5	C 0.21 Si 0.25 Mn 1.25 Cr 1.20	≈ 660 N/mm ²	Steel for case-hardening alloyed	Cavity plates and machine parts

40 CrMnMo 7	C Si Mn Cr Mo	0.40 0.40 1.50 1.90 0.20	$\approx 1080 \text{ N/mm}^2$	Tool steel alloyed and pre-toughened, ideal for nitriding and polishing	Cavity plates, inserts and high-strength machine parts
40 CrMnMoS 8-6	C Si Mn Cr Mo S	0.40 0.40 1.50 1.90 0.20 0.06	$\approx 1080 \text{ N/mm}^2$	Tool steel alloyed and pre-toughened, good machinability	Cavity plates for mould bases and die sets with increased requirements on strength
X 38 CrMo 16	C Cr Mo	0.36 16.00 1.20	$\approx 1010 \text{ N/mm}^2$	Tool steel pre-toughened, corrosion-resistant, polishable, high-alloyed	Moulds for processing corrosive plastics
X 37 CrMoV 5-1	C Si Mn Cr Mo V	0.38 1.00 0.40 5.30 1.20 0.40	$\approx 780 \text{ N/mm}^2$	Hot-work steel high-alloyed	Cavity plates and inserts for plastic injection moulds
X 37 CrMoV 5-1	C Si Mn Cr Mo V	0.38 1.00 0.40 5.30 1.20 0.40	$\approx 780 \text{ N/mm}^2$	Hot-work steel suitable for mirror polishing, electro-slag remelted, high-alloy	Cavity plates and inserts for die casting (Al, Mg, Zn etc.) and injection moulds
X 40 CrMoV 5-1	C Si Cr Mo	0.40 1.00 5.30 1.40	$\approx 780 \text{ N/mm}^2$	Hot-work steel high-temperature resistant, high temperature wear resistant, excellent thermal conductivity, high-alloy	Standard material for hot-work tools, extrusion moulds, dies, tools for plastics processing

40 CrMnNiMo 8-6-4	C	0.40	$\approx 1080 \text{ N/mm}^2$	Tool steel quenched and tempered steel, with uniform strength for larger dimensions; suitable for polishing and nitriding	Large moulds with deep cavities for items such as bumpers or dashboards
	Mn	1.50			
	Cr	1.90			
	Mo	0.20			
	Ni	1.10			
	Si	0.30			
90 MnCrV 8	C	0.90	$\approx 760 \text{ N/mm}^2$	Steel for through hardening dimensional stability and high hardenability; wear-resistant, cold-work steel with very good machinability	Mould plates, inserts exposed to abrasive stress cutting punches, wear plates, cutting dies and guiding plates; guiding rails
	Si	0.20			
	Mn	2.00			
	Cr	0.40			
	V	0.10			
HS 6-5-2 C	C	0.90	$\approx 920 \text{ N/mm}^2$	HSS - High speed steel very high adhesive and abrasive wear resistance in combination with high toughness and compressive strength	Blocks for eroding, cutting punches and fine blanking punches; impact extrusion punches and dies; inserts with a very high wear resistance
	Si	0.30			
	Mn	0.30			
	Cr	4.00			
	Mo	5.00			
	V	1.90			
	W	6.20			

Designation of the steels

In addition to the descriptive steel grade naming system indicated above, within **EN 10027-2** is defined a system for creating unique steel grade numbers.

While less descriptive and intuitive than the grand names they are easier to tabulate and use in data processing applications.

The number is in the following format: $x.yyzz(zz)$

Where x is the material type (only 1 is specified so far), yy is the steel group number (specified in EN10027-2) and zz(zz) is a sequential number designated by the certifying body, the number in brackets being unused but reserved for later use.

Designation of the steels

Following the indications of the standard described in previous tables, the numerical designation of steel 1.0577 has the following meaning:

- 1. is the first digit, which represents the group number of the material (in the specific case steel);
- 05 is the second digit, which represents the steel group number (in the specific case, with reference to the previous table, it is a quality unalloyed steel with a carbon content greater than 0.25% and less than 0.55 and with breaking load between 500 and 700 N / mm²
- 77 is the characteristic sequential number of steel attributed by the European Registration Office

Designation of the steels

Designazione alfanumerica EN 10027-1	Designazione Numerica EN 10027-2
S185	1.0035
S235JRG1	1.0036
S235JR	1.0037
S235JRG2	1.0038
S235J0	1.0114
S235J2G3	1.0116
S275JR	1.0044
S275J0	1.0143
S275J2G3	1.0144
S355JR	1.0045
S355J0	1.0553
S355J2G3	1.0570
S355K2G3	1.0595
E295	1.0050
E335	1.0060
E360	1.0070

Designation of the steels

Designazione		Analisi Chimica Indicativa (% min - max)								
UNI EN 10027- 1	UNI EN 10027-2	AISI	C	Mn	P	S	Si	Cr	Ni	Mo
X5 CrNi 1810	1.4301	304	0,07	2	0,045	0,015	1	17 19,5	8 10,5	—
X2 CrNi 1811	1.4306	304L	0,03	2	0,045	0,015	1	18 20	10 12	—
X22 CrNi 2520	1.4845	310	0,25	2	0,045	0,030	1,5	24 26	19 22	—
X5 CrNiMo 1712	1.4401	316	0,07	2	0,045	0,015	1	16,5 18,5	10 13	2 2,5
X2 CrNiMo 1712	1.4404	316L	0,03	2	0,045	0,015	1	16,5 18,5	10 13	2 2,5
X6 CrNiTi 1811	1.4541	321	0,08	2	0,045	0,015	1	17 19	9 12	—
X20 Cr 13	1.4021	420	0,16 0,25	1,5	0,04	0,015	1	12 14	—	—
X8 Cr 17	1.4016	430	0,08	1	0,04	0,015	1	16 18	—	—

Other types of steel classifications

Classification of steels based on uses

- STEELS FOR GENERAL STRUCTURAL PURPOSES
- SPECIAL STRUCTURAL STEELS
- STAINLESS STEELS
- Tool steels
- Steel for particular uses

Classification Systems in USA

