

Table 16. Mechanical properties

Grade	Rolled condition	Material condition	Tensile properties (note 5)					Hardness HV (note 5)		Bend mandrel diameter (180° bend) for strip thicknesses up to and including 10 mm (For thicknesses over 10 mm see note 8.)	Remarks
			Yield strength, $R_e$ , min.	Tensile strength, $R_m$		Elongation, $A$ , min.		min.	max.		
				min.	max.	50 mm	80 mm (note 9)				
4	HS	Hot rolled	N/mm <sup>2</sup> (170)	N/mm <sup>2</sup> (280)	N/mm <sup>2</sup> —	% (25)	% (23)	—	—	1a	The bend mandrel diameter for strip > 3 mm thick is 2a  Thickness 3 mm max. For temper-rolled conditions H2 and H3, the bend angle is 90°
4	CS	Annealed (note 7)	(140)	280	350	30	(28)	—	105	0a	
4	CS	Skin passed (note 3)	(140)	280	370	30	(28)	—	115	0a	
4	CS	Temper rolled, H1 (note 4)	—	290	390	20	(18)	95	120	0a	
4	CS	Temper rolled, H2 (note 4)	—	350	420	—	—	110	135	2a	
4	CS	Temper rolled, H3 (note 4)	—	420	540	—	—	135	165	2a	
4	CS	Temper rolled, H4 (note 4)	—	540	640	—	—	165	195	—	
4	CS	Hard rolled, H5	—	540	—	—	—	165	—	—	
4	CS	Extra hard rolled, H6	—	710	—	—	—	210	—	—	
10	HS	Hot rolled	—	—	—	—	—	—	135	1a	
10	HS/CS	Annealed (note 7)	—	—	—	—	—	—	120	1a	
10	HS/CS	Hardened in water from 900 °C (core properties of case-hardened component)	—	—	—	—	—	200	300	—	
12	HS	Hot rolled	170	310	—	25	(23)	—	—	1a	The bend mandrel diameter for strip ≤ 1.2 mm thick is 0a
12	CS	Skin passed (note 3)	170	310	410	28	(26)	—	—	1a	
17	HS	Hot rolled	200	350	—	25	(23)	—	—	2a	
17	CS	Annealed (note 7)	190	340	—	26	(24)	—	—	1a	
20	HS	Hot rolled	350	540	—	18	(16)	—	—	2a	
20	CS	Annealed (note 7)	230	420	—	20	(18)	—	—	3a	
22	HS	Hot rolled	230	400	—	24	(22)	—	—	2a	
22	CS	Annealed (note 7)	200	370	—	25	(23)	—	—	1a	
30	HS	Hot rolled	280	500	—	18	(16)	—	—	3a	
30	CS	Annealed (note 7)	230	380	—	20	(18)	—	—	1a	
40	HS	Hot rolled	300	540	—	16	(14)	—	(230)	4a	
40	HS	Normalized	300	540	—	16	(14)	—	230	4a	
40	CS	Annealed (note 7)	250	420	—	18	(16)	—	155	1a	
40	CS	Temper rolled, H3	—	—	—	—	—	220	260	—	
40	CS	Induction or flame hardened	—	—	—	—	—	600	—	—	

50	HS	Hot rolled	--	--	--	--	--	--	(230)	--	
50	HS/CS	Normalized	--	--	--	--	--	--	230	4 <sub>a</sub>	
50	HS	Annealed	--	--	--	--	--	--	175	2 <sub>a</sub>	
50	CS	Annealed } (note 7)	--	--	--	--	--	--	165	1 <sub>a</sub>	
50	CS	Temper rolled, H3	--	--	--	--	--	230	270	--	
50	HS/CS	Induction or flame hardened	--	--	--	--	--	700	--	--	
60	HS	Hot rolled	--	--	--	--	--	--	(270)	--	
60	HS/CS	Normalized	--	--	--	--	--	--	270	--	
60	HS	Annealed	--	--	--	--	--	--	185	3 <sub>a</sub>	
60	CS	Annealed (note 7)	--	--	--	--	--	--	170	1 <sub>a</sub>	Thickness < 1.0 mm
60	CS	Annealed	--	--	--	--	--	--	175	2 <sub>a</sub>	Thickness ≥ 1.0 mm
60	CS	Temper rolled, H3	--	--	--	--	--	235	275	--	
60	CS	Hardened and tempered	--	--	--	--	--	280	530	20 <sub>a</sub>	
70	HS	Hot rolled	--	--	--	--	--	--	(285)	--	
70	HS/CS	Normalized	--	--	--	--	--	250	300	--	
70	HS	Annealed	--	--	--	--	--	--	195	4 <sub>a</sub>	
70	CS	Annealed (note 7)	--	--	--	--	--	--	180	2 <sub>a</sub>	Thickness < 1.0 mm
70	CS	Annealed	--	--	--	--	--	--	185	3 <sub>a</sub>	Thickness ≥ 1.0 mm
70	CS	Temper rolled, H3	--	--	--	--	--	240	280	--	
70	CS	Hardened and tempered	--	--	--	--	--	370	545	20 <sub>a</sub>	
80	HS	Hot rolled	--	--	--	--	--	--	(300)	--	
80	HS/CS	Normalized	--	--	--	--	--	270	320	--	
80	HS	Annealed	--	--	--	--	--	--	205	5 <sub>a</sub>	
80	CS	Annealed (note 7)	--	--	--	--	--	--	190	3 <sub>a</sub>	Thickness < 1.0 mm
80	CS	Annealed	--	--	--	--	--	--	195	4 <sub>a</sub>	Thickness ≥ 1.0 mm
80	CS	Temper rolled, H3	--	--	--	--	--	250	280	--	
80	CS	Hardened and tempered	--	--	--	--	--	395	580	20 <sub>a</sub>	
95	HS	Hot rolled	--	--	--	--	--	--	(330)	--	
95	HS/CS	Normalized	--	--	--	--	--	330	350	--	
95	HS	Annealed	--	--	--	--	--	--	220	6 <sub>a</sub>	
95	CS	Annealed (note 7)	--	--	--	--	--	--	205	3 <sub>a</sub>	Thickness < 1.0 mm
95	CS	Annealed	--	--	--	--	--	--	210	4 <sub>a</sub>	Thickness ≥ 1.0 mm
95	CS	Hardened and tempered	--	--	--	--	--	420	650	24 <sub>a</sub>	

*a* is the thickness of the bend test piece.

NOTE 1. Tempers and mechanical properties for CS4 grade, as listed, are applicable up to 3 mm thick; above 3 mm such properties are to be the subject of an agreement between manufacturer and purchaser.

NOTE 2. CS4 in the H3 condition has to have the axis of the bend at right angles to the direction of final rolling.

NOTE 3. It is recommended that material in the skin passed (SP) condition should be used within a period of six weeks, in order to avoid the loss, during storage, of the beneficial effect of skin passing (see note 2.5).

NOTE 4. Temper rolled rimmed steels are prone to age hardening which leads to an increase in hardness and a decrease in ductility. Because of this factor, the period between final processing at the mill and fabrication should be kept to a minimum.

Freedom from age-hardening may be achieved by the selection of an aluminium-stabilized steel.

NOTE 5. Tensile and hardness property figures in brackets are for guidance only.

NOTE 6. Material grades 60, 70, 80 and 95 in the hardened and tempered (HT) condition are supplied with hardnesses in bands of 40 HV within the overall hardness ranges given in the table.

NOTE 7. Material supplied in the annealed (A) condition has to be capable of meeting the specified properties in the hardened and tempered (HT) condition, when heat treated by a process agreed between the manufacturer and purchaser.

NOTE 8. Bend mandrel diameters for strip > 10 mm thick may be specified by agreement between manufacturer and purchaser.

NOTE 9. The 80 mm gauge length is currently not used in the UK but, as a step towards conforming with European practice, tentative values have been included.

4.5.2.2 Grades 50, 60, 70, 80 and 95. Decarburization should be minimal and, when specially requested, complete plus partial decarburization, as indicated by the proportion of ferrite, shall not extend to a depth below the surface

greater than 3 % of the nominal thickness of the material, at a distance of not less than 20 mm from the edge.

NOTE. In certain CS conditions, material free from total decarburization\* may be available by arrangement between purchaser and supplier.

Table 15. Chemical composition

Grade	Rolled condition	Type of steel	C		Si		Mn		S	P
			min.	max.	min.	max.	min.	max.	max.	max.
			%	%	%	%	%	%	%	%
4	HS CS	Mild steel	—	0.12	—	—	—	0.60	0.050	0.050
10	HS CS	Case hardening	0.08	0.15	0.10	0.35	0.60	0.90	0.045	0.045
12	HS CS	'12' carbon	0.10	0.15	—	—	0.40	0.60	0.050	0.050
17	HS CS	'17' carbon	0.15	0.20	—	—	0.40	0.60	0.050	0.050
20	HS CS	'20' carbon	0.15	0.25	0.05	0.35	1.30	1.70	0.045	0.045
22	HS CS	'22' carbon	0.20	0.25	—	—	0.40	0.60	0.050	0.050
30	HS CS	'30' carbon	0.25	0.35	0.05	0.35	0.50	0.90	0.045	0.045
40	HS CS	'40' carbon	0.35	0.45	0.05	0.35	0.50	0.90	0.045	0.045
50	HS CS	'50' carbon	0.45	0.55	0.05	0.35	0.50	0.90	0.045	0.045
60	HS CS	'60' carbon	0.55	0.65	0.05	0.35	0.50	0.90	0.045	0.045
70	HS CS	'70' carbon	0.65	0.75	0.05	0.35	0.50	0.90	0.045	0.045
80	HS CS	'80' carbon	0.75	0.85	0.05	0.35	0.50	0.90	0.045	0.045
95	HS CS	'95' carbon	0.90	1.00	0.05	0.35	0.30	0.60	0.040	0.040

NOTE 1. Unless otherwise agreed at the time of ordering, the deoxidation condition for grade 4 is at the discretion of the manufacturer. Grades 12, 17 and 22 are available as rimming, balanced or killed steels and any preference should be indicated by employing the appropriate prefix to the grade (see 4.5.1). Grades 10, 20, 30, 40, 50, 60, 70, 80 and 95 are all killed steels.

NOTE 2. For grades 30 to 95 inclusive the purchaser may order to restricted ranges of carbon and manganese within the ranges specified in the table. For steels containing up to and including 0.85 % C, the minimum carbon range is 0.05 % (e.g. 0.40/0.45 % C). Above 0.85 % carbon the minimum carbon range is 0.07 % (e.g. 0.93/1.00 % C). These steel types may also be ordered with a restricted manganese range of 0.20 % (e.g. 0.60/0.80 % Mn) when this is required for special applications.

NOTE 3. The purchaser may order to specified lower maxima for sulphur and phosphorus by arrangement with the supplier.

NOTE 4. The analysis of the product may vary from the chemical composition, specified in the table for the appropriate grade, by the variations given in appendix B. This does not apply to rimmed (R) or balanced (B) steels, which may show wider variations than those given in appendix B.

NOTE 5. Where case hardening is to be carried out, a silicon-killed, aluminium-free steel is more suitable.

\*Total depth of decarburization = complete (where present) + partial decarburization.