

## 4.9 STAINLESS STEEL

As described in Notes on Materials: 190 the system of designation for stainless steel has been changed by the introduction of BS EN 10088. The mechanical properties given below are for the grades in BS EN 10088. The nearest equivalent old designation is also given.

### 4.9.1 MATERIAL GRADES

For structural use with high resistance to corrosion: use austenitic or duplex stainless steels.

Suggested grades for atmospheric applications												
Steel grade	Location											
	Rural			Urban			Industrial			Marine		
	L	M	H	L	M	H	L	M	H	L	M	H
304L	✓	✓	✓	✓	✓	(✓)	(✓)	(✓)	X	✓	(✓)	X
316L	○	○	○	○	✓	✓	✓	✓	(✓)	✓	✓	(✓)
duplex 2205	○	○	○	○	○	○	○	○	✓	○	○	✓

L - Least corrosive conditions within that category.      WARNING: Consult Arup Swimming Pool Design Guide where appropriate.  
M - Typical of that category.  
H - Corrosion higher than typical.  
O - Potentially over-specified for corrosion.  
✓ - The optimum choice for corrosion resistance.  
X - Likely to suffer excess corrosion.  
(✓) - Can be considered if precautions are taken.

### 4.9.2 MECHANICAL PROPERTIES

Old designation	Material Name	Material number	0.2% proof stress (N/mm <sup>2</sup> )		UTS (N/mm <sup>2</sup> )		Elongation (%)	
			Hot Rolled Plate	Bars, rods +sections	Hot Rolled Plate	Bars, rods +sections	Hot Rolled Plate	Bars, rods +sections
304L 304 S11	X2CrNi19-11	1.4306	200	180	500 to 650	460 to 680	45	45
316L 316S11	X2CrNiMo17-12-2	1.4404	220	200	520 to 670	500 to 700	45	40
316L 316S13	X2CrNiMo18-14-3	1.4435	220	200	520 to 670	500 to 700	45	40
Duplex 2205	X2CrNiMoN22-5-3	1.4462	460	450	640 to 840	650 to 880	25	25

### 4.9.3 PHYSICAL PROPERTIES

Old designation	Material Number	Density (kg/m <sup>3</sup> )	Thermal expansion 20 - 100 C (10 <sup>-6</sup> /C)	Thermal conductivity (W/m C)	Heat capacity (J/kg C)
304L	1.4306	7900	16	15	500
316L	1.4404	8000	16	15	500
duplex 2205	1.4462	7800	13	15	500

### 4.9.4 DESIGN STRENGTH

The basic design strength,  $p_y$ , may generally be taken as the 0.2% proof stress given in 4.9.2 as those are minimum values. The exception is Duplex 2205 where a maximum of 450N/mm<sup>2</sup> should be used and this should be verified by mill certificates. For duplex 2205 with thickness 10<t<20mm a material safety factor of 1.05 should be used.

Alternatively based on tensile tests  $p_y = \sigma_{0.2} / 1.1$  where  $\sigma_{0.2}$  is the average test value of the 0.2% proof stress. If mill certificates are used  $p_y = \sigma_{m0.2} / 1.2$  where  $\sigma_{m0.2}$  is the average value of the 0.2% proof stress as given on the mill certificate or release note.

### 4.9.5 ELASTIC PROPERTIES

Grade	Design values of elastic properties			Values of constants to be used for determining secant modulus (see over)			
	Young's modulus, E (N/mm <sup>2</sup> )		Shear modulus, G (N/mm <sup>2</sup> )	Transverse direction		Longitudinal direction	
	Transverse direction	Longitudinal direction		k	m	k	m
304L	200 000	200 000	76 900	2.22	7.50	2.22	5.50
316L	195 000	190 000	74 000	2.05	8.00	2.00	6.00
duplex 2205	205 000	200 000	77 900	0.91	4.00	0.89	4.00

#### Deflection calculations

For estimating deflections, use the secant modulus: 
$$E_s = \frac{E_{st} + E_{sc}}{2}$$

where 
$$E_{st} = \frac{E}{1 + k \left( \frac{p_t}{p_y} \right)^m}$$

and 
$$E_{sc} = \frac{E}{1 + k \left( \frac{p_c}{p_y} \right)^m}$$

$p_t$  and  $p_c$  are the values of  $p$  in the tension and compression flange respectively.  
 $k$  and  $m$  are constants obtained from the previous table.

### 4.9.6 AVAILABILITY

Sheet, plate, bar and tubes widely available for 304L and 316L.  
Similar for duplex 2205 but not as widely stocked.

Certain rolled sections available for 304L and 316L. None for duplex 2205.

	$f_y$	UTS	Weldable	Sizes (mm)
High tensile rod		1350	N	4 - 11 $\phi$
		1100	N	12 - 19 $\phi$
		950	N	19 - 25 $\phi$
Reinforcing bar and plain rod	300	500	N	6 - 50 $\phi$ plain
	460	625	N	6 - 32 $\phi$ deformed
	180		Y	6 - 50 $\phi$
Structural sections	180+		Y	I, E, L 250 - 300 □ 100 $\phi$ ○ 400 $\phi$

### 4.9.7 REFERENCES

1. SCI, Concise guide to the structural design of stainless steel.
2. BS EN 10088 : 1995, Stainless steels, Parts 1 - 3