KINGSFORM METALWORKS

ENGINEERING TOOLKIT

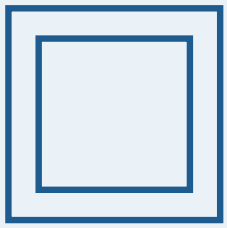
TUBE SIZE REFERENCE

Round, square and rectangular tube geometry, mass, section properties, standards and drawing callouts

ROUND

OD x wall

SQUARE



B x B x t

RECTANGULAR

B x H x t

DOCUMENT	VERSION	RELEASE DATE	LANGUAGE
KFR-014	1.0	2026-07-17	English
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A4 PDF	KingsForm Engineering	info@kingsformmetalworks.com	www.kingsformmetalworks.com

Engineering reference only. The released drawing, purchase specification, governing standard, mill certificate and customer requirements remain controlling.

01 SELECTION AND DESIGNATION

Specify the tube by product form - not by appearance alone

Tube, pipe and hollow section terminology can look similar while dimensional rules, tolerances and intended service are different.

Decision	Mechanical tube	Structural hollow section	Pipe / pressure tube	Engineering implication
Primary purpose	Fabricated components, frames, mechanisms	Load-bearing frames and structures	Fluid, pressure or process service	Start with service and governing specification
Typical designation	OD x wall; B x B x t; B x H x t	CHS / SHS / RHS plus grade and standard	NPS / DN plus schedule or wall	Do not substitute schedule for OD x wall
Critical attributes	OD / width, wall, straightness, finish, weld seam	Section size, wall, corner radii, yield strength	Pressure rating, chemistry, heat treatment, examination	The same nominal size can have different tolerances
Typical standards	ASTM A513, ASTM A554-26, ASTM B221	ASTM A500, ISO 10799-2, ISO 12633-2	ISO 4200 tables plus product-specific pressure standard	State the exact standard and edition if contractually required

Drawing callout anatomy

Example	What it defines	What still needs project control
ROUND TUBE 25.4 OD x 1.5 WALL, ASTM A513 Type 2	Round mechanical tube, nominal OD and wall, carbon-steel ERW product family	Grade / condition, length, OD and wall tolerance, seam orientation, finish and inspection
SHS 40 x 40 x 2, ASTM A500 Grade C	Square structural hollow section with nominal outside size and wall	Corner radius, actual mass, coating state, weld seam and cut-length tolerance
RHS 80 x 40 x 3, ISO 10799-2	Cold-formed rectangular structural hollow section	Material delivery standard, grade, orientation, end condition and acceptance records
SS ROUND 38.1 x 1.5, ASTM A554, 304, 180 GRIT	Stainless welded mechanical tube with material and cosmetic finish	Finish direction, weld-bead treatment, protected surfaces and visual acceptance

Do not write only “25 mm tube” or “2 inch tube”. State section shape, outside dimensions, nominal wall, material / grade, product standard, finish, cut length, tolerance and any seam-orientation requirement.

02 GEOMETRY AND MASS

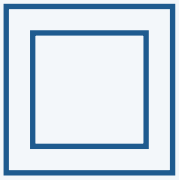
Use outside dimensions as the primary reference

The equations below use ideal sharp-corner geometry. Real square and rectangular tube has corner radii, so certified mass and section properties can differ.

ROUND TUBE

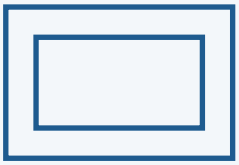
D, t, ID = D - 2t

SQUARE TUBE



B, t, inside B - 2t

RECTANGULAR TUBE



B, H, t; define orientation

Section	Metal area A (mm²)	Mass per metre m (kg/m)	Second moment / modulus
Round	A = pi/4 [D^2 - (D - 2t)^2] = pi t (D - t)	m = A x density / 1,000,000	I = pi/64 [D^4 - d^4]; Z = I / (D/2)
Square - sharp-corner ideal	A = B^2 - (B - 2t)^2 = 4t(B - t)	Same mass equation	I = [B^4 - (B - 2t)^4] / 12; Z = I / (B/2)
Rectangular - sharp-corner ideal	A = BH - (B - 2t)(H - 2t)	Same mass equation	Ix = [B H^3 - b h^3]/12; Iy = [H B^3 - h b^3]/12

Density changes mass - geometry does not

Material	Density kg/m³	Area for 25.4 x 1.5 mm²	Calculated mass kg/m
Carbon steel	7,850	112.6	0.884
Stainless steel	7,900	112.6	0.890
Aluminium alloy	2,700	112.6	0.304

For quoting, calculate theoretical mass from nominal dimensions, then confirm purchasing mass, corner geometry, wall tolerance and invoicing basis with the material supplier. For structural verification, use the governing standard or certified section-property table.

03 ROUND TUBE - METRIC REFERENCE

Common OD x wall combinations and theoretical steel mass

The table is a compact engineering reference, not a stock list. Values use density 7,850 kg/m3 and nominal dimensions.

OD mm	Wall mm	ID mm	Area mm²	Steel kg/m	I mm4	Z mm3
10	1	8.0	28.3	0.222	290	58
12	1	10.0	34.6	0.271	527	88
12.7	1.2	10.3	43.4	0.340	724	114
16	1.2	13.6	55.8	0.438	1,538	192
19.1	1.2	16.7	67.5	0.530	2,715	284
20	1.5	17.0	87.2	0.684	3,754	375
22	1.5	19.0	96.6	0.758	5,102	464
25	1.5	22.0	110.7	0.869	7,676	614
25.4	1.5	22.4	112.6	0.884	8,073	636
30	1.5	27.0	134.3	1.054	13,674	912
31.8	1.5	28.8	142.8	1.121	16,426	1,033
32	2	28.0	188.5	1.480	21,300	1,331
38.1	1.5	35.1	172.5	1.354	28,928	1,519
40	2	36.0	238.8	1.874	43,216	2,161
42.4	2	38.4	253.8	1.993	51,915	2,449
50	2	46.0	301.6	2.368	87,010	3,480
50.8	2	46.8	306.6	2.407	91,428	3,600
60.3	2.5	55.3	454.0	3.564	189,931	6,300
76.2	3	70.2	689.9	5.416	462,853	12,148
101.6	3	95.6	929.3	7.295	1,130,352	22,251

Diameter-to-wall ratio D/t is a useful fabrication indicator. A larger D/t generally means a thinner, more distortion-sensitive wall. It does not by itself define bendability, collapse resistance or structural capacity.

Quick conversions

Nominal inch OD	Metric OD mm	Typical use note
1/2	12.70	Small handles, guards and instrumentation frames
5/8	15.88	Light frames and furniture components
3/4	19.05	General light fabrication
1	25.40	Common mechanical tube size
1-1/4	31.75	Frames, rails and support members
1-1/2	38.10	Medium frames and welded structures
2	50.80	Larger frames, rails and equipment structures
3	76.20	Heavy frames and large components

04 ROUND TUBE - SELECTION DETAILS

OD, ID, wall and section performance answer different questions

Choose the dimension that controls the functional interface, then assign tolerances and inspection to that feature.

Design question	Primary size variable	Why it matters	Common mistake
Does a bearing, sleeve or clamp fit outside?	Outside diameter and ovality	Controls external fit and clamping contact	Specifying only nominal pipe size
Does a shaft, cable or fluid path fit inside?	Minimum inside diameter / bore	Wall tolerance and weld bead can reduce usable bore	Calculating ID from nominal wall without allowance
Will it resist bending?	OD and section modulus Z	Material farther from the neutral axis increases bending efficiency	Comparing tubes only by mass
Will it resist torsion?	Polar section properties and joint details	Closed round sections are efficient in torsion	Ignoring holes, slots and welded attachments
Will it bend without collapse?	OD, wall, CLR, material condition and tooling	Thin-wall tight-radius bends need controlled support	Using D/t alone as an approval rule
Will the end be machined or welded?	Wall, concentricity, seam and local tolerance	End operations can expose seam and wall variation	Assuming seamless-like concentricity from ERW tube

Tolerance chain for a telescoping pair

Interface	Minimum clearance check	Engineering note
Outer tube ID vs inner tube OD	Clearance_min = ID_outer,min - OD_inner,max	Include ovality, coating, weld bead and misalignment
Bush / sleeve vs tube OD	Interference or clearance from worst-case diameters	Define whether fit is sliding, location or press fit
Cap / plug vs tube ID	Use the minimum usable bore	Confirm seam bead and corner / bore shape
Clamp vs tube OD	Check maximum OD and ovality	A split clamp may tolerate more variation than a rigid bore

When the inside diameter is function-critical, specify the required bore or plug-gauge condition directly. Nominal OD and wall do not guarantee a precise internal fit.

05 SQUARE TUBE REFERENCE

Nominal B x B x t, theoretical mass and ideal sharp-corner properties

Actual square hollow sections have outside and inside corner radii. Use the table for comparison and early quoting only.

B mm	Wall mm	Inside mm	Area mm²	Steel kg/m	I mm4	Z mm3
12	1	10.0	44.0	0.345	895	149
15	1.5	12.0	81.0	0.636	2,491	332
20	1.5	17.0	111.0	0.871	6,373	637
25	1.5	22.0	141.0	1.107	13,031	1,042
30	2	26.0	224.0	1.758	29,419	1,961
35	2	31.0	264.0	2.072	48,092	2,748
40	2	36.0	304.0	2.386	73,365	3,668
40	3	34.0	444.0	3.485	101,972	5,099
50	2	46.0	384.0	3.014	147,712	5,908
50	3	44.0	564.0	4.427	208,492	8,340
60	3	54.0	684.0	5.369	371,412	12,380
75	3	69.0	864.0	6.782	747,792	19,941
80	4	72.0	1216.0	9.546	1,173,845	29,346
100	4	92.0	1536.0	12.058	2,363,392	47,268
120	5	110.0	2300.0	18.055	5,079,167	84,653

Corner geometry matters

Feature	Effect	Drawing / procurement action
Outside corner radius	Changes envelope contact, welding gaps and appearance	Request standard corner range or maximum radius if mating is critical
Inside corner radius	Reduces clear internal space and affects insert design	Do not size an internal plug from B - 2t alone
Weld seam	Can affect bending direction, piercing and cosmetic finish	State seam orientation only when functionally necessary
Concavity / convexity	Can affect flush mounting and fixture contact	Define flatness / profile where a face is a datum
Twist and straightness	Affects long frames and automated fixturing	State cut length and straightness requirement at the needed length

06 RECTANGULAR TUBE REFERENCE

Orientation changes bending stiffness

For B x H x t in this guide, B is the horizontal width and H is the vertical depth used for Ix. Rotate the section and the strong / weak axes exchange.

B x H mm	t mm	Steel kg/m	Ix mm4	Iy mm4	Zx mm3	Zy mm3
20 x 10	1.5	0.636	1,181	3,801	236	380
30 x 15	1.5	0.989	4,550	14,067	607	938
30 x 20	1.5	1.107	8,946	17,116	895	1,141
40 x 20	2	1.758	14,379	44,459	1,438	2,223
50 x 25	2	2.229	29,604	90,079	2,368	3,603
60 x 30	2	2.700	52,979	159,499	3,532	5,317
60 x 40	3	4.427	143,132	273,852	7,157	9,128
80 x 40	3	5.369	184,292	558,532	9,215	13,963
100 x 50	3	6.782	374,392	1,121,192	14,976	22,424
100 x 50	4	8.918	473,659	1,441,259	18,946	28,825
120 x 60	4	10.802	847,659	2,551,979	28,255	42,533
150 x 75	5	16.878	2,069,479	6,230,417	55,186	83,072

Orientation	Bending axis	Practical effect
Deep dimension vertical	Uses Ix based on H3	Usually the stronger bending orientation for vertical gravity load
Deep dimension horizontal	Uses Iy based on B3	Lower vertical stiffness but may suit packaging, access or lateral load
Tube used as a column	Both axes and buckling length matter	The weaker radius of gyration often controls
Welded rectangular frame	Member orientation plus joint stiffness matter	Corner mitres, weld location and attachment eccentricity can dominate

Do not label an RHS only as “80 x 40”. The drawing must make the 80 mm and 40 mm directions unambiguous at bends, mitres, holes, welded brackets and finished assembly datums.

07 SECTION PROPERTIES

Compare stiffness, strength efficiency and buckling about the correct axis

Area controls mass and axial stress. Second moment I controls elastic deflection. Section modulus Z controls elastic bending stress. Radius of gyration r helps column-buckling comparison.

Property	Symbol / equation	Use	Unit
Area	A	Mass, axial stress and average shear	mm2
Second moment of area	I	Elastic bending stiffness: deflection proportional to 1 / EI	mm4
Section modulus	Z = I / c	Elastic bending stress: sigma = M / Z	mm3
Radius of gyration	r = sqrt(I / A)	Slenderness comparison: KL / r	mm
Polar second moment - round	J = pi/32 (D4 - d4)	Elastic torsional stiffness for circular tube	mm4

Equal mass does not mean equal performance

Section	Area mm²	kg/m	Ix mm4	Iy mm4	Zx mm3
Round 50.8 x 2.0	307	2.41	91,428	91,428	3,600
Square 40 x 40 x 3	444	3.49	101,972	101,972	5,099
RHS 60 x 30 x 3	504	3.96	72,792	225,072	4,853

Decision	Check first	Why
Limit deflection	E x I about the actual bending axis	A high-strength alloy does not increase elastic modulus proportionally
Limit elastic bending stress	Z and material yield strength	A deeper section can increase Z without a large mass increase
Avoid local denting / crushing	Wall, corner geometry, load introduction and inserts	Global section properties do not capture concentrated contact
Avoid column buckling	KL / r about both axes and end conditions	The weaker axis and actual unsupported length often govern
Design welded joints	Load path, weld group, HAZ and local wall flexibility	Member-table properties alone are insufficient

08 PRODUCTS, MATERIALS AND STANDARDS

The section size is only one line of the specification

Different product standards control manufacturing route, tolerances, mechanical properties, condition and inspection. Select the standard that matches the application.

Product family	Common reference	Shapes / use	Key project controls
Carbon-steel mechanical tube	ASTM A513/A513M-25	Round, square, rectangular and special ERW mechanical tubing	Type, steel grade, hot- or cold-rolled feed, condition, dimensional tolerance and surface
Carbon-steel structural tube	ASTM A500/A500M-23	Cold-formed round and shaped structural tubing	Grade, structural use, wall, corner geometry, weld seam and certification
Cold-formed structural hollow section	ISO 10799-1 and ISO 10799-2:2011	CHS, SHS and RHS in non-alloy / fine-grain steels	Delivery condition, grade, dimensions, tolerances and certified section properties
Hot-finished structural hollow section	ISO 12633-1 and ISO 12633-2:2011	Hot-finished CHS, SHS and RHS	Grade, dimensions, tolerances and hot-finished product route
Stainless mechanical tube	ASTM A554-26 or ISO 1127 dimensional reference	Welded stainless round / shape tube for mechanical, ornamental and corrosion-resistant use	Grade, finish, weld bead treatment, heat treatment and appearance
Aluminium extruded tube	ASTM B221 or project extrusion standard	Round, square, rectangular and custom extruded tube / profile	Alloy, temper, dimensional tolerance, straightness, surface and anodizing allowance
Plain-end steel tube tables	ISO 4200:1991	General OD, wall and conventional mass tables	Use with a product / delivery standard; not a complete material specification

Density reference for theoretical mass

Material family	Typical calculation density kg/m³	Use note
Carbon / low-alloy steel	7,850	Use specified product mass table when available
Austenitic stainless steel	about 7,900 to 8,000	Grade-dependent; use mill / standard value for final mass
Ferritic stainless steel	about 7,700	Grade-dependent
Aluminium alloys	about 2,700	Alloy-dependent but adequate for preliminary mass
Copper	about 8,960	Use product-specific standard and temper
Titanium alloys	about 4,430 to 4,510	Grade-dependent

A tube size reference must never be used as a material substitution approval. Confirm chemistry, mechanical properties, weldability, temper / condition, corrosion environment and regulatory requirements.

09 FABRICATION IMPLICATIONS

Choose a section that can be cut, bent, formed, welded and inspected

Availability is not enough. The size must suit tooling, fixturing, joining, coating and the final tolerance stack.

Operation	Size variables that matter	Design checks before release
Saw / laser cutting	OD / width, wall, section height and length	Cutting method, kerf, burr, squareness, deformation and nesting
Rotary-draw bending	OD, wall, CLR, straight length, seam and material condition	Tooling availability, D/t, bend spacing, ovality, thinning and springback
Roll bending	Section depth, wall, requested radius and arc length	Minimum achievable radius, twist, flatness and end straight length
Punching / drilling	Wall, face width, hole size and access	Hole-to-edge, collapse support, burr direction and opposite-wall damage
End forming	OD / ID, wall, seam, expansion or reduction amount	Tool access, splits, wrinkles, wall variation and final gauge
Welding	Wall, corner radius, seam location and fit-up gap	Burn-through, mismatch, local crushing, access and distortion
Machining	Wall, concentricity, straightness and stock allowance	ERW seam, interrupted cuts, fixture support and final wall
Powder coating / plating	Outside envelope, bore, holes and threads	Masking, drainage, coating build and telescoping interfaces

Tube size selection workflow

Step	Decision	Output
1	Define load, interface, envelope and environment	Required section shape and functional dimensions
2	Choose product family and material standard	Mechanical tube, structural HSS, stainless or aluminium extrusion
3	Screen commercially practical dimensions	OD / B / H / wall range and minimum order implications
4	Check stiffness, strength, buckling and local load introduction	Candidate section and orientation
5	Check cutting, bending, forming, welding and coating	Manufacturable size and tolerances
6	Specify drawing callout, reports and inspection	Released procurement and manufacturing definition

Use stock size as an input, not the final design criterion. A slightly different section may reduce tooling, weld length, distortion, coating rework or packaging volume enough to lower total cost.

10 DRAWING AND RFQ CHECKLIST

Release enough information to quote and manufacture the same tube you intended

Use the checklist before sending a tube part, welded frame or raw-tube RFQ.

01	Product family is identified: mechanical tube, structural hollow section, pressure tube or extrusion.
02	Section shape is unambiguous: round, square, rectangular or special.
03	Outside dimensions and nominal wall are stated with units.
04	Rectangular-section orientation is clear in every view and assembly.
05	Material grade, alloy and delivery condition / temper are stated.
06	Governing product standard and any edition requirement are stated.
07	Cut length and cut-end condition are specified.
08	OD / width / height tolerance is assigned only as tightly as function requires.
09	Wall tolerance and minimum wall are addressed where structural or machining function requires.
10	Straightness, twist, squareness and flatness are defined where needed.
11	Corner-radius limits are defined for mating or cosmetic faces.
12	Weld-seam orientation or bead removal is specified only when functionally necessary.
13	Inside-bore requirement is stated directly when plugs, shafts or cables must pass.
14	Telescoping, clamp, bearing and insert fits are checked at worst-case dimensions.
15	Bend radius, bend plane, straight lengths and post-bend acceptance are defined.
16	Hole / slot locations reference stable datums and account for section distortion.
17	Welded frame datums and final dimensional state are defined.
18	Surface finish, coating and masking are stated.
19	Material certificate / heat traceability requirements are stated.
20	Inspection method and reporting level match critical characteristics.
21	Theoretical mass is not used as a substitute for supplier-certified mass or structural properties.
22	BOM, drawing, 3D model and purchase text use the same size designation.
23	Approved substitutions require review of dimensions, grade, condition, weld seam, finish and properties.
24	Packaging protects long sections from bow, twist, abrasion and corrosion.

Minimum RFQ package

Document / data	Minimum content
2D drawing	Dimensions, tolerances, datums, bends, holes, welds, finish and notes
3D model	Native or STEP geometry matching the drawing revision
BOM / raw-material line	Section size, wall, material, standard, condition and quantity
Annual / batch demand	Prototype, batch quantity, annual volume and forecast
Quality requirement	Certificate, inspection report, FAI, gauges and critical-characteristic plan
Logistics	Required cut length, packaging, corrosion protection and destination

11 STANDARDS AND SOURCE LINKS

Verify the governing edition before contract release

The references below are official publisher pages. They are starting points, not a substitute for the purchased standard or project specification.

Reference	Application	Official source
ASTM A513/A513M-25	Electric-resistance-welded carbon and alloy steel mechanical tubing	https://store.astm.org/a0513_a0513m-25.html
ASTM A500/A500M-23	Cold-formed welded and seamless carbon-steel structural tubing	https://store.astm.org/a0500_a0500m-23.html
ASTM A554-26	Welded stainless-steel mechanical tubing	https://store.astm.org/a0554-26.html
ASTM B221	Aluminium and aluminium-alloy extruded tube and profiles	https://store.astm.org/b0221-21.html
ISO 10799-2:2011	Cold-formed welded structural hollow sections - dimensions and properties	https://www.iso.org/standard/52312.html
ISO 12633-2:2011	Hot-finished structural hollow sections - dimensions and properties	https://www.iso.org/standard/52310.html
ISO 1127:1992	Stainless-steel tube dimensions, tolerances and conventional masses	https://www.iso.org/standard/5660.html
ISO 4200:1991	Plain-end steel tube dimension and mass tables	https://www.iso.org/standard/9985.html

PROJECT HANDOFF
Send the drawing, 3D model, BOM, target material, finish, quantity and destination for a manufacturability review.

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Disclaimer

This document is a general engineering reference. It is not a structural design approval, pressure-design standard, material substitution authorization or guarantee of mill availability. Final decisions must be based on the released drawing, applicable law, purchased standards, certified material data, load cases, manufacturing process and customer requirements.