

# AISI 4130 Mechanical Properties and Heat Treatment Reference

Strength, hardness, section size and heat-treatment condition data

Engineering reference - property values are condition-specific, not universal acceptance minima

## Material identity

|                 |                               |
|-----------------|-------------------------------|
| GRADE           | SAE 4130 / commonly AISI 4130 |
| UNS             | G41300                        |
| STEEL FAMILY    | Cr-Mo low-alloy steel         |
| DENSITY         | 7.85 g/cm³                    |
| ELASTIC MODULUS | 205 GPa (typical steel value) |



## Reference chemical composition (wt.%)

| Element | Range       | Element | Range       |
|---------|-------------|---------|-------------|
| C       | 0.28 - 0.33 | Mn      | 0.40 - 0.60 |
| Cr      | 0.80 - 1.10 | Mo      | 0.15 - 0.25 |
| Si      | 0.15 - 0.35 | P       | ≤ 0.035     |
| S       | ≤ 0.040     | Fe      | Balance     |

### Use the grade correctly

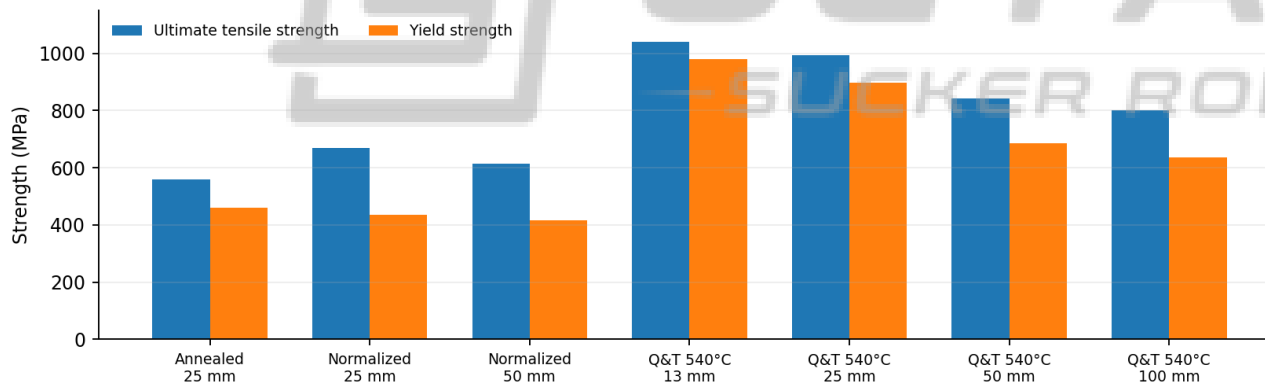
SAE J404 defines alloy-steel chemistry. It does not, by itself, establish a universal tensile strength, yield strength or hardness for every 4130 product form. Mechanical tubing is controlled by its applicable product specification and delivery condition.

## Why one “4130 strength” value is not enough

### Interpretation

The same nominal chemistry produces different strength, ductility and hardness after annealing, normalizing or quench-and-temper treatment. Section size also changes cooling response, so test data must be read together with diameter and heat-treatment condition.

| Condition        | Round size | UTS MPa | Yield MPa | Elong. % | Hardness |
|------------------|------------|---------|-----------|----------|----------|
| Annealed 865°C   | 25 mm      | 560     | 460       | 21.5     | 217 HB   |
| Normalized 870°C | 25 mm      | 670     | 435       | 25.5     | 197 HB   |
| Normalized 870°C | 50 mm      | 615     | 415       | 28.2     | 167 HB   |
| Q&T; 855/540°C   | 13 mm      | 1040    | 979       | 18.1     | 302 HB   |
| Q&T; 855/540°C   | 25 mm      | 993     | 896       | 18.5     | 293 HB   |
| Q&T; 855/540°C   | 50 mm      | 841     | 685       | 21.2     | 241 HB   |
| Q&T; 855/540°C   | 100 mm     | 800     | 635       | 21.5     | 235 HB   |



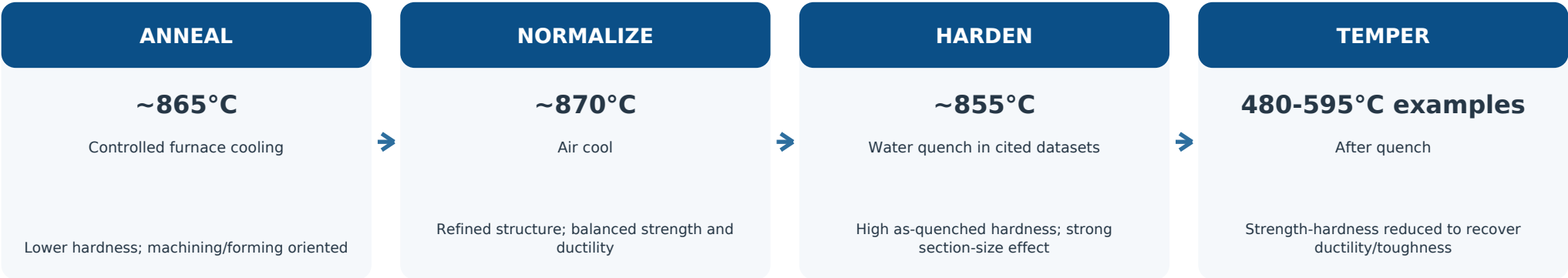
### What the chart shows

At the same 855°C quench + 540°C temper, strength decreases as the round section grows from 13 to 100 mm. This is a section-size/hardenability effect, not a change in the nominal 4130 chemistry.

### Acceptance rule

Treat these values as reference datasets. Contract acceptance should use the specified product standard, heat-treatment condition, specimen location and project minimums - not a generic web datasheet value.

## Reference heat-treatment routes



## What changes after treatment

| Condition / example | UTS      | Yield   | Elongation | Hardness | Engineering reading                             |
|---------------------|----------|---------|------------|----------|-------------------------------------------------|
| Normalized 25 mm    | 670 MPa  | 435 MPa | 25.5%      | 197 HB   | Balanced normalized condition; good ductility   |
| Q&T; 13 mm, 540°C   | 1040 MPa | 979 MPa | 18.1%      | 302 HB   | High strength retained in small section         |
| Q&T; 50 mm, 540°C   | 841 MPa  | 685 MPa | 21.2%      | 241 HB   | Lower strength than 13 mm at same nominal cycle |
| Q&T; 100 mm, 540°C  | 800 MPa  | 635 MPa | 21.5%      | 235 HB   | Large section shows reduced through-response    |

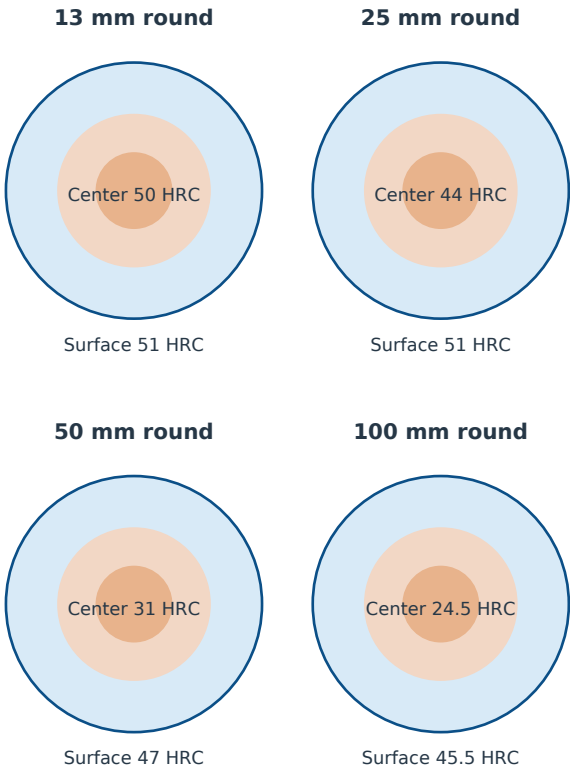
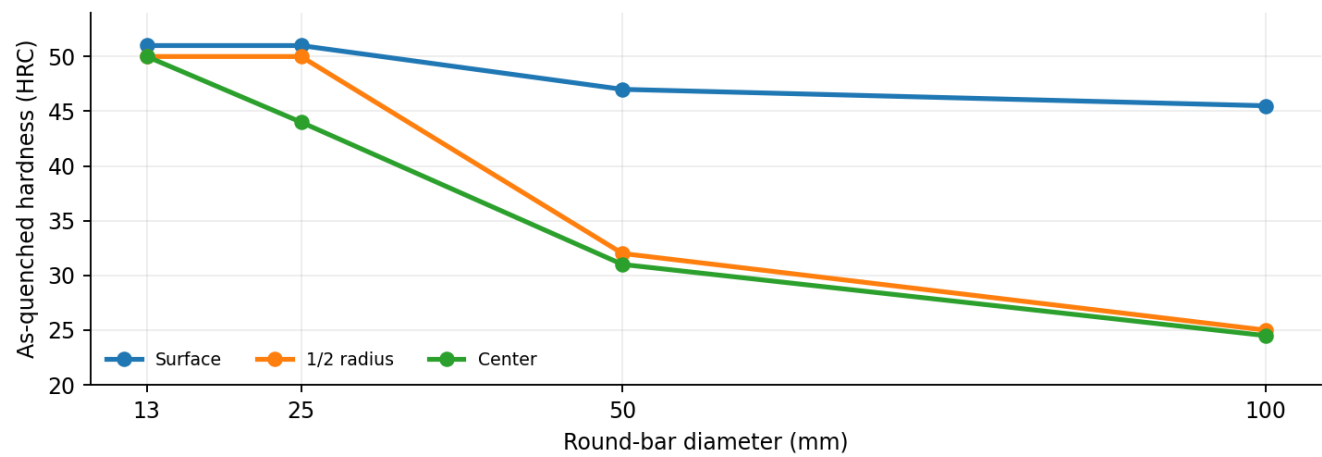
### Engineering implication

Higher hardness is not automatically “better.” Final condition should be selected around required yield strength, ductility, toughness, machinability and the actual section thickness.

### Process-control implication

A heat-treatment certificate should identify the cycle and lot. For thick sections or critical parts, verify whether the specified mechanical tests represent the relevant material location.

## Same steel, same austenitizing temperature - different core response



## As-quenched hardness profile used in the comparison

| Diameter | Surface  | 1/2 radius | Center   | Surface - center |
|----------|----------|------------|----------|------------------|
| 13 mm    | 51 HRC   | 50 HRC     | 50 HRC   | 1 HRC            |
| 25 mm    | 51 HRC   | 50 HRC     | 44 HRC   | 7 HRC            |
| 50 mm    | 47 HRC   | 32 HRC     | 31 HRC   | 16 HRC           |
| 100 mm   | 45.5 HRC | 25 HRC     | 24.5 HRC | 21 HRC           |

### Why this matters

A surface hardness reading can overstate the condition of the core in a heavy section. When through-section performance matters, acceptance should specify the relevant test location or a validated heat-treatment route.

## Condition selection by engineering objective

| Engineering objective               | Condition / route to consider    | Primary control                          | Additional verification                                   |
|-------------------------------------|----------------------------------|------------------------------------------|-----------------------------------------------------------|
| Machine before final heat treatment | Annealed / softer delivery       | Hardness and machinability               | Machining allowance; final HT distortion                  |
| General mechanical component        | Normalized                       | Yield + tensile + ductility              | Section size; final dimensional check                     |
| Higher-load component               | Quenched and tempered            | Yield strength + hardness                | Toughness and actual test location                        |
| Thick-section component             | Validated Q&T; route             | Core response / through-hardening        | Surface-to-center hardness or representative tensile test |
| Fatigue-sensitive component         | Project-specific final condition | Strength + ductility + surface condition | Stress concentration, finish, decarb, NDT                 |

## Separate stable physical properties from condition-sensitive mechanical properties

| Relatively stable / typical                                                                                                          | Condition-sensitive                                                                                                     |
|--------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|
| Density: 7.85 g/cm <sup>3</sup><br>Elastic modulus: 205 GPa<br>Bulk modulus: 140 GPa<br>Shear modulus: 80 GPa<br>Poisson ratio: 0.29 | Yield strength<br>Ultimate tensile strength<br>Hardness<br>Elongation<br>Reduction of area<br>Impact/toughness response |

### Procurement checkpoint

A purchase description such as “4130 steel” is incomplete for a critical part. Define product form, section size, delivery condition, required strength or hardness, test basis, and traceability so the received material can be objectively accepted.



## Five rules for using 4130 property data

1

### Tie strength to condition

Do not quote yield or tensile strength without identifying heat treatment and representative section size.

2

### Treat chemistry and performance separately

SAE 4130 chemistry defines the alloy family; finished-product mechanical acceptance comes from the applicable specification or PO.

3

### Account for section size

Quench response becomes less uniform through the section as diameter increases; surface hardness may not represent core condition.

4

### Use reference values as reference values

The property tables in this PDF reproduce published condition-specific datasets. They are not universal minimum acceptance values.

5

### Make the acceptance basis auditable

Specify product form, dimensions, delivery condition, test location, required properties, and heat/lot traceability.

## Reference basis used for this PDF

- SAE J404\_200901 - Chemical Compositions of SAE Alloy Steels (SAE International).
- ASM/MatWeb AISI 4130 material-condition datasets: annealed, normalized, and water-quenched + tempered conditions for multiple round-bar diameters.
- Condition datasets used here include M4130A, M4130C/R, M4130D, M4130J, M4130K, M4130L and M4130M.
- MatWeb notes that some displayed values may be rounded or converted; use governing specification values for contractual engineering calculations.