



C45 / C45E / C45R

QUENCHED AND TEMPERED STEELS

Reference standard: EN ISO 683-1:2018

W.-Nr.	1.0503 / 1.1191 / 1.1201	AFNOR	XC48
AISI	1045	BS	080M46
UNI	C45	JIS	S45C
DIN	Ck45	Other	C45E

CHEMICAL COMPOSITION

C	Si	Mn	P	S	Cr	Mo	Ni	Cu
0.42-0.50 ±0.03	0.10-0.40 ±0.03	0.50-0.80 ±0.04	0.025 max + 0.005	0.035 max ±0.005	0.40 max + 0.05	0.10 max + 0.03	0.40 max + 0.03	0.3 max + 0.05

Cast analysis composition, % by mass | Second row: permissible deviations of the product analysis | Cr+Mo+Ni = max 0.63%

Values for C45E (1.1191) | C45R (1.1201): S 0.020-0.040% | C45 (1.0503): P and S max 0.045%

Impact energy, +H hardenability band and +A hardness (max 207 HB) specified for C45E and C45R only

TEMPERATURE IN °C

Hot working	Normalising +N	Hardening +Q	Hardening +Q	Tempering +T	Stress relieving +SR
1,100-850 °C	840-880 °C in air	820 °C in water	860 °C oil or polymer	550-660 °C in air	50 °C below the tempering temperature

Machinability annealing +A	Isothermal annealing +I	As-rolled +U	Jominy test-piece hardening	Preheating for welding	Post-weld stress relieving
690 °C, cooling 10 °C/h down to 600 then air (max 207 HB)	810 °C in furnace down to 660 °C then air (160- 216 HB)	(169-250 HB)	850 °C in water	250 °C	550 °C, furnace cooling

Critical points: AC1 730 • AC3 775 • Ms 340 °C | Hardness in the +S (shearability) condition: max 255 HBW

MECHANICAL PROPERTIES

HOT-ROLLED - Longitudinal tensile test at 20 °C Mechanical properties in the <u>normalised</u> condition, EN ISO 683-1:2018							
Diameter/thick. (in mm)		R N/mm ² min	ReH N/mm ² min	A% min	Z% min	KV2 J min	HBW for info.
>	≤						
-	16/16	620	340	14	-	-	190
16/16	100/100	580	305	16	-	-	172
100/100	250/250	560	275	16	-	-	162

HOT-ROLLED - Longitudinal tensile and impact test at 20 °C Mechanical properties in the <u>quenched and tempered</u> condition, EN ISO 683-1:2018							
Diameter/thick. (in mm)		R N/mm ²	ReH N/mm ² min	A% min	Z% min	KV2 J min	HBW for info.
>	≤						
-	16/8	700-850	490	14	35	15	213-253
16/8	40/20	650-800	430	16	40	15	200-240
40/20	100/60	630-780	370	17	45	15	192-232

ReH = upper yield strength; where no marked yield occurs, Rp 0.2 applies | KV2 = Charpy V-notch impact energy, 2 mm striker radius, average of 3 test pieces

TEMPERING TABLE *						
R N/mm ²	2,330	2,240	1,880	1,390	1,030	810
HB	615	597	510	401	311	242
HRC	58	57	52	43	33	23
°C	100	200	300	400	500	600

* Test condition: Ø 10 mm round bar quenched in water at 840 °C. Reference values at room temperature; above 450 HBW the hardness figures are conversions, not measurements

COLD-DRAWN - Longitudinal tensile test at 20 °C EN ISO 683-7:2024*					
Diameter (in mm)		R** N/mm ²	Rp 0.2** N/mm ² min	A% min	HBW for info.
>	≤				
5***	10	750-1,050	565	5	225-319
10	16	710-1,030	500	6	218-311
16	40	650-1,000	410	7	200-298
40	63	630-900	360	8	192-271
63	100	580-850	310	8	172-253

QUENCHED AND TEMPERED, COLD-DRAWN +QT+C - Longitudinal tensile test at 20 °C EN ISO 683-7:2024				
Diameter (in mm)		R N/mm ²	Rp 0.2 N/mm ² min	A% min
>	≤			
5	10	850-1,050	595	8
10	16	810-1,010	565	8
16	40	700-900	525	9
40	63	650-850	455	10
63	100	650-850	455	11

* Values also valid for the cold-drawn and quenched-tempered condition (+C +QT) | ** For flats, the Rp 0.2 value may differ by -10% and R by ±10% | *** For thicknesses below 5 mm the mechanical properties may be agreed at the order stage

HOT-ROLLED, PEELED AND ROLLER-BURNISHED - Longitudinal tensile test at 20 °C - EN ISO 683-7:2024*			
Diameter (in mm)		R N/mm ²	HBW
>	≤		
16	40	580-820	172-241
40	63	580-820	172-241
63	100	580-820	172-241

QUENCHED AND TEMPERED, PEELED AND ROLLER-BURNISHED +QT+SH* EN ISO 683-7:2024					
Diameter (in mm)		R N/mm ²	Rp 0.2 N/mm ² min	A% min	KV2 J min
>	≤				
16	40	650-800	430	16	25
40	63	630-780	370	17	25
63	100	630-780	370	17	25

FORGED NORMALIZED - Longitudinal tensile and impact test at 20 °C EN 10250-2:1999								
Diameter (in mm)		R N/mm ² min	ReH N/mm ² min	A% L min	A% T min	KV2 L J min	KV2 T J min	HBW min
>	≤							
-	100	580	305	16	-	-	-	172
100	250	560	275	16	12	18	10	162
250	500	540	240	16	12	15	10	158
500	1,000	530	230	15	11	12	10	156

FORGED QUENCHED AND TEMPERED - Longitudinal tensile and impact test at 20 °C EN 10250-2:1999								
Diameter/thick. (in mm)		R N/mm ² min	ReH N/mm ² min	A% L min	A% T min	KV2 L J min	KV2 T J min	HBW min
>	≤							
-	100/70	630	370	17	-	25	-	192
100/70	250/160	590	340	18	12	22	15	176
250/160	500/330	540	320	17	11	20	12	158

L = longitudinal | T = tangential | The forged quenched and tempered condition is specified for C45E (1.1191) only; the normalized one applies to C45 and C45E

HARDENABILITY VALUES *																
	1	2	3	4	5	6	7	8	9	10	11	13	15	20	25	30
Min	55	51	37	30	28	27	26	25	24	23	22	21	20	-	-	-
Max	62	61	61	60	57	51	44	37	34	33	32	31	30	29	28	27

* Jominy in HRC - +H band for C45E / C45R (EN ISO 683-1:2018, minimum grain size G5 per UNI 3245) - distance from the quenched end in mm

Temperature ° C	Elastic modulus GPa		Mean expansion 10 ⁻⁶ K ⁻¹ (20 °C → T)
	E long	G tang	
20	210	81	-
100	205	78	11.1
200	195	74	12.1
300	185	71	12.9
400	175	67	13.5
500	-	-	13.9