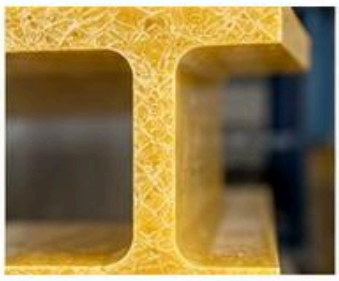
TECHNICAL DATA SHEET
Product Data · Design Formulas · Applications

FRP I-Beam Profile

PULTRUDED GFRP I-BEAM & WIDE FLANGE








Specifications | **Sections & Sizes** | **Structural Properties** | **Applications**

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NABAK COMPOSITE | **nabakcomposite.com** | **+98 21 4881 2124** | **+98 912 396 3078** | **@nabak.composite**

NABAK COMPOSITE FRP I-beam (FRP / GRP I-Beam) is a pultruded I-shaped GFRP profile with two flanges and one web. It is the main structural member of composite structures and replaces steel I-beams as beams and columns of platforms, footbridges, cooling towers, marine structures and chemical plants — at a quarter of the weight, rust-free, electrically insulating and paint-free.

76 – 305 mm	≥ 23 GPa	≥ 240 MPa	≈ 1/4
Composite beam depth	Longitudinal modulus of elasticity	Longitudinal flexural strength (E23)	of the weight of an equal steel I-beam

What is an FRP I-beam?

Composite beam, also known as **composite I-beam**, **FRP I-beam**, **GFRP beam**, **fiberglass beam**, **composite structural beam** and **composite I-profile**, is made by pultruding continuous glass-fibre rovings and transverse mats impregnated with resin through a heated I-shaped die. Dense longitudinal fibres are placed in the flanges for maximum bending stiffness and strength, while mats and multi-directional fabrics in the web provide shear strength and bolt bearing.

FRP is the general name for fibre-reinforced polymers, and GFRP (or GRP) is FRP made with glass fibre. The doubly symmetric section of a composite I-beam puts the shear centre at the centroid, so, unlike channels and angles, load on the beam axis causes no torsion — making the FRP I-beam the most efficient composite profile for bending.

NABAK COMPOSITE beam types

I-beam (narrow flange)
Flange width about half the depth; the highest bending stiffness for the weight; platform and bridge beams.

Wide-flange WF beam
Flange width equal to depth; higher weak-axis stiffness; columns and unbraced beams.

Resins
Isophthalic for general use, vinyl ester for chemical environments, fire-retardant resin for public spaces.

Colour and surface
Yellow, grey, green and custom colours with a UV-resistant veil over the whole surface of the GFRP beam.

Advantages of FRP beams over steel I-beams

- **Corrosion-resistant:** composite beams do not rust in seawater, chlorine, acids or sewage; no galvanizing, painting or periodic repair.
- **Lightweight:** a 203×102×9.5 composite I-beam weighs only 6.8 kg/m; installed by hand and easily carried to remote locations.
- **Electrically insulating and non-magnetic:** safe platforms in substations, battery rooms and near sensitive equipment.
- **High strength-to-weight ratio:** the specific strength of GFRP beams is several times that of structural steel.
- **No welding or fire:** cut and bolted on site; suited to refineries and areas where hot work is restricted.
- **Long service life:** the life-cycle cost of composite beams in corrosive environments is far below steel I-beams.

Applications of FRP composite beams

Industrial platforms and walkways
Beams and columns of composite grating platforms in petrochemical and treatment plants

Pedestrian bridges
Main beams of lightweight bridges with composite decking

Cooling towers
Internal frame of towers with GFRP beams and columns

Marine structures
Jetties, coastal platforms and structures in contact with saltwater

Substations and utilities
Insulating structures and work platforms near live equipment

Chemical industry
Support structures for tanks, pipes and equipment in corrosive fumes

Composite I-beam table (narrow flange)

Table 1 — FRP I-beam: sizes and section properties (t = flange and web thickness, ρ = 1.85 g/cm³)

Size h×b×t (mm)	A (mm²)	Weight (kg/m)	I_x (mm⁴)	W_x (mm³)	i_x (mm)	I_y (mm⁴)	i_y (mm)	J (mm⁴)	C_w (mm⁶)
76 × 38 × 6.4	891	1.65	7.25×10^{5}	1.91×10^{4}	28.5	5.99×10^{4}	8.2	1.22×10^{4}	7.26×10^{7}
102 × 51 × 6.4	1224	2.26	1.87×10^{6}	3.67×10^{4}	39.1	1.43×10^{5}	10.8	1.67×10^{4}	3.28×10^{8}
152 × 76 × 6.4	1864	3.45	6.60×10^{6}	8.68×10^{4}	59.5	4.71×10^{5}	15.9	2.54×10^{4}	2.50×10^{9}
152 × 76 × 9.5	2708	5.01	9.20×10^{6}	1.21×10^{5}	58.3	7.05×10^{5}	16.1	8.15×10^{4}	3.58×10^{9}
203 × 102 × 9.5	3686	6.82	2.31×10^{7}	2.27×10^{5}	79.1	1.69×10^{6}	21.4	1.11×10^{5}	1.59×10^{10}
254 × 127 × 12.7	6129	11.34	5.96×10^{7}	4.70×10^{5}	98.6	4.37×10^{6}	26.7	3.30×10^{5}	6.37×10^{10}
305 × 152 × 12.7	7412	13.71	1.06×10^{8}	6.93×10^{5}	119.4	7.48×10^{6}	31.8	3.98×10^{5}	1.60×10^{11}

Composite wide-flange (WF) beam table

Table 2 — FRP WF beam: sizes and section properties

Size h×b×t (mm)	A (mm²)	Weight (kg/m)	I_x (mm⁴)	W_x (mm³)	i_x (mm)	I_y (mm⁴)	i_y (mm)	J (mm⁴)	C_w (mm⁶)
102 × 102 × 6.4	1876	3.47	3.37×10^{6}	6.60×10^{4}	42.4	1.13×10^{6}	24.6	2.56×10^{4}	2.59×10^{9}
152 × 152 × 9.5	4152	7.68	1.65×10^{7}	2.18×10^{5}	63.1	5.57×10^{6}	36.6	1.25×10^{5}	2.83×10^{10}
203 × 203 × 9.5	5605	10.37	4.11×10^{7}	4.05×10^{5}	85.6	1.33×10^{7}	48.6	1.69×10^{5}	1.24×10^{11}
254 × 254 × 12.7	9355	17.31	1.07×10^{8}	8.40×10^{5}	106.8	3.47×10^{7}	60.9	5.03×10^{5}	5.05×10^{11}

Properties are calculated with Formulas 1 to 5 (page 4) for sharp corners. Sizes are based on common imperial sizes of pultruded profiles (3 to 12 inches). Standard length is 6 m; lengths up to 12 m and cutting and drilling to drawing can be ordered. Tolerances per EN 13706-2.

I-beam or WF? For bending members whose compression flange is restrained by grating or decking, the narrow-flange composite I-beam is stiffer for the same weight. For columns and beams without lateral restraint, the wide-flange WF beam is the better choice thanks to its three to five times higher I_y; however, its wide, thin flanges are more sensitive to local buckling (Formula 8).

Selection guide for composite beams

Table 3 — Recommended FRP beam for common applications

Application	Recommended composite beam (mm)	Design note
Grating platform joist (span 1 – 1.5 m)	I 102×51×6.4 / I 152×76×6.4	Bolt grating to the flange (continuous restraint)
Main platform beam (span 2 – 3 m)	I 203×102×9.5 / I 254×127×12.7	Check deflection with Table 5 (page 3)
Footbridge beam (span 3 – 5 m)	I 305×152×12.7 or double beam	Check deflection, vibration and concentrated loads
Platform column (height 2 – 3 m)	WF 152×152×9.5 / WF 203×203×9.5	Weak-axis and local buckling (Formulas 8 and 9)
Cantilever beam and pipe support	WF 102×102×6.4 / I 152×76×9.5	Lateral restraint at the free end
Light roof and canopy beam	I 102×51×6.4 / I 152×76×6.4	Purlins or roof sheet restrain the flange

Mechanical properties of composite beams

Table 4 — Reference properties of GFRP I-beam (based on EN 13706 grade E23)

Property	EN 13706 grade E23 minimum	Typical value, FRP beam	Role in design
Longitudinal modulus E_L (flange)	23 GPa	23 – 28 GPa	Bending deflection and buckling
Shear modulus G_{LT} (web)	–	3 – 4 GPa	Shear deflection, lateral-torsional and local buckling
Longitudinal flexural / tensile strength	240 MPa	250 – 350 MPa	Section strength
Longitudinal compressive strength	–	240 – 300 MPa	Columns and compression flange
In-plane shear strength of the web	25 MPa (apparent)	40 – 60 MPa	Web shear at supports
Transverse compressive strength	–	70 – 120 MPa	Web crushing under concentrated load
Pin-bearing strength, longitudinal / transverse	150 / 70 MPa	180 – 220 / 90 – 120 MPa	Bolted connections

Allowable load table of composite beams by span

Table 5 — Allowable uniform load (kN/m) of a simply supported composite I-beam with continuous lateral restraint; deflection limit L/250 (bending + shear) and FS = 2.5

I-beam (mm)	L = 1.5 m	L = 2.0 m	L = 3.0 m	L = 4.0 m	L = 5.0 m
102 × 51 × 6.4	3.54	1.56	0.48	0.20	–
152 × 76 × 6.4	10.5	5.13	1.63	0.70	0.36
152 × 76 × 9.5	15.6	7.17	2.27	0.98	0.51
203 × 102 × 9.5	33.7	16.4	5.45	2.40	1.26
254 × 127 × 12.7	74.7	38.2	13.4	6.02	3.18
305 × 152 × 12.7	82.5	46.4	20.6	10.3	5.49

Values are the lesser of the deflection case (Formula 6) and the stress case with stress limit $\min(\sigma_u, \sigma_{fl}) / 2.5$, where σ_{fl} is the lower bound of flange local buckling (Formula 8). Loads exclude beam self-weight and concentrated loads. Calculated with E = 23 GPa and G = 3 GPa as a design example; final design should follow ASCE/SEI 74. Without lateral restraint the allowable load drops sharply (Formula 7).

Table 6 — Allowable concentrated load at midspan (kN), continuous lateral restraint, L/250 and FS = 2.5

I-beam (mm)	L = 1.5 m	L = 2.0 m	L = 3.0 m
152 × 76 × 6.4	7.88	5.91	3.01
203 × 102 × 9.5	25.3	18.9	9.98
254 × 127 × 12.7	60.1	44.7	24.2
305 × 152 × 12.7	61.9	46.4	31.0

Composite beam compared with steel I-beam

Table 7 — Composite I-beam 203×102×9.5 vs steel IPE 200

Feature	GFRP beam 203×102×9.5	Steel IPE 200
Weight (kg/m)	6.8	22.4
I_x (mm⁴) / stiffness EI (kN·m²)	2.31×10^7 / ≈ 531	1.94×10^7 / ≈ 4080
Corrosion in marine and chemical environments	None	Severe
Electrical conductivity	Insulating	Conductive
Governing design criterion	Deflection and buckling	Strength

Section property formulas for composite I-beams

1. Cross-section area and weight

$$A = 2\,b\,t_f + h_w\,t_w\,,\quad h_w = h - 2t_f$$

203×102×9.5: A = 2 × 102 × 9.5 + 184 × 9.5 ≈ 3686 mm²; w = 1.85 × 3686 × 10^{-3} ≈ 6.82 kg/m

2. Moment of inertia and section modulus, strong axis

$$I_x = \frac{b\,h^3 - (b - t_w)\,h_w^3}{12}\,,\quad W_x = \frac{2I_x}{h}$$

203×102×9.5: I_x ≈ 2.31×10^7 mm⁴, W_x ≈ 2.27×10^5 mm³

3. Weak-axis moment of inertia

$$I_y = \frac{2\,t_f\,b^3 + h_w\,t_w^3}{12}\,,\quad i = \sqrt{(I/A)}$$

203×102×9.5: I_y ≈ 1.69×10^6 mm⁴, i_y ≈ 21.4 mm

4. Torsion constant and warping constant

$$J = \frac{2\,b\,t_f^3 + h_w\,t_w^3}{3}\,,\quad C_w \approx \frac{I_y\,(h - t_f)^2}{4}$$

203×102×9.5: J ≈ 1.11×10^5 mm⁴, C_w ≈ 1.59×10^{10} mm⁶

5. Web shear area

$$A_w = h_w \cdot t_w\,,\quad \tau = \frac{V}{A_w} \le \frac{\tau_u}{FS}$$

152×76×6.4: A_w = 139.2 × 6.4 ≈ 891 mm². In a composite beam the web carries almost all the shear, and its contribution to shear deflection is significant.

Deflection of composite beams (Timoshenko theory)

6. Total deflection of a simply supported beam under uniform load

$$\delta = \frac{5\,q\,L^4}{384\,E_L\,I_x} + \frac{q\,L^2}{8\,k\,G_{LT}\,A_w} \le \frac{L}{250}$$

Example — composite I-beam 152×76×6.4, span 3 m, uniform load 1.5 kN/m, continuous lateral restraint (k = 1):

$\delta_b = 5 \times 1.5 \times 3000^4 / (384 \times 23\,000 \times 6.60\times10^6) \approx 10.4$ mm

$\delta_s = 1.5 \times 3000^2 / (8 \times 3000 \times 891) \approx 0.63$ mm → $\delta \approx 11.1$ mm ≤ 12.0 mm ✓

$\sigma = qL^2/(8W_x) = 1.5 \times 3000^2 / (8 \times 8.68\times10^4) \approx 19.4$ MPa ≪ 85 / 2.5 = 34 MPa ✓

The FRP beam stress is far below the allowable value and deflection governs the design — the defining feature of all composite beams. Shear deflection accounts for about 6% at this span and more at shorter spans.

Increasing composite beam stiffness: since deflection is controlled by E·I and the composite E is fixed, the most effective approach is a deeper beam (I grows with the cube of depth). Replacing a 152 mm beam with a 203 mm beam increases stiffness 3.5 times while only doubling the weight. Continuous fixing of composite decking to the top flange also increases stiffness through composite action.

Buckling of composite beams and columns

7. Lateral-torsional buckling of an I-beam

$$M_{cr} = C_b \frac{\pi}{L_b} \sqrt{(E I_y G J + (\frac{\pi E}{L_b})^2 I_y C_w)}$$

C_b moment-gradient factor (1 for uniform moment, ≈ 1.14 for uniform load). Beam 152×76×6.4 with C_b = 1: L_b = 3 m → M_{cr} ≈ 1.29 kN·m; L_b = 1 m → M_{cr} ≈ 8.3 kN·m. Section capacity limited by flange local buckling is ≈ 7.4 kN·m, so lateral restraint every metre unlocks the full capacity of the composite beam.

8. Local buckling of the compression flange (lower bound)

$$\sigma_{fl} \approx G_{LT} \cdot (\frac{t_f}{b/2})^2$$

Free flange edge with a pinned support at the web; conservative, since the web partly restrains the flange. 152×76×6.4 → ≈ 85 MPa; 203×203×9.5 (WF) → ≈ 26 MPa. Detailed calculation per ASCE/SEI 74.

9. Column buckling about the weak axis

$$P_{cr} = \frac{\pi^2 E I_y}{(K L)^2}, \quad P_a = \frac{\min(P_{cr}, \sigma_{fl} A, \sigma_c A)}{FS}$$

WF column 152×152×9.5, 3 m long, pinned both ends: P_{cr} ≈ 140 kN, σ_{fl} A ≈ 195 kN → P_a ≈ 140 / 2.5 ≈ 56 kN

10. Bolted web connection capacity (clip angles)

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

4 M12 bolts in a 9.5 mm web, σ_{br} = 150 MPa, FS = 3: P_{br} = 4 × 12 × 9.5 × 150 / 3 ≈ 22.8 kN

11. Web crushing at supports

$$R_a = \frac{\sigma_{c,T} \cdot t_w \cdot (N + 2.5\, t_f)}{FS}$$

203×102×9.5, N = 100 mm, $\sigma_{c,T}$ ≈ 70 MPa, FS = 3: R_a ≈ 27.4 kN; for higher loads install a web stiffener (FRP angle or plate).

Installation guide for composite beams

1 **Lateral restraint:** restrain the compression flange of FRP beams with grating, decking or cross joists at spacing ≤ 1 m.

2 **Connections:** use double composite clip angles on the web with stainless or FRP bolts and wide washers.

3 **Stiffeners:** install bonded and bolted composite web stiffeners under concentrated loads and over supports.

4 **Cutting and drilling:** use diamond or carbide saws and drills; seal cut surfaces with compatible resin.

5 **Bearing:** beam bearing length on supports at least 100 mm, with no sharp-edge contact.

6 **Sustained load:** for large permanent loads, account for composite creep (deflection increase over time) in design.

NABAK COMPOSITE

Request a quote for FRP composite beams: send section type (I or WF) and size, length and number of bars, span and load, colour, resin type and the cutting and drilling drawing.
Nabak Saze Gostar | nabakcomposite.com | +98 21 4881 2124 | Mobile +98 912 396 3078 | Instagram @nabak.composite

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 and load tables are for illustration; structural design must be carried out by an engineer to ASCE/SEI 74 or CEN/TS 19101. NABAK COMPOSITE reserves the right to change technical specifications without notice.