

C45 & C45E Steel (1.0503 vs 1.1191): Composition, Mechanical Properties & Heat Treatment

Steelmet Industries - Bright Bars, Alloy Steels, Free Cutting Steels, Stainless Steels

Description



Cold-drawn C45 (1.0503) and C45E (1.1191) medium-carbon bright steel bars manufactured to tight ISO tolerances by Steelmet Industries.

C45 (1.0503) and **C45E (1.1191)** are two of the most widely specified medium-carbon unalloyed engineering steels under European standards (**EN 10083-2** and **EN ISO 683-1**). Known for balanced tensile strength, wear resistance, and machinability, both grades serve as core materials for shafts, spindles, gears, axles, studs, and induction-hardened machine components.

Although engineers and buyers often treat C45 and C45E as interchangeable, they differ in one critical metallurgical detail: **steelmaking purity (sulfur and phosphorus limits)**. Choosing C45E over standard C45 can prevent surface cracking during high-frequency induction hardening and improve fatigue life in dynamically loaded parts.

At **Steelmet Industries**, we supply C45 and C45E in hot-rolled black bars, forged rounds, and precision **cold-drawn bright steel bars** (rounds, hexagons, squares, and flats) backed by full mill test certification. Below is a practical technical comparison to help you specify the right grade.

C45 vs. C45E vs. C45R: What Do the Suffixes Mean?

Under **EN 10083-2** (Steels for quenching and tempering), the base designation **C45** indicates a non-alloy quality steel with a nominal carbon content of **0.45%**. The suffix letters define how the steel was refined and tested:

- **C45 (Material No. 1.0503):** Standard non-alloy quality steel. Allows up to 0.045% maximum sulfur and 0.045% maximum phosphorus. Suitable for general mechanical parts, normalized shafts, and standard quenched-and-tempered components.
- **C45E (Material No. 1.1191):** Special steel (â??Eâ?• stands for *Edelstahl* / special quality). Refined to restrict both sulfur and phosphorus to **0.030% maximum** (0.035% in older EN 10083-2 revisions). This cleaner microstructure reduces non-metallic sulfide inclusions, making C45E the preferred choice for induction hardening and high-fatigue rotating shafts.
- **C45R (Material No. 1.1201):** Controlled-sulfur variant of special steel C45E, containing a deliberate sulfur window of **0.020% to 0.040%** to improve chip breaking and tool life during high-speed CNC turning and drilling.

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Chemical Composition Comparison: C45 (1.0503) vs. C45E (1.1191)

Both grades share identical target ranges for carbon, silicon, manganese, and residual alloying elements. The sole compositional distinction is the tighter control over tramp impurities (P and S) in C45E:

Element	C45 (1.0503) %	C45E (1.1191) %	C45R (1.1201) %
Carbon (C)	0.42 â?? 0.50	0.42 â?? 0.50	0.42 â?? 0.50
Manganese (Mn)	0.50 â?? 0.80	0.50 â?? 0.80	0.50 â?? 0.80
Silicon (Si)	0.40 max	0.40 max	0.40 max
Phosphorus (P)	**0.045 max**	**0.030 max**	**0.030 max**
Sulfur (S)	**0.045 max**	**0.030 max**	**0.020 â?? 0.040**
Chromium (Cr)	0.40 max	0.40 max	0.40 max
Molybdenum (Mo)	0.10 max	0.10 max	0.10 max
Nickel (Ni)	0.40 max	0.40 max	0.40 max

Note: Combined Cr + Mo + Ni content must not exceed 0.63% under EN 10083-2 / EN ISO 683-1.

Mechanical Properties of C45 & C45E Steel

Because C45 and C45E are unalloyed medium-carbon steels, their hardenability is limited by section thickness (ruling section). As bar diameter increases, core cooling rates during quenching slow down, reducing attainable yield and tensile strength:

1. Quenched and Tempered Condition (+QT)

Diameter / Ruling Section	Yield Strength (Re) Min	Tensile Strength (Rm)	Elongation (A) Min	Charpy Impact (KV) Min (C45E only)
Up to 16 mm	490 MPa	700 â?? 850 MPa	14%	25 J (at +20Â°C)
> 16 mm to 40 mm	430 MPa	650 â?? 800 MPa	16%	25 J (at +20Â°C)
> 40 mm to 100 mm	370 MPa	630 â?? 780 MPa	17%	25 J (at +20Â°C)

2. Normalized (+N) & Cold-Drawn Bright Bar (+C) Conditions

Supply Condition	Diameter Range	Yield Strength (Re) Min	Tensile Strength (Rm)	Typical Hardness
Normalized (+N)	16 mm â?? 100 mm	305 MPa	580 MPa min	170 â?? 210 HB
Cold Drawn (+C)	10 mm â?? 16 mm	565 MPa	710 â?? 1030 MPa	210 â?? 300 HB
Cold Drawn (+C)	> 16 mm â?? 40 mm	500 MPa	650 â?? 1000 MPa	195 â?? 290 HB
Cold Drawn (+C)	> 40 mm â?? 63 mm	410 MPa	630 â?? 950 MPa	190 â?? 280 HB

Note: Cold-drawn mechanical values follow EN 10277 (Bright steel products). Cold drawing work-hardens the bar surface and raises yield strength without thermal heat treatment.

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International Equivalent Grades for C45 & C45E

When cross-referencing global engineering drawings, C45 and C45E correspond closely to the following international standards:

Standard / Country	Equivalent Grade	Notes
DIN / EN (Europe)	C45 (1.0503) / C45E (1.1191)	Formerly Ck45 under older DIN 17200
AISI / SAE (USA)	SAE 1045 / AISI 1045	Standard 0.45% medium-carbon steel
BS 970 (UK)	080M46 / EN8 / EN8D	EN8 (080M40) has 0.40% C nominal; 080M46 matches 0.45% C
IS 1570 (India)	C45 / 45C8	Standard Indian medium-carbon steel
JIS G4051 (Japan)	S45C	Widely used in Japanese automotive & tooling
GOST (Russia)	45	Direct carbon-percentage designation

Review full cross-standard mappings on our DIN Specifications and SAE Specifications pages.

Heat Treatment Guidelines for C45 and C45E

Proper thermal cycles allow C45 and C45E to achieve either maximum core strength or a hard wear-resistant outer case:

- **Normalizing:** Heat to **840Â°C â?? 880Â°C**, hold until uniform temperature is reached, and cool in still air. Refines grain structure after forging or hot rolling.
- **Soft Annealing:** Heat to **650Â°C â?? 700Â°C**, soak thoroughly, and cool slowly in the furnace (max hardness ~207 HB) to maximize machinability before heavy CNC operations.
- **Through Hardening (Quenching):** Austenitize at **820Â°C â?? 860Â°C**. Quench in water for larger sections or oil/polymer for thinner sections and complex shapes to minimize distortion.
- **Tempering:** Reheat immediately after quenching to **550Â°C â?? 660Â°C** depending on target tensile strength, hold for at least 1 hour per 25 mm of section, and cool in air.
- **Flame & Induction Hardening:** Rapidly heat the surface layer to **850Â°C â?? 880Â°C** followed by immediate water or polymer spray quenching, achieving a surface hardness of **53 â?? 60 HRC** with a tough, unhardened core. **C45E (1.1191)** is strongly recommended for induction hardening due to its low inclusion content.

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Machinability & Weldability

- **Machinability:** Rated at approximately 55% to 65% relative to free-cutting steel (1212). Cold-drawn C45 bright bars (+C) provide clean chip formation and tight ISO h9/h11 tolerances for CNC turning, milling, and thread rolling.
- **Weldability:** Fair to moderate. Because carbon content sits around 0.45%, rapid cooling after welding can form brittle martensite in the heat-affected zone. Preheat components to **200Â°C â?? 300Â°C**, use low-hydrogen electrodes, and perform stress-relief annealing at 550Â°C â?? 600Â°C immediately after welding.

Industrial Applications of C45 & C45E Bright Bars

Explore our Uses & Applications overview to see how C45 and C45E are deployed across key industries:

- **Power Transmission & Machinery:** Motor shafts, pump shafts, lead screws, spindles, couplings, and splined axles.
- **Gears & Sprockets:** Medium-duty spur gears, pinions, chain sprockets, and induction-hardened gear racks.
- **Automotive & Agricultural Equipment:** Connecting rods, wheel hubs, tie-rod ends, pins, and hydraulic piston rods (induction-hardened and hard-chrome plated).
- **Fasteners & Tooling:** High-tensile studs, anchor bolts, die bolsters, mould plates, and clamping fixtures.

Frequently Asked Questions on C45 & C45E Steel

1. When should I specify C45E (1.1191) instead of standard C45 (1.0503)?

Specify **C45E** whenever your component undergoes **induction hardening, flame hardening, or high-cycle fatigue loading**. Its lower sulfur and phosphorus limits (0.030% max) minimize sulfide stringers that can act as crack initiation sites during rapid surface quenching.

2. Is C45 the exact same steel as EN8?

They belong to the same medium-carbon engineering steel family and are often used for similar applications, but their nominal carbon ranges differ slightly. Standard BS 970 **EN8 (080M40)** has 0.36% to 0.44% carbon (0.40% nominal), whereas **C45 (1.0503)** has 0.42% to 0.50% carbon (0.45% nominal), giving C45 slightly higher achievable hardness after quenching.

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3. What is the maximum hardness C45E can achieve after induction hardening?

Properly induction-hardened and water-quenched C45E typically reaches a surface hardness of **55 to 60 HRC** (roughly 580 to 690 HV), depending on frequency, power density, and carbon content within the 0.42% â?? 0.50% band.

4. Does Steelmet Industries supply C45 and C45E in cold-drawn bright bar form?

Yes. We supply C45 and C45E in cold-drawn, peeled, and turned bright bars across rounds, hexagons, squares, and flats, as well as hot-rolled and forged rounds for larger diameters.

Source Certified C45 & C45E Bright Bars from Steelmet Industries

Steelmet Industries manufactures and supplies precision Cold Drawn Bright Steel Bars and hot-rolled bars in **C45 (1.0503)** and **C45E (1.1191)** with ISO h9, h10, and h11 tolerances. Every batch is supplied with full mill test certificates, chemical and mechanical reports, and adherence to our Quality Policy.

Request a Quote or Technical Consultation:
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1. Grade Guide

Tags

1. 1.0503
2. 1.1191

3. C45 Steel
4. C45E Steel
5. Cold Drawn Steel Bright Bars
6. EN 10083-2
7. Induction Hardening Steel
8. Steel Grades
9. Steelmet Industries

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