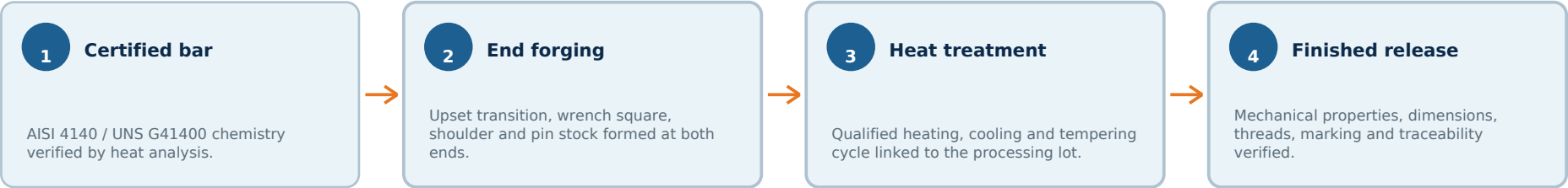




Solid alloy-steel rod body with forged ends and machined pin connections

QUALIFICATION PATH



MATERIAL AND GRADE DATA

Control point	Reference value	Meaning
AISI 4140 carbon	0.38-0.43%	Higher heat-treatment response than lower-carbon 4130
Chromium	0.80-1.10%	Supports hardenability; does not make the rod corrosion resistant
Molybdenum	0.15-0.25%	Supports through-section response and tempering stability
API Grade DA yield	85 ksi / 586 MPa minimum	Finished-product release threshold
API Grade DA tensile	115 ksi / 793 MPa minimum	Finished-product release threshold

CRITICAL DISTINCTION

AISI 4140 identifies the alloy route. API Grade DA identifies a finished sucker-rod strength class. Chemistry alone does not qualify the rod; the finished product must pass the ordered mechanical, dimensional, thread and inspection requirements.



Rod Diameter, Weight and Axial Load

NOMINAL SOLID-BODY CALCULATIONS

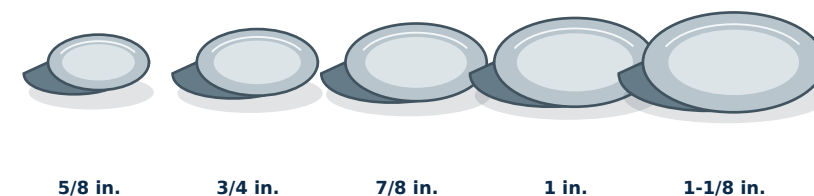
MASS PER UNIT LENGTH AND PER KILOMETRE

Rod diameter	Body area	Mass	Body mass per 1,000 m	Suspended body weight in air
5/8 in.	0.3068 in ² / 197.9 mm ²	1.554 kg/m	1.554 t	15.2 kN
3/4 in.	0.4418 in ² / 285.0 mm ²	2.237 kg/m	2.237 t	21.9 kN
7/8 in.	0.6013 in ² / 387.9 mm ²	3.045 kg/m	3.045 t	29.9 kN
1 in.	0.7854 in ² / 506.7 mm ²	3.978 kg/m	3.978 t	39.0 kN
1-1/8 in.	0.9940 in ² / 641.3 mm ²	5.034 kg/m	5.034 t	49.4 kN

NOMINAL AXIAL STRESS REFERENCE

Rod diameter	At 20 klbf	At 30 klbf	Body force at 85 ksi
5/8 in.	65.2 ksi	97.8 ksi	26.1 klbf
3/4 in.	45.3 ksi	67.9 ksi	37.6 klbf
7/8 in.	33.3 ksi	49.9 ksi	51.1 klbf
1 in.	25.5 ksi	38.2 ksi	66.8 klbf
1-1/8 in.	20.1 ksi	30.2 ksi	84.5 klbf

Nominal body diameters - proportional 3D view

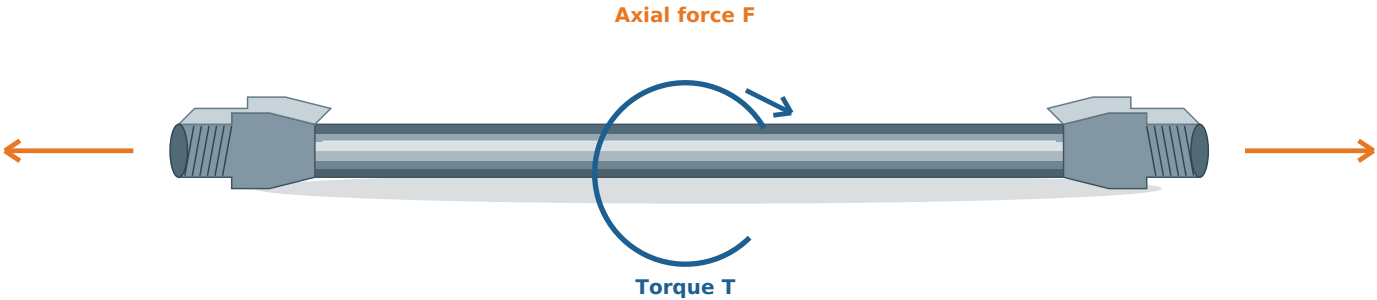


CALCULATION BOUNDARY

Values use nominal solid-body diameter and a steel density of 7,850 kg/m³. Forged ends, couplings, buoyancy and manufacturing tolerances are excluded. The 85 ksi force is a theoretical body-area reference, not a working-load rating.

Combined Axial and Torsional Stress

ILLUSTRATIVE NOMINAL BODY-STRESS COMPARISON



Axial stress

$$\sigma_a = 4F / (\pi \times d^2)$$

Torsional shear

$$\tau = 16T / (\pi \times d^3)$$

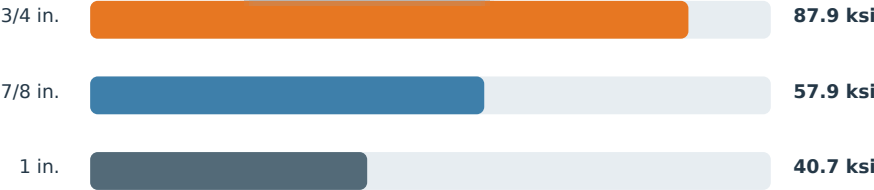
Equivalent stress

$$\sigma_{vm} = \sqrt{\sigma_a^2 + 3 \times \tau^2}$$

COMPARISON AT 20,000 LBF AND 300 LBF-FT

Rod diameter	Axial stress	Torsional shear	Von Mises stress	Ratio to 85 ksi reference
3/4 in.	45.3 ksi	43.5 ksi	87.9 ksi	103.4%
7/8 in.	33.3 ksi	27.4 ksi	57.9 ksi	68.1%
1 in.	25.5 ksi	18.3 ksi	40.7 ksi	47.9%

Von Mises equivalent stress



ENGINEERING LIMITATION

These are nominal body-stress calculations, not allowable operating ratings. Connection stress concentration, bending, corrosion, wear, transient torque and the required design margin are excluded. A result above 85 ksi shows that this illustrative load case exceeds the Grade DA yield reference before those additional effects are added.

COUPLING DIMENSIONS AND CALCULATED RADIAL GAIN

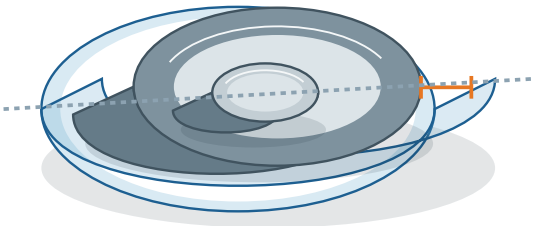
Rod size	Full-size OD	Slim-hole OD	OD reduction	Additional radial clearance
5/8 in.	1.500 in.	1.252 in.	0.248 in.	0.124 in. / 3.15 mm
3/4 in.	1.625 in.	1.500 in.	0.125 in.	0.063 in. / 1.59 mm
7/8 in.	1.811 in.	1.626 in.	0.185 in.	0.093 in. / 2.35 mm
1 in.	2.189 in.	2.000 in.	0.189 in.	0.095 in. / 2.40 mm
1-1/8 in.	2.375 in.	2.258 in.	0.117 in.	0.059 in. / 1.49 mm



7/8 in. rod example - same tubing ID

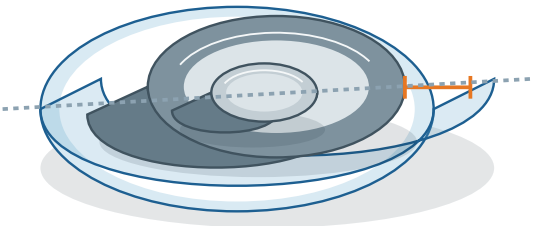
The tubing boundary is held constant so that the coupling OD effect can be compared directly.

Full-size coupling



OD 1.811 in. / 46.0 mm
Baseline radial clearance

Slim-hole coupling



OD 1.626 in. / 41.3 mm
+2.35 mm radial clearance

CLEARANCE CALCULATION

Radial clearance = (tubing ID - coupling OD) / 2

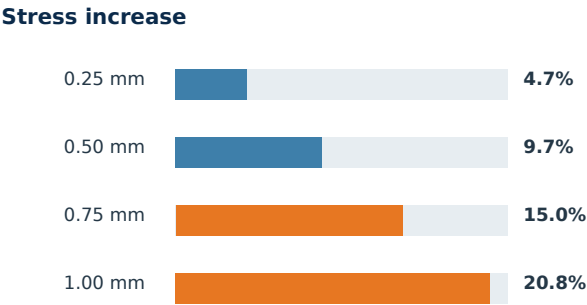
Additional radial clearance = (full-size OD - slim-hole OD) / 2

SELECTION RULE

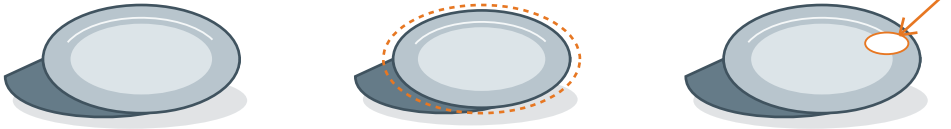
A smaller OD improves geometric clearance, but it does not automatically prove adequate connection capacity. Verify coupling grade, applied load, tubing ID, well deviation and the approved make-up procedure.

UNIFORM RADIAL LOSS AND NOMINAL STRESS

Uniform radial loss	Remaining diameter	Approx. area loss	Nominal stress increase
0.25 mm	21.73 mm	4.4%	4.7%
0.50 mm	21.23 mm	8.8%	9.7%
0.75 mm	20.73 mm	13.0%	15.0%
1.00 mm	20.23 mm	17.2%	20.8%



WHAT THE CALCULATION CAN AND CANNOT SHOW



Nominal section

Uniform loss

Localized pit

Uniform loss changes section area; a pit also creates a local stress concentration.

MINIMUM RELEASE EVIDENCE

Control location	Coverage / evidence
Forged transitions and shoulders	Both ends; 100% visual examination; surface NDT when specified
External pin threads	Both pins; 100% working-gauge verification and protection
Finished rod body	Full-length straightness and post-straightening surface check
Material and heat treatment	Heat identity, furnace record and lot-linked tensile results
Final release	100% marking, traceability, preservation and packing verification

ACCEPTANCE BOUNDARY

Calculated diameter loss is not a universal field rejection limit. Final acceptance must consider defect geometry, location, cyclic load range, corrosion history and the applicable used-rod procedure.