Stainless steel. What is it ?

The term "stainless" was used initially in the development of the steel for the cutlery business in the production of knives, forks, spoons etc. There are now many stainless steel types and grades used in applications requiring resistance to staining, oxidation and general corrosion resistance.

The main element of stainless steel is iron (Fe) hence it is an iron alloy containing a minimum of 12% chromium. Additional alloying elements are added to provide strength, cold working ability and toughness for example:-

Copper
Molybdenum
Titanium
Nickel

Other non-metals are added primarily Nitrogen and Carbon.

The main objective in the selection of a type and grade of stainless steel is to meet the performance requirements for strength and durability in its particular intended application.

The two common grades of stainless steel used for construction fixings in the stone and masonry sectors are from the Austenitic group commonly referred to as follows:-

Grade 304 or Grade 316

Grade 304 is generally specified for normal environmental applications.
Grade 316 is specified where a higher level of corrosion resistance is required e.g. marine environment.

Why choose stainless steel?

The cost of stainless steel is very competitive compared with other nickel or titanium based alloys and offers a range of corrosion resistant properties suitable for large number of industrial applications. Their strength is superior to plastics materials stainless steel can be hot or cold worked and fabricate using standard and traditional engineering techniques. Unlike certain plastics stainless steel is fully recyclable.

What makes stainless steel "stainless" ?

The reason for the high level of corrosion resistance of stainless steel is due to its self repairing properties. This is achieved by the formation of naturally occurring chromium-rich "passive" chromium oxide film on the surface of the steel. The film is extremely adherent and chemically stable providing sufficient oxygen is available to the surface for the chromium rich oxide film to form.

It is important to remember that stainless steel can corrode under certain conditions and it is essential therefore to select the correct grade for a given application.

The family group of stainless steels.

Stainless steels are divided into four main group types namely:-
Austenitic, Ferritic, Martensitic and Duplex.
These names describe the crystalline structure of the steel.

Austenitic stainless steels have typically 18% chromium and contain nickel. This changes the metallic structure from ferritic to austenitic and improves the corrosion resistance. They cannot be hardened by heat

treatment. They are non-magnetic however a small amount of local magnetism is produced after cold forming such as bending and rolling.

Ferritic stainless steels contain chromium as their main alloying element of between 13% - 17% and have a low carbon content. They are magnetic and cannot be hardened by heat treatment.

Martensitic stainless steels have typically 12% chromium with higher carbon content than the ferritic types. They are magnetic and can be hardened by normal quenching and tempering techniques like medium and high plain carbon steels. Martensitic steels are commonly used in the production of cutlery and are also used in the aerospace industry.

Duplex stainless steels are used where both corrosion resistance and strength are required. They cannot be hardened by heat treatment. Their metallic structure is a combination of austenite and ferrite.

"Super" Austenitic and "Super" Duplex stainless steels have a greater resistance to pitting or crevice corrosion than the ordinary austenitic or duplex steels. This is due to additional chromium, nitrogen and molybdenum.

Precipitation Hardening stainless steels can be hardened and strengthened like the martensitic group by heat treatment. The metallic structure has a different mechanism to the process of the martensitic types consequently either austenitic or martensitic precipitation hardening structures can be formed.

Stainless steel and its corrosion and oxidation resistance.

As a general rule, the higher the chromium content of stainless steel the higher the corrosion resistance. When nickel is added to create the austenitic steel the oxide film is strengthened and increases the durability in more aggressive environments. If molybdenum is added to either austenitic or ferritic stainless steel the pitting corrosion resistance is greatly improved.

The new European standards.

The main purpose of the new European Standards is to remove internal trade barriers and national technical rules and
thus help to create better business opportunities for UK and other European countries.

The new system is designed to create a common technical language and understanding that replaces the current operating
standards which exist in different countries.

The new applicable European standards for stainless steel are as follows:-

Product standards.

EN 10088-1	Stainless steel grades.
EN 10088-2	Stainless steel flat products for general purposes.
EN 10088-3	Stainless steel long products for general purposes.
EN 10095	Heat resisting flat and long products.
EN 10028-7	Stainless steel flat products for pressure purposes.
EN 10272	Stainless steel rolled bar for pressure purposes.

Tolerance standards for dimension and shape.

EN 10029	Hot rolled steel plate.
EN 10051	Hot rolled steel strip.
EN 10259	Cold rolled stainless steel strip.
EN 10258	Cold rolled stainless steel narrow strip (max 60 cm width)

International material Standards: EN, ASTM and JIS

Corrosion resisting standards:-

EN 10088-2 (Previously UK BS 1449 part 2)	Stainless steel - Sheet, plate and strip for general purposes.
EN 10151	Stainless steel strip for springs.
ASTM A240	Heat-resisting Cr and Cr-Ni stainless steel plate, sheet and strip for pressure vessels.
ASTM A167	Stainless and heat-resisting Chromium-Nickel steel plate, sheet and strip.
ASTM A176	Stainless and heat resisting Chromium steel plate, sheet and strip.
ASTM A666	Austenitic stainless steel sheet, strip, plate, bar for structural and architectural applications.
JIS G4308	Stainless steel wire rods.
JIS G4303	Stainless steel bars

MECHANICAL PROPERTIES OF STAINLESS STEEL

	EN	Rp0.2 N/mm²	Rp1.0 N/mm²	Rm N/mm²	ASTM	Rp0.2 N/mm²	Rm N/mm²
Ferritic	1.4512	220	-	380	S40910	170	380
	1.4000	230	-	400	S41008	205	415
	1.4016	260	-	430	S43000	205	450
	1.4510	240	-	420	S43035	205	415
Mart.	1.4021	-	-	-	S42010	-	-
	1.4028	-	-	-	S42000	-	-
	1.4018	680	-	840	-	-	-
Duplex	1.4362	400	-	630	S32304	400	600
	1.4460	460	-	620	S31200	485	620
	1.4462	460	-	640	S31803	450	620
	1.4410	530	-	730	S32750	550	795
Austenitic	1.4372	350	380	750	S20100	260	655
	1.4310	250	280	600	S30100	205	515
	1.4307	200	240	500	S30403	170	485
	1.4301	210	250	520	S30400	205	515
	1.4311	270	310	550	S30453	205	515
	1.4541	200	240	500	S32100	205	515
	1.4306	200	240	500	S30403	170	485
	1.4303	220	250	500	S30500	205	515
	1.4404	220	260	520	S31603	170	485
	1.4401	220	260	520	S31600	205	515
	1.4406	280	320	580	S31653	205	515
	1.4571	220	260	520	S31603	205	515
	1.4432	220	260	520	S31603	170	485
	1.4436	220	260	530	S31600	205	515
	1.4435	220	260	520	S31603	170	485
	1.4438	220	260	520	S31703	205	515
	1.4434	270	310	540	S31753	240	550
	1.4439	270	310	580	S31726	240	550
	1.4539	220	260	520	N08904	215	490
	1.4547	300	340	650	S31254	300	650
	1.4652	430	470	750	S32654	430	750
	1.4948	190	230	510	S30409	205	515
	1.4878	190	230	500	S32109	205	515
	1.4818	290	330	600	S30415	290	600
	1.4833	210	250	500	S30908	205	515
	1.4828	230	270	550	-	-	-
	1.4835	310	350	650	S30815	310	600
	1.4845	210	250	500	S31008	205	515
	1.4854	300	340	650	S35315	270	650

PHYSICAL PROPERTIES

		Density	Modulus of elasticity		Thermal expansion RT to	
		ρKg/dm³	EKN/mm²		$\alpha x10^{-6}$	C°
	EN	RT	RT	400°C	100°C	400°C
Ferritic	1.4512	7.7	220	195	10.5	12.0
	1.4000	-	-	-	10.5	12.0
	1.4016	-	-	-	10.5	10.5
	1.4510	-	-	-	10.5	10.5
Mart.	1.4021	7.7	215	190	10.5	12.0
	1.4028	-	215	190	10.5	12.0
	1.4018	-	200	170	10.3	11.6
Duplex	1.4362	7.8	200	172	16.0	17.5
	1.4460	-	-	-	-	-
	1.4462	-	-	-	-	-
	1.4410	-	-	-	-	-
Austenitic	1.4372	7.8	200	172	16.0	17.5
	1.4310	7.9	-	-	-	-
	1.4307	7.9	200	172	16.0	17.5
	1.4301	-	-	-	-	-
	1.4311	-	-	-	-	-
	1.4541	-	-	-	-	-
	1.4306	7.9	200	172	16.0	17.5
	1.4303	-	-	-	-	-
	1.4404	8.0	200	172	16.0	17.5
	1.4401	-	-	-	-	-
	1.4406	-	-	-	-	-
	1.4571	-	-	-	-	-
	1.4432	8.0	200	172	16.0	17.5
	1.4436	-	-	-	-	-
	1.4435	-	-	-	-	-
	1.4438	8.0	200	172	16.0	17.5
	1.4434	-	-	-	-	-
	1.4439	8.0	200	172	16.0	17.5
	1.4539	-	195	166	16.0	17.0
	1.4547	-	195	166	16.0	18.0
	1.4652	-	190	163	15.0	16.2
		Density	500	1000°C	500	1000°C
	1.4948	7.9	160	125	18.2	-
	1.4878	7.9	-	-	18.2	-
	1.4818	7.8	-	-	18.2	20.0
	1.4833	7.9	160	125	17.8	19.5
	1.4828	7.9	-	-	17.8	19.5
	1.4835	7.8	-	-	18.2	19.5
	1.4845	7.9	-	-	17.3	19.0
	1.4854	7.9	-	-	16.5	18.0

CHEMICAL COMPOSITION

	International steel number/name			Typical composition, %					
	EN	ASTM	JIS	C	N	Cr	Ni	Mo	Other
Ferritic	1.4512	S40910	SUH 409L	0.02	-	12	-	-	Ti
	1.4000	410S	SUH 410S	0.04	-	12	-	-	-
	1.4016	430	SUS 430	0.04	-	16.5	-	-	-
	1.4510	S43035	SUS 430LX	0.04	-	18	-	-	Ti
Mart.	1.4021	S42010	SUS 420J1	0.20	-	13	-	-	-
	1.4028	420	SUS 420J2	0.30	-	12.5	-	-	-
	1.4018	-	-	0.03	0.04	16	5	1	-
Duplex	1.4362	S32304	-	0.02	0.10	23	4.5	0.3	-
	1.4460	S31200	SUS 329J1	0.02	0.09	25	5	1.5	-
	1.4462	S31803	-	0.02	0.17	22	5.7	3.1	-
	1.4410	S32750	-	0.02	0.27	25	7	4	-
Austenitic	1.4372	201	SUS 201	0.05	0.15	17	5	-	6.5Mn
	1.4310	301	SUS 301	0.10	0.04	17	7	-	-
	1.4307	304L	SUS 304L	0.02	0.06	18.3	9.2	-	-
	1.4301	304	SUS 304	0.04	0.06	18.3	8.7	-	-
	1.4311	304LN	SUS 304LN	0.02	0.14	18.3	8.7	-	-
	1.4541	321	SUS 321	0.04	0.01	17.3	9.2	-	Ti
	1.4305	303	SUS 303	0.07	0.06	18	8.5	-	S
	1.4567	S30430	SUS XM7	0.01	0.02	18	9	-	3.5Cu
	1.4306	304L	SUS 304L	0.02	0.06	18.3	10.2	-	-
	1.4303	305	SUS 305J1	0.02	0.02	18	11.5	-	-
	1.4404	316L	-	0.02	0.06	17.3	11	2.2	-
	1.4401	316	SUS 316	0.04	0.04	16.8	10.7	2.2	-
	1.4406	316LN	SUS 316LN	0.02	0.14	17.5	11	2.2	-
	1.4571	316Ti	SUS 316Ti	0.04	0.01	17	11	2.2	Ti
	1.4432	316L	-	0.02	0.06	17	11.7	2.7	-
	1.4436	316	SUS 316	0.04	0.06	17	11	2.7	-
	1.4435	316L	SUS 316L	0.02	0.6	17.3	12.7	2.7	-
	1.4438	317L	SUS 317L	0.02	0.08	18.3	12.2	3.2	-
	1.4434	317LN	SUS 317LN	0.02	0.12	17	11	3.2	-
	1.4439	S31726	-	0.02	0.14	17.3	12.7	4.2	-
	1.4539	N08904	-	0.01	0.06	20	25	4.5	1.5Cu
	1.4547	S31254	-	0.01	0.20	20	18	6.1	Cu
	1.4652	S32654	-	0.01	0.50	24	22	7.3	3.5Mn,Cu
	1.4948	304H	SUS 304	0.05	0.06	18.3	8.7	-	-
	1.4878	321H	SUS 321	0.05	0.01	17.3	9.2	-	Ti
	1.4818	S30415	-	0.05	0.15	18.3	9.5	-	1.3Si, Ce
	1.4833	309S	SUH 309	0.06	0.08	22.5	12.5	-	-
	1.4828	-	-	0.04	0.04	20	12	-	2Si
	1.4835	S30815	-	0.09	0.17	21	11	-	1.7Si, Ce
	1.4845	310S	SUH 310	0.05	0.06	25	20	-	-
	1.4854	S35315	-	0.05	0.15	25	35	-	1.5Si, Ce