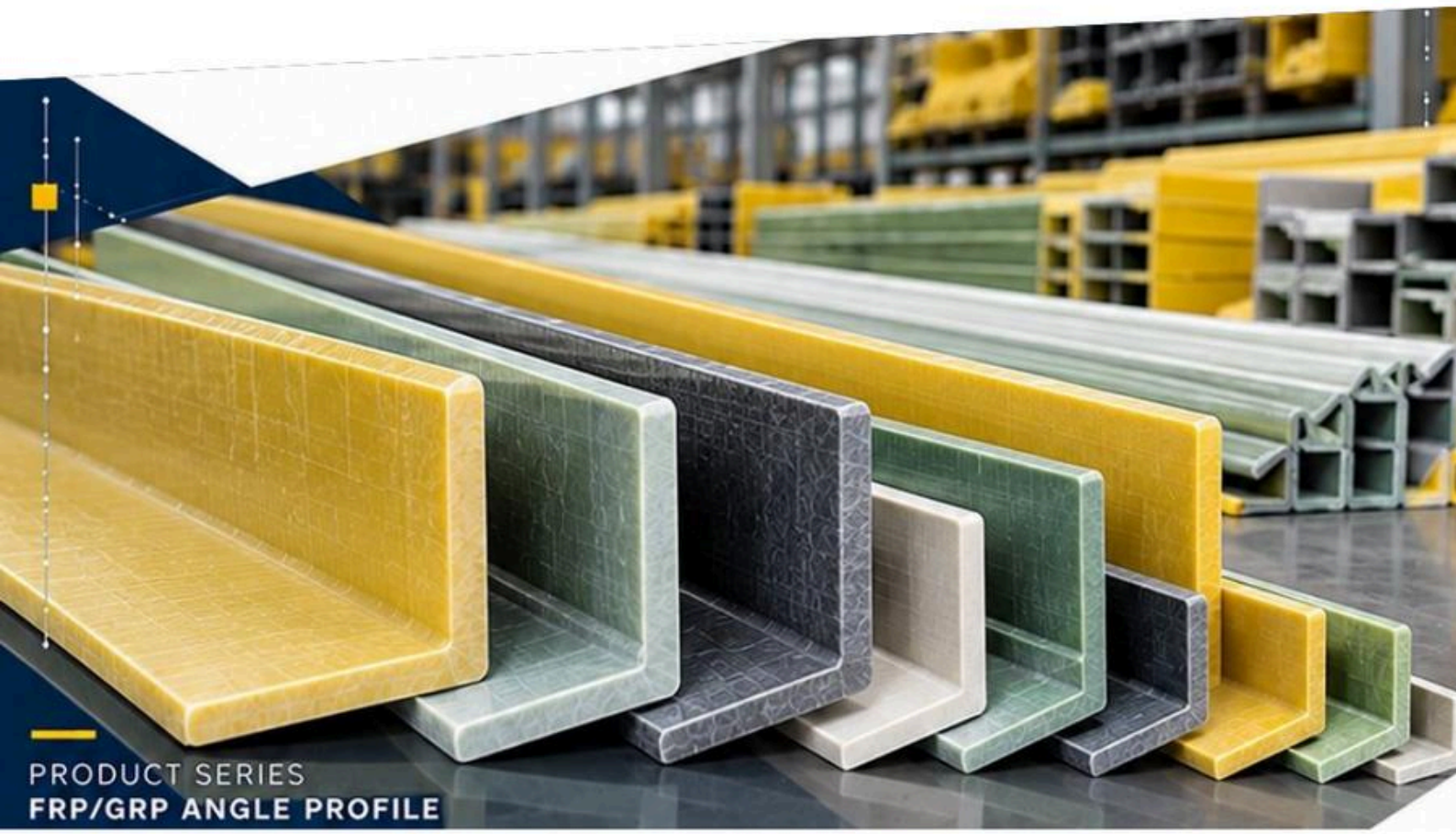
TECHNICAL DATA SHEET
Product Data · Design Formulas · Applications

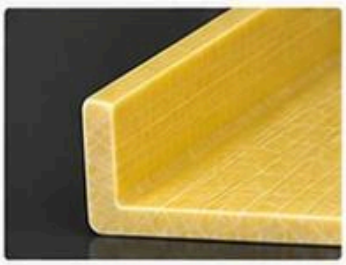
FRP Angle Profile

PULTRUDED GFRP EQUAL & UNEQUAL ANGLE

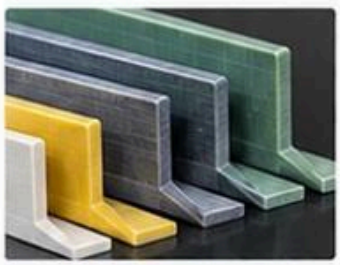




Sections & Sizes



Specifications



Colors & Finish



Applications

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NABAK COMPOSITE FRP angle (FRP / GRP Angle Profile) is a pultruded L-shaped GFRP profile with equal or unequal legs. Lightweight, rust-free, electrically insulating and paint-free, it is the most widely used connection, bracing and support member in composite structures, FRP grating platforms, cable trays and equipment in corrosive environments.

25 – 150 mm	3 – 12.7 mm	≥ 240 MPa	≈ 1/4
Angle leg width	Leg thickness	Longitudinal tensile strength (E23)	of the weight of an equal steel angle

What is FRP angle (GFRP angle profile)?

Composite angle, also known as **FRP angle**, **GFRP angle**, **fiberglass angle**, **composite angle profile** and **pultruded angle**, is made by continuously pulling glass-fibre rovings and transverse mats impregnated with resin through a heated L-shaped die. Continuous fibres around the corner ensure an integral connection of the two legs, and the 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. Composite angle is an **open, asymmetric section**: its principal axes are inclined, its torsional stiffness is low and in compression it is sensitive to torsional buckling. FRP angle is therefore used mainly for connections, tension bracing, supports and framing, while composite tube is a better choice for columns.

Structure and types of composite angle

Equal-leg angle
Two legs of equal width; the most common FRP angle for connections, bracing and framing.

Unequal-leg angle
Long leg for higher stiffness in one direction; grating edge supports and cantilevers.

Integral corner
Continuous fibres and an inside corner radius that reduces stress concentration.

Surface veil
Smooth, resin-rich surface for UV and chemical resistance and a uniform finish of GFRP angle.

Advantages of FRP angle over steel angle

- **Corrosion-resistant:** composite angle does not rust in seawater, chlorine, acids or sewage; no galvanizing or painting.
- **Lightweight:** a 50×50×5 GFRP angle weighs only 0.88 kg/m — about a quarter of an equal steel angle.
- **Electrically insulating:** safety in substations, battery rooms and structures near live lines.
- **Non-magnetic and non-sparking:** suited to explosive atmospheres and sensitive equipment.
- **Simple fabrication:** cut with a diamond saw and bolted or bonded; no welding or hot work.
- **Compatible with FRP systems:** same material as composite grating, handrail and tube in one structure.

Applications of FRP composite angle

Clip angles
Beam-to-column and beam-to-beam connections in composite tube and I-beam structures

Grating supports
Edge angles to seat FRP grating on concrete walls and beams

Bracing and trusses
Tension members and light bracing of platforms and cooling towers

Hatch and trench frames
Frames for trench covers, inspection hatches and treatment-plant channels

Cable tray and panels
Insulating brackets, posts and frames in electrical installations

Edging and protection
Wall-corner guards, stair nosings and equipment frames in corrosive areas

Equal-leg composite angle table

Table 1 — Equal-leg FRP angle: sizes and section properties (ρ = 1.85 g/cm³)

Size b×b×t (mm)	A (mm²)	Weight (kg/m)	Centroid e (mm)	$I_x = I_y$ (mm⁴)	I_u maximum (mm⁴)	I_v minimum (mm⁴)	i_v (mm)	J (mm⁴)
25 × 25 × 3	141	0.26	7.4	8.20×10^{3}	1.30×10^{4}	3.38×10^{3}	4.9	423
38 × 38 × 6.4	445	0.82	11.8	5.75×10^{4}	9.07×10^{4}	2.44×10^{4}	7.4	6.08×10^{3}
40 × 40 × 4	304	0.56	11.5	4.61×10^{4}	7.34×10^{4}	1.88×10^{4}	7.9	1.62×10^{3}
50 × 50 × 5	475	0.88	14.3	1.13×10^{5}	1.79×10^{5}	4.59×10^{4}	9.8	3.96×10^{3}
50 × 50 × 6.4	599	1.11	14.8	1.38×10^{5}	2.20×10^{5}	5.72×10^{4}	9.8	8.18×10^{3}
76 × 76 × 6.4	932	1.72	21.4	5.17×10^{5}	8.25×10^{5}	2.10×10^{5}	15.0	1.27×10^{4}
76 × 76 × 9.5	1354	2.50	22.5	7.25×10^{5}	1.15×10^{6}	2.99×10^{5}	14.9	4.07×10^{4}
100 × 100 × 6.4	1239	2.29	27.4	1.21×10^{6}	1.94×10^{6}	4.89×10^{5}	19.9	1.69×10^{4}
100 × 100 × 9.5	1810	3.35	28.5	1.72×10^{6}	2.74×10^{6}	7.01×10^{5}	19.7	5.44×10^{4}
100 × 100 × 12.7	2379	4.40	29.7	2.20×10^{6}	3.49×10^{6}	9.09×10^{5}	19.6	1.28×10^{5}
150 × 150 × 9.5	2760	5.11	41.0	6.08×10^{6}	9.71×10^{6}	2.45×10^{6}	29.8	8.30×10^{4}

Unequal-leg composite angle table

Table 2 — Unequal-leg FRP angle: sizes and section properties

Size B×b×t (mm)	A (mm²)	Weight (kg/m)	e_y / e_x (mm)	I_x (mm⁴)	I_y (mm⁴)	I_v minimum (mm⁴)	i_v (mm)	J (mm⁴)
76 × 50 × 6.4	765	1.42	25.3 / 12.3	4.50×10^{5}	1.57×10^{5}	9.05×10^{4}	10.9	1.05×10^{4}
100 × 50 × 6.4	919	1.70	35.8 / 10.8	9.60×10^{5}	1.68×10^{5}	1.07×10^{5}	10.8	1.25×10^{4}
100 × 76 × 9.5	1582	2.93	31.9 / 19.9	1.57×10^{6}	7.88×10^{5}	4.19×10^{5}	16.3	4.76×10^{4}
150 × 100 × 9.5	2285	4.23	48.6 / 23.6	5.32×10^{6}	1.94×10^{6}	1.10×10^{6}	21.9	6.87×10^{4}

e is the distance of the centroid from the back of the leg; u and v are the principal axes (at 45° for equal angles). Properties are calculated with the formulas on page 4 for a sharp corner; the actual corner radius changes the values slightly. Common market sizes of pultruded composite angle are supplied in 6 m lengths; tolerances per EN 13706-2.

Selection guide for composite angle by application

Table 3 — Recommended FRP angle for common applications

Application	Recommended angle (mm)	Design note
Clip angle for 100 mm tube beam-to-column joint	76 × 76 × 9.5 or 100 × 100 × 9.5	Check transverse bending of the leg (Formula 12)
FRP grating edge support	50 × 50 × 6.4 / 76 × 50 × 6.4	Seat width ≥ 38 mm for grating
Platform tension bracing	50 × 50 × 5 / 76 × 76 × 6.4	Shear lag of single-leg connection (Formula 9)
Short compression brace	76 × 76 × 9.5 or double angle	Torsional and flexural buckling (Formula 8)
Hatch frames and channel covers	40 × 40 × 4 / 50 × 50 × 5	Framing with stainless or FRP bolts
Cable-tray bracket	76 × 50 × 6.4 / 100 × 50 × 6.4	Long leg in the load direction
Edging and corner guard	25 × 25 × 3 / 38 × 38 × 6.4	Bonded or riveted

Choosing thickness: in composite angle, the leg width-to-thickness ratio (b/t) matters more than overall size. Angles with b/t ≤ 8 (such as 50×50×6.4 and 76×76×9.5) perform much better in compression and connections than thin-walled angles, although they weigh slightly more per metre.

Mechanical properties of composite angle (EN 13706 grade)

Table 4 — Reference properties of pultruded GFRP angle

Property	Test method	EN 13706 grade E23 minimum	Typical value, FRP angle
Longitudinal tensile modulus E_L	EN ISO 527-4	23 GPa	23 – 28 GPa
Transverse modulus E_T	EN ISO 527-4	–	7 – 9 GPa
In-plane shear modulus G_{LT}	–	–	3 – 4 GPa
Tensile strength, longitudinal / transverse	EN ISO 527-4	240 / 50 MPa	250 – 350 / 50 – 80 MPa
Flexural strength, longitudinal / transverse	EN ISO 14125	240 / 100 MPa	250 – 350 / 100 – 130 MPa
Longitudinal compressive strength	EN ISO 14126	–	240 – 300 MPa
Apparent shear strength	EN ISO 14130	25 MPa	25 – 35 MPa
Pin-bearing strength, longitudinal / transverse	EN 13706	150 / 70 MPa	180 – 220 / 90 – 120 MPa
Poisson's ratio ν_{LT}	–	–	0.25 – 0.33
Density / longitudinal expansion coefficient	–	–	1.8 – 1.9 g/cm³ / 8 – 10 ×10^{-6} /°C

The E_L/G_{LT} ratio of composite angle is about 7 to 8 (steel ≈ 2.6); this low shear modulus is the main reason FRP angle is sensitive to torsional buckling in compression (Formula 8). Values are typical ranges of the FRP and GFRP composites industry and are not NABAK COMPOSITE's own laboratory results.

Composite angle compared with steel and aluminium angle

Table 5 — FRP angle vs S235 steel angle and 6063-T6 aluminium angle

Feature	GFRP angle	Steel angle	Aluminium angle
Weight 50×50×5 (kg/m)	0.88	3.77	1.28
Modulus E / shear modulus G (GPa)	23 / 3	210 / 81	70 / 26
Behaviour up to failure	Linear elastic, brittle	Ductile	Ductile
Corrosion in chemical and marine environments	None	Severe	Moderate
Electrical conductivity	Insulating	Conductive	Conductive
Suitability for tension members and connections	Very suitable	Very suitable	Very suitable
Suitability for long compression members	Limited (buckling)	Good	Moderate

Resin, colour and length of FRP angle

Table 6 — Ordering options for composite angle

Option	Choices	Remarks
Resin	Isophthalic / vinyl ester / fire-retardant	Vinyl ester for severe chemical environments; fire-retardant to ASTM E84 ≤ 25
Colour	Yellow, grey, green, cream, black, custom RAL	Pigment through the thickness of GFRP angle
Length	6 m standard; up to 12 m and cut to size	Factory cutting and drilling to drawing

Back-to-back double angle: two composite angles stitched together with spacers and bolts form a symmetric section that removes the weak v-axis and the torsional buckling of a single angle. For truss members and long compression braces, use FRP double angles or composite tube instead of a single angle.

Section formulas for composite angle

1. Cross-section area and weight

$$A = t\,(B + b - t)\,, \quad w = \rho \cdot A$$

50×50×5: A = 5 × 95 = 475 mm²; w = 1.85 × 475 × 10^{-3} ≈ 0.88 kg/m

2. Centroid of an equal-leg angle

$$e = \frac{b^2 + b\,t - t^2}{2\,(2b - t)}$$

50×50×5: e = (2500 + 250 - 25) / 190 ≈ 14.3 mm from the back of each leg

3. Moment of inertia about the geometric axis (rectangular parts)

$$I_x = \Sigma\,(\,\frac{b_i\,h_i^3}{12} + A_i\,(y_i - e)^2\,)$$

The angle is divided into two rectangles b×t and t×(b - t). 50×50×5: I_x ≈ 1.13×10^5 mm⁴

4. Product of inertia

$$I_{xy} = \Sigma\,A_i\,(x_i - e_x)(y_i - e_y)$$

For an angle I_{xy} is not zero, i.e. the x and y axes are not principal axes. 50×50×5: $|I_{xy}|$ ≈ 6.6×10^4 mm⁴

5. Principal moments of inertia (Mohr's circle)

$$I_{u,v} = \frac{I_x + I_y}{2} \pm \sqrt{(\,\frac{I_x - I_y}{2}\,)^2 + I_{xy}^2}\,, \quad \tan 2\theta = \frac{-2\,I_{xy}}{I_x - I_y}$$

For an equal-leg angle θ = 45° and $I_{u,v} = I_x \pm |I_{xy}|$. 50×50×5: I_u ≈ 1.79×10^5 and I_v ≈ 4.59×10^4 mm⁴. The v-axis (corner diagonal) is the weakest axis of composite angle.

6. Minimum radius of gyration

$$i_v = \sqrt{(\,\frac{I_v}{A}\,)}$$

50×50×5: i_v = √(45 900 / 475) ≈ 9.8 mm; basis of the slenderness of compression members

7. Torsion constant of an open section

$$J \approx \frac{(B + b - t)\cdot t^3}{3}$$

50×50×5: J = 95 × 125 / 3 ≈ 3.96×10^3 mm⁴; about one hundredth of a 50×50×4 tube of similar weight (3.89×10^5)

Angle or tube? The torsion constant of an open composite angle grows with the cube of thickness and is hundreds of times smaller than that of a closed FRP tube of the same weight. Where torsion, buckling or long compression members occur, choose composite tube; for connections, tension bracing and supports, composite angle is the right choice.

Step-by-step example — composite angle 50×50×5:

Rect 1 (50×5): A_1 = 250, y_1 = 2.5 ; Rect 2 (5×45): A_2 = 225, y_2 = 27.5 → e = (625 + 6187.5)/475 ≈ 14.3 mm

$I_x = 50\times5^3/12 + 250\times11.8^2 + 5\times45^3/12 + 225\times13.2^2 \approx 1.13\times10^5$ mm⁴

$I_u = 1.13\times10^5 + 6.6\times10^4 \approx 1.79\times10^5$; $I_v = 1.13\times10^5 - 6.6\times10^4 \approx 4.6\times10^4$ mm⁴

These values appear in Table 1 and are the basis of the design formulas on page 5.

Design formulas for composite angle

8. Torsional buckling and flexural buckling about the v-axis (compression member)

$$\sigma_T \approx G_{LT} \cdot \left(\frac{t}{b}\right)^2, \quad P_v = \frac{\pi^2 E_L I_v}{(K L)^2}, \quad P_a = \frac{\min(\sigma_T A, P_v, \sigma_c A)}{FS}$$

Example — compression brace FRP angle 50×50×5, G = 3 GPa, E = 23 GPa, FS = 2.5:

Torsional: $\sigma_T = 3000 \times (5/50)^2 = 30$ MPa → $P_T = 30 \times 475 \approx 14.3$ kN

L = 1.5 m: $P_v = \pi^2 \times 23\,000 \times 45\,900 / 1500^2 \approx 4.6$ kN → governs → $P_a \approx 1.9$ kN

L = 0.6 m: $P_v \approx 28.9$ kN → torsional governs → $P_a \approx 14.3 / 2.5 \approx 5.7$ kN

The torsional buckling stress of composite angle (30 MPa) is only about 12% of the material's compressive strength — the key design point for FRP angle in compression. Thicker legs (larger t/b) or back-to-back double angles reduce this limitation.

9. Tension member connected by one leg (shear lag)

$$A_e = U \cdot A_n, \quad U = 1 - \frac{\bar{x}}{L_c}, \quad T_a = \frac{A_e \cdot \sigma_t}{FS}$$

50×50×5 with 2 M10 bolts (11 mm holes) at 50 mm: $A_n = 420$, $\bar{x} = 14.3$, $U \approx 0.71$ → $A_e \approx 300$ mm² → $T_a \approx 300 \times 240 / 2.5 \approx 28.8$ kN

10. Bolt bearing and minimum distances

$$P_{br} = \frac{n\, d\, t\, \sigma_{br}}{FS}; \quad e_1 \geq 2d,\ e_2 \geq 1.5d,\ p \geq 4d$$

2 M10 bolts in a 5 mm leg, $\sigma_{br} = 150$ MPa, FS = 3 → $P_{br} = 5.0$ kN; in composite angle the connection is usually governed by bolt bearing.

11. Local buckling of the free leg (simplified)

$$\sigma_{cr} \approx 0.425 \frac{\pi^2 E}{12(1-\nu^2)} \left(\frac{t}{b'}\right)^2$$

b' = b − t/2. Isotropic relation; for orthotropic FRP profiles, Formula 8 (dependent on G) is more conservative and governs.

12. Eccentric load on a clip angle

$$M = V \cdot e_c, \quad \sigma = \frac{6\,M}{w \cdot t^2}$$

Clip angle 76×76×9.5, length w = 150 mm, V = 5 kN, $e_c = 40$ mm: σ = 6 × 200 000 / (150 × 90.25) ≈ 88.6 MPa; below the 100 MPa transverse flexural strength, but FS ≈ 1.1 is low → thicker leg or longer w

Fabrication guide for composite angle

1 **Cutting:** cut FRP angle with a diamond or carbide saw blade at low feed pressure so the edge does not delaminate.

2 **Drilling:** use a carbide drill, hole 1 to 1.5 mm larger than the bolt, observing the distances of Formula 10.

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

4 **Connection:** stainless or FRP bolts with wide washers; in critical joints, structural epoxy adhesive together with bolts.

5 **Load direction:** apply the main load along the fibre direction; limit transverse bending of the leg and the angle corner.

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

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Request a quote for FRP angle: send leg size and thickness, length and number of bars, colour, resin type and the cutting and drilling drawing.
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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.