

| | |
|------------------------|-------------------------|
| Quality | C35E |
| According to standards | EN 10083-2: 2006 |
| Number | 1.1181 |

Chemical composition

| C% | Si% max | Mn% | P% max | S% max | Cr% max | Mo% max | Ni% max | Deviations allowed for analysis product |
|---------------------|----------------|---------------------|------------------|------------------|------------|------------|------------|--|
| 0,32-0,39 ± 0.02 | 0,40 + 0.03 | 0,50-0,80 ± 0.04 | 0,030 + 0.005 | 0,035 + 0.005 | 0,40 | 0,10 | 0,40 | |

Cr+Mo+Ni max 0.63%
For C35R n° 1.1180, S% 0.020-0.040 product deviations ± 0.005
For C35 n° 1.0501, max P% - S% 0.045

Temperature °C

| Hot-forming | Normalizing | Quenching | Quenching | Tempering | Stress-relieving | | |
|----------------------------|---|---------------|----------------------------------|---------------------|---|-----------------------------------|--------------------------------------|
| 1100-850 | 880 air | 850 water | 880 oil or polymer | 540-680 air | 50° under the temperature of tempering | | |
| Soft annealing | Isothermal annealing | Natural state | End quench hardenability test | Pre-heating welding | | Stress-relieving after welding | |
| 700 air (HB max 210) | 840 furnace cooling to 650, then air (HB 140-195) | (HB max 220) | 870 | 100 | Ac1 730 | Ac3 795 | Ms 380 Mf 160 |

Mechanical and physical properties

Hot-rolled mechanical properties in **normalized** condition EN 10083-2: 2006

| size d / t mm | | Testing at room temperature (longitudinal) | | | | | |
|------------------|---------|--|--|------------|------------|--------------|-----------|
| from | to | R N/mm ² | Re ^{a)} N/mm ² min. | A% min. | C% min. | Kv J min. | HB min |
| 16/16 | | 550 | 300 | 18 | | | 159 |
| 16/16 | 100/100 | 520 | 270 | 19 | | | 155 |
| 100/100 | 250/250 | 500 | 245 | 19 | | | 152 |

d = diameter t = thickness

Hot-rolled mechanical properties in **quenched and tempered** condition EN 10083-2: 2006

| size d / t mm | | Testing at room temperature (longitudinal) | | | | | |
|------------------|--------|--|---|------------|------------|-------------|-----------------------|
| from | to | R N/mm ² | Re ^{a)} N/mm ² min | A% min. | C% min. | Kv J min | HB for information |
| 16/8 | | 630-780 | 430 | 17 | 40 | | 192-232 |
| 16/8 | 40/20 | 600-750 | 380 | 19 | 45 | 35 | 178-225 |
| 40/20 | 100/60 | 550-700 | 320 | 20 | 50 | 35 | 159-213 |

^{a)} Re upper yield strength or, if no yield phenomenon occurs, Rp_{0.2} has to be considered

d = diameter t = thickness

Table of tempering values obtained at room temperature on rounds Ø 10 mm after quenching at 850 °C in water

| | | | | | | |
|----------------------------|------------|------------|------------|------------|------------|------------|
| HB | 467 | 448 | 412 | 343 | 268 | 226 |
| HRC | 49 | 47.5 | 44 | 37 | 27.5 | 20 |
| R N/mm ² | 1700 | 1610 | 1440 | 1140 | 890 | 760 |
| Tempering at °C | 100 | 200 | 300 | 400 | 500 | 600 |

C35E 1.1181 C35R 1.1180 EN 10277-5: 2008

| Cold-drawn +C ^{c)} | | | | | | Hot-rolled + peeled-reeled +SH ^{c)} | | | |
|-----------------------------|----|--|-----------------------|-----|-------------|--|-----------------------|-----|---------|
| size | | Testing at room temperature (longitudinal) | | | | Testing at room temperature (longitudinal) | | | |
| mm | | R ^{a)} | Rp 0.2 ^{a)} | A% | HB | R | Rp 0.2 | A% | HB |
| from | to | N/mm ² | N/mm ² min | min | for inform. | N/mm ² | N/mm ² min | min | |
| 5 ^{b)} | 10 | 650-1000 | 510 | 6 | 200-298 | | | | |
| | 10 | 600-950 | 420 | 7 | 178-286 | | | | |
| | 16 | 580-880 | 320 | 8 | 172-263 | 520-700 | | | 154-207 |
| | 40 | 550-840 | 300 | 9 | 159-250 | 520-700 | | | 154-207 |
| | 63 | 520-800 | 270 | 9 | 155-240 | 520-700 | | | 154-207 |

^{a)} for flats and special sections, yield point can be – 10% and tensile strength can be ± 10%

^{b)} for thickness < 5 mm, mechanical properties should be agreed before order placement

^{c)} values valid also for +C+SL and +SH+SL

C35E 1.1181 C35R 1.1180 EN 10277-5: 2008

| Hot-rolled, quenched and tempered, cold-drawn +QT +C ^{c)} | | | | | | Cold-drawn + quenched and tempered +C +QT ^{c)} | | | |
|--|----|--|-----------------------|-----|-------------|---|-----------------------|-----|-------------|
| size | | Testing at room temperature (longitudinal) | | | | Testing at room temperature (longitudinal) | | | |
| mm | | R | Rp 0.2 | A% | HB | R | Rp 0.2 | A% | HB |
| from | to | N/mm ² | N/mm ² min | min | for inform. | N/mm ² | N/mm ² min | min | for inform. |
| 5 ^{b)} | 10 | 750-950 | 525 | 9 | 225-286 | | | | |
| | 10 | 700-900 | 490 | 9 | 213-271 | | | | |
| | 16 | 650-850 | 455 | 10 | 200-253 | 600-750 | 370 | 19 | 178-225 |
| | 40 | 570-770 | 400 | 11 | 169-231 | 550-700 | 320 | 20 | 159-213 |
| | 63 | 550-750 | 385 | 12 | 159-225 | 550-700 | 320 | 20 | 159-213 |

^{b)} for thickness < 5 mm, mechanical properties should be agreed before order placement

^{c)} values valid also for +QT+C+SL and +C+QT+SL

Forged normalized EN 10250-2: 2001

| size | | Testing at room temperature | | | | | | | |
|------|-----|-----------------------------|-----------------------|------|------|------|-------|-------|-----|
| mm | | R | Re ^{c)} | A% L | A% T | A% Q | Kv L | Kv T | HB |
| from | to | N/mm ² min | N/mm ² min | min | min | min | J min | J min | min |
| | 100 | 520 | 270 | 19 | | | 30 | | 155 |
| | 100 | 500 | 245 | 19 | 15 | | 25 | 15 | 152 |
| | 250 | 480 | 220 | 19 | 15 | | 20 | 12 | 146 |
| | 500 | 470 | 210 | 18 | 14 | | 17 | 12 | 141 |

Forged quenched and tempered EN 10250-2: 2001

| size d / t | | Testing at room temperature | | | | | | | |
|------------|---------|-----------------------------|-----------------------|------|------|------|-------|-------|-----|
| mm | | R | Re ^{c)} | A% L | A% T | A% Q | KvL | Kv T | HB |
| from | to | N/mm ² min | N/mm ² min | min | min | min | J min | J min | min |
| | 100/70 | 550 | 320 | 20 | | | 35 | | 159 |
| | 100/70 | 490 | 290 | 22 | 15 | | 31 | 20 | 149 |
| | 250/160 | 470 | 270 | 21 | 14 | | 25 | 16 | 141 |

L = longitudinal T = tangential Q = radial

^{c)} Re upper yield strength or, if no yield phenomenon occurs, Rp 0.2 has to be considered

d = diameter t = thickness

EN 10083-2: 2006 Jominy test HRC grain size 5 min.

| mm distance from quenched extremity | | | | | | | | | | | | | | | | |
|-------------------------------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|--------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 13 | 15 | 20 | 25 | H |
| min | 48 | 40 | 33 | 24 | 22 | 20 | | | | | | | | | | normal |
| max | 58 | 57 | 55 | 53 | 49 | 41 | 34 | 31 | 28 | 27 | 26 | 25 | 24 | | | |

| EUROPE EN | ITALY UNI | CHINA GB | GERMANY DIN | FRANCE AFNOR | U.K. B.S. | RUSSIA GOST | USA AISI/SAE |
|-----------|-----------|----------|-------------|--------------|-----------|-------------|--------------|
| C35E | C35 | 35 | Ck35 | XC38H1 | 080M36 | 35 | 1034 |

C35E

| Temperature | Mod. of elasticity GPa | | Thermal expansion |
|---------------|------------------------|---------|------------------------|
| | E long. | G tang. | $10^{-6} \cdot K^{-1}$ |
| Testing at °C | | | |
| 20 | 210 | 80 | |
| 100 | 205 | 78 | 11.1 |
| 200 | 195 | 74 | 12.1 |
| 250 | | | |
| 300 | 185 | 71 | 12.9 |
| 350 | | | |
| 400 | 175 | 67 | 13.5 |
| 500 | | | 13.9 |
| 600 | 155 | 59 | 14.1 |

| Specific heat capacity | Density | Thermal conductivity | Specific electric resist. | Electrical conductivity |
|------------------------|--------------------|----------------------|---------------------------|---------------------------|
| J/(Kg•K) | Kg/dm ³ | W/(m•K) | Ohm•mm ² /m | Siemens•m/mm ² |
| 460 | 7.85 | 50 | 0.12 | 8.33 |

| Heat treatment | Temperature (+ ... °C) - min. values | | | | | | | | Fatigue data |
|----------------|--------------------------------------|-----|-----|-----|-----|-----|-----|-----|--|
| | 20 | 200 | 300 | 350 | 400 | 450 | 500 | 600 | |
| +N | 275 | 220 | 185 | 165 | 145 | | | | Rp 0.2 N/mm ² |
| +N | | | | 246 | 187 | 100 | 53 | | Creep rupture, 10.000 h N/mm ² ¹⁾ |
| +N | | | | 218 | 138 | 70 | 34 | | Creep rupture, 100.000 h N/mm ² ¹⁾ |
| +N | 334 | | | | | | | | Cyclic yield strength, σ_y' |
| +QT | 328 | | | | | | | | N/mm ² low cycle fatigue |
| +N | 0.25 | | | | | | | | Cyclic strength exponent, n' |
| +QT | 0.23 | | | | | | | | low cycle fatigue |
| +N | 1599 | | | | | | | | Cyclic strength coefficient, K' |
| +QT | 1355 | | | | | | | | N/mm ² low cycle fatigue |
| +N | 1545 | | | | | | | | Fatigue strength coefficient, σ_f' |
| +QT | 1050 | | | | | | | | N/mm ² low cycle fatigue |
| +N | - 0.14 | | | | | | | | Fatigue strength exponent, b |
| +QT | - 0.11 | | | | | | | | low cycle fatigue |
| +N | 0.90 | | | | | | | | Fatigue ductility coefficient, g_f' |
| +QT | 0.33 | | | | | | | | low cycle fatigue |
| +N | - 0.57 | | | | | | | | Fatigue ductility exponent, c |
| +QT | - 0.47 | | | | | | | | low cycle fatigue |

¹⁾ Creep rupture strength EN 10269: 2001

+N Normalized +QT Quenched an Tempered