TECHNICAL DATA SHEET
Product Data · Design Formulas · Applications

FRP Square & Rectangular Tube

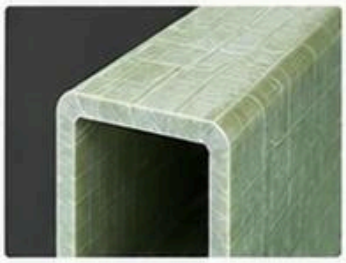
PULTRUDED GFRP BOX PROFILE



PRODUCT SERIES
FRP/GRP SQUARE & RECTANGULAR TUBE



Sections & Sizes



Specifications



Colors & Finish



Applications

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NABAK COMPOSITE FRP tube (FRP / GRP Square & Rectangular Tube) is a hollow square or rectangular pultruded GFRP profile. A lightweight structural shape with a closed section and high torsional stiffness, it does not rust, is electrically and thermally insulating, needs no painting, and replaces steel, galvanized and aluminium tube in structures and equipment in corrosive environments.

25 – 200 mm	≥ 240 MPa	≥ 23 GPa	6 / 12 m
Tube section size	Longitudinal tensile strength (E23)	Longitudinal modulus of elasticity	Bar length

What is FRP tube (GFRP box profile)?

Composite tube, also known as **FRP tube**, **GFRP tube**, **fiberglass tube**, **composite box profile**, **composite square and rectangular tube** and **fiberglass square pipe**, is made by pultrusion: continuous glass-fibre rovings together with multi-directional mats and fabrics pass through a resin bath, are shaped over a fixed mandrel in a heated die and cured as a hollow profile. A surface veil protects the profile against UV and moisture.

FRP is the general name for fibre-reinforced polymers, and GFRP (or GRP) is FRP made with glass fibre. For the same weight, the closed section of composite tube has far higher torsional stiffness than open profiles (channel, I-beam and angle) and resists lateral-torsional buckling better; FRP tube is therefore the first choice for composite columns, light beams, frames and truss members.

Layered wall structure of composite tube

Surface veil	Transverse mat	Longitudinal roving	Inner mat and veil
Resin-rich layer with polyester fibres for a smooth surface, UV resistance and no fibre blooming.	Continuous mat or ±45° fabric providing transverse and shear strength and bolt-bearing resistance.	The main core of continuous glass fibre along the length; source of the axial and flexural strength and modulus of FRP tube.	Inner layer that balances the section, prevents warping and protects the inner surface.

Advantages of FRP tube over steel tube

- **Corrosion-resistant:** composite tube does not rust in seawater, acid fumes, chlorine or sewage; no galvanizing or painting.
- **Lightweight:** GFRP profile density is about 1.85 g/cm³; a 100×100×6 tube weighs only 4.2 kg/m.
- **Electrically and thermally insulating:** suited to substations, line maintenance platforms and areas with electric-shock risk.
- **Non-magnetic and radio-transparent:** suited to antenna structures, radar and measuring equipment.
- **Easy fabrication:** cut with a diamond saw and bolted or bonded; no welding or hot-work permits.
- **Long service life:** life-cycle cost far below steel tube in corrosive environments.

Colour, resin and surface of FRP tube

Table 1 — Resin and colour options for composite tube

Resin	Approx. service temperature	Feature	Recommended use
Isophthalic polyester	≈ 80 °C	Economical, good chemical resistance	General structures, architecture, water and sewage
Vinyl ester	≈ 100 °C	Excellent chemical and fatigue resistance	Petrochemicals, cooling towers, electroplating
Fire-retardant resin	≈ 80 °C	ASTM E84 ≤ 25, self-extinguishing	Public spaces, tunnels, substations

Common colours of composite tube are **yellow, grey, green, cream and black**, and custom RAL colours are also produced. The pigment is dispersed through the full thickness of the GFRP profile and does not wear or scratch off.

Square composite tube table

Table 2 — Square FRP tube: sizes and section properties (ρ = 1.85 g/cm³)

Size B×B×t (mm)	Cross-section area A (mm²)	Weight (kg/m)	Moment of inertia I (mm⁴)	Section modulus W (mm³)	Radius of gyration i (mm)	Torsion constant J (mm⁴)
25 × 25 × 3	264	0.49	2.17×10^{4}	1.74×10^{3}	9.1	3.19×10^{4}
38 × 38 × 3.2	445	0.82	9.07×10^{4}	4.77×10^{3}	14.3	1.35×10^{5}
40 × 40 × 4	576	1.07	1.26×10^{5}	6.30×10^{3}	14.8	1.87×10^{5}
50 × 50 × 4	736	1.36	2.62×10^{5}	1.05×10^{4}	18.9	3.89×10^{5}
50 × 50 × 6	1056	1.95	3.47×10^{5}	1.39×10^{4}	18.1	5.11×10^{5}
60 × 60 × 5	1100	2.04	5.59×10^{5}	1.86×10^{4}	22.5	8.32×10^{5}
76 × 76 × 6.4	1782	3.30	1.45×10^{6}	3.82×10^{4}	28.5	2.16×10^{6}
100 × 100 × 6	2256	4.17	3.34×10^{6}	6.67×10^{4}	38.5	4.98×10^{6}
100 × 100 × 8	2944	5.45	4.18×10^{6}	8.37×10^{4}	37.7	6.23×10^{6}

Rectangular composite tube table

Table 3 — Rectangular FRP tube: sizes and section properties about the strong x-axis

Size H×B×t (mm)	Cross-section area A (mm²)	Weight (kg/m)	I_x (mm⁴)	W_x (mm³)	i_x / i_y (mm)	J (mm⁴)
50 × 25 × 3	414	0.77	1.26×10^{5}	5.02×10^{3}	17.4 / 9.8	9.30×10^{4}
60 × 40 × 4	736	1.36	3.45×10^{5}	1.15×10^{4}	21.7 / 15.6	3.53×10^{5}
80 × 40 × 4	896	1.66	7.11×10^{5}	1.78×10^{4}	28.2 / 16.0	5.35×10^{5}
100 × 50 × 5	1400	2.59	1.74×10^{6}	3.47×10^{4}	35.2 / 20.0	1.31×10^{6}
120 × 60 × 6	2016	3.73	3.60×10^{6}	6.00×10^{4}	42.3 / 24.0	2.71×10^{6}
150 × 75 × 6	2556	4.73	7.30×10^{6}	9.73×10^{4}	53.4 / 30.6	5.56×10^{6}
200 × 100 × 8	4544	8.41	2.31×10^{7}	2.31×10^{5}	71.2 / 40.8	1.76×10^{7}

Section properties are calculated with Formulas 1 to 4 (page 4) for sharp corners; actual rounded corners reduce the values slightly. Sizes are common market sizes of pultruded composite tube; custom sizes are possible with a new die. Tolerances per EN 13706-2.

Square or rectangular? Square composite tube has equal stiffness in both directions and is the better choice for columns, handrail posts and compression members. Rectangular FRP tube, with its long side in the load direction, deflects less for the same weight and suits beams, platform joists and purlins.

Length, tolerances and packing

Table 4 — Typical tolerances of pultruded FRP tube (EN 13706-2)

Parameter	Typical tolerance	Remarks
Outside section dimensions	±0.5 to ±1.0 mm	Depending on the size of the composite tube
Wall thickness	±10% (minimum ±0.2 mm)	Checked on all four sides
Straightness	≤ 0.2% of length	6 m bar: maximum 12 mm bow
Twist	≤ 1° per metre	Important in frames and connections
Bar length	6000 mm (+20 / -0)	Lengths up to 12 m and cut to size

Mechanical properties of composite tube per EN 13706

Table 5 — Minimum properties of EN 13706-3 pultruded profile grades and typical values of FRP tube

Property	Test method	Grade E23 (minimum)	Grade E17 (minimum)	Typical value, GFRP tube
Longitudinal tensile modulus	EN ISO 527-4	23 GPa	17 GPa	23 – 28 GPa
Longitudinal tensile strength	EN ISO 527-4	240 MPa	170 MPa	250 – 350 MPa
Transverse tensile strength	EN ISO 527-4	50 MPa	30 MPa	50 – 80 MPa
Longitudinal flexural strength	EN ISO 14125	240 MPa	170 MPa	250 – 350 MPa
Transverse flexural strength	EN ISO 14125	100 MPa	70 MPa	100 – 130 MPa
Apparent shear strength	EN ISO 14130	25 MPa	15 MPa	25 – 35 MPa
Pin-bearing strength (longitudinal / transverse)	EN 13706 Annex	150 / 70 MPa	90 / 50 MPa	180 – 220 / 90 – 120 MPa
In-plane shear modulus G	—	—	—	3 – 4 GPa
Density / Barcol hardness	ISO 1183 / EN 59	—	—	1.8 – 1.9 g/cm³ / ≥ 45
Longitudinal coefficient of thermal expansion	—	—	—	8 – 10 ×10^{-6} /°C

Grade values are quoted from the common text of EN 13706-3; the last column shows typical ranges of the FRP and GFRP composites industry, not NABAK COMPOSITE's own laboratory results. NABAK composite tube is designed on the basis of grade E23.

Composite tube compared with steel and aluminium tube

Table 6 — FRP tube vs steel and aluminium tube

Feature	GFRP composite tube	S235 steel tube	6063-T6 aluminium tube
Density (g/cm³)	1.85	7.85	2.7
Strength (MPa)	240 – 350 (ultimate)	235 (yield)	170 (yield)
Modulus of elasticity (GPa)	23 – 28	210	70
Specific strength (strength / density)	≈ 130 – 190	≈ 30	≈ 63
Corrosion in chemical and marine environments	None	Severe	Moderate
Electrical / thermal conductivity	Insulating / ≈ 0.3	Conductive / ≈ 50	Conductive / ≈ 200
Governing design criterion	Deflection and buckling	Strength	Strength and deflection

Applications of FRP composite tube

Platforms and walkways
Beams, columns and bracing of composite grating platforms in corrosive environments

Handrails and guardrails
Posts and rails of FRP handrails and industrial safety guards

Cooling towers
Internal columns, beams and bracing of towers in GFRP tube

Substations and power lines
Insulating structures, ladders and work platforms near live equipment

Canopies, greenhouses and architecture
Light frames for canopies, greenhouses and facades in coloured fiberglass tube

Equipment and machinery
Frames, chassis and supports in chemical, food and electroplating industries

Section property formulas for composite tube

1. Cross-section area and weight of the tube

$$A = B\,H - (B - 2t)(H - 2t)\,, \quad w = \rho\,A$$

100×50×5: A = 5000 - 40 × 90 = 1400 mm²; w = 1.85 × 1400 × 10^{-3} ≈ 2.59 kg/m

2. Moment of inertia and section modulus

$$I_x = \frac{B\,H^3 - b\,h^3}{12}\,, \quad W_x = \frac{2\,I_x}{H}$$

b = B - 2t, h = H - 2t. 100×50×5: $I_x \approx 1.74\times10^6$ mm⁴, $W_x \approx 3.47\times10^4$ mm³

3. Radius of gyration

$$i = \sqrt{\left(\frac{I}{A}\right)}$$

60×60×5: i = √(5.59×10^5 / 1100) ≈ 22.5 mm; used to calculate column slenderness

4. Torsion constant of a closed section (Bredt)

$$J = \frac{4\,A_m^{\,2}\,t}{p_m}\,, \quad A_m = (B - t)(H - t)$$

p_m centreline perimeter. 50×50×4: J = 4 × 2116² × 4 / 184 ≈ 3.89×10^5 mm⁴

Beam design with FRP tube (bending + shear deflection)

5. Total deflection of a simple beam under uniform load (Timoshenko)

$$\delta = \frac{5\,q\,L^4}{384\,E\,I} + \frac{q\,L^2}{8\,G\,A_w} \le \frac{L}{250}\,, \quad A_w = 2\,t\,(H - 2t)$$

Example — rectangular composite tube 100×50×5, span 2 m, uniform load 1 kN/m, E = 23 GPa, G = 3 GPa:

$\delta_b = 5 \times 1 \times 2000^4 / (384 \times 23\,000 \times 1.74\times10^6) \approx 5.22$ mm

$A_w = 2 \times 5 \times 90 = 900$ mm² → $\delta_s = 1 \times 2000^2 / (8 \times 3000 \times 900) \approx 0.19$ mm

$\delta = 5.40$ mm ≤ L/250 = 8.0 mm ✓ ; $\sigma = qL^2/(8W_x) \approx 14.4$ MPa ≪ 240/2.5 = 96 MPa

Shear deflection is significant in composites because of the low shear modulus, and its share grows in short spans. In FRP tube, stress is usually far below the allowable value and deflection governs the design.

6. Local buckling of the compression wall of the tube

$$\sigma_{cr,local} \approx k \cdot \frac{\pi^2\,E}{12\,(1 - \nu^2)} \cdot \left(\frac{t}{b}\right)^2\,, \quad k \approx 4$$

b clear width of the wall (B - t). For the tubes in this data sheet, with b/t ≤ 20, local buckling lies beyond the material strength and does not govern; thin-walled tubes with b/t above 30 must be checked (simplified relation for an isotropic plate; for greater accuracy use orthotropic pultrusion design rules).

7. Shear stress in the tube webs

$$\tau = \frac{V}{A_w} \le \frac{\tau_u}{FS}$$

Example above: V = qL/2 = 1000 N → τ = 1000 / 900 ≈ 1.1 MPa ≪ 25 / 2.5 = 10 MPa; in short beams with heavy concentrated loads, check web shear and crushing under the load.

Column, torsion and connection design of composite tube

8. Overall column buckling (Euler) and slenderness

$$P_{cr} = \frac{\pi^2 E I}{(K L)^2}\ ,\quad \lambda = \frac{K L}{i}\ ,\quad P_a = \frac{\min(P_{cr},\ \sigma_c A)}{FS}$$

Example — square tube column 60×60×5, length 2.5 m, pinned both ends (K = 1):

$P_{cr} = \pi^2 \times 23\,000 \times 5.59\times10^5 / 2500^2 \approx 20.3$ kN ; $\lambda = 2500 / 22.5 \approx 111$

$\sigma_c A = 240 \times 1100 \approx 264$ kN → Euler governs → $P_a = 20.3 / 2.5 \approx 8.1$ kN

Because of the low modulus, slender composite columns are governed by overall buckling; intermediate bracing or a larger tube (76×76×6.4 with $P_{cr} \approx 53$ kN) multiplies the capacity.

9. Shear stress and angle of twist

$$\tau = \frac{T}{2 A_m t}\ ,\quad \theta = \frac{T L}{G J}$$

50×50×4 with T = 100 N·m: τ ≈ 5.9 MPa and θ ≈ 0.086 rad/m ≈ 4.9°/m

10. Bearing capacity of a bolted connection

$$P_{br} = \frac{n \cdot d \cdot t \cdot \sigma_{br}}{FS}$$

2 M10 bolts in a 5 mm wall, σ_{br} = 150 MPa (E23), FS = 3: $P_{br} = 2 \times 10 \times 5 \times 150 / 3 = 5.0$ kN

11. Minimum bolt distances

$$e_1 \geq 2d\ ,\quad e_2 \geq 1.5d\ ,\quad p \geq 4d$$

e_1 end distance, e_2 edge distance, p bolt pitch. M10 bolt: $e_1 \geq 20$, $e_2 \geq 15$, $p \geq 40$ mm

12. Thermal expansion of the member

$$\Delta L = \alpha \cdot L \cdot \Delta T$$

6 m tube, $\alpha = 9\times10^{-6}$, ΔT = 40 °C → $\Delta L \approx 2.2$ mm; close to steel and compatible with hybrid structures

Fabrication and installation guide for composite tube

1 **Cutting:** cut FRP tube with a diamond or carbide circular saw at high speed and low feed pressure to avoid edge delamination.

2 **Drilling:** drill with a carbide or diamond bit, hole 1 to 1.5 mm larger than the bolt; support the part underneath.

3 **Sealing:** coat cut surfaces and holes of composite tube with compatible resin so fibres are not exposed to moisture.

4 **Connection:** use GFRP angles and plates with stainless or FRP bolts and wide washers; fit spacer bushes inside the tube at bolt positions.

5 **Torque:** tighten bolts to a controlled torque so the tube wall is not crushed; do not use impact wrenches.

6 **Safety:** wear a mask, goggles and gloves when cutting and drilling, and collect fibre dust with extraction.

NABAK COMPOSITE

Request a quote for FRP tube: send section size and thickness, length and number of bars, colour, resin type (iso, vinyl ester, fire-retardant) and application.
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Disclaimer: The information in this data sheet is based on general, typical data of the FRP and GFRP composites industry and the EN 13706 standard, and is intended as guidance only. Examples are for illustration; structural design must be carried out by a qualified engineer. NABAK COMPOSITE reserves the right to change technical specifications without notice.