TECHNICAL DATA SHEET
Product Data · Design Formulas · Applications

FRP Smooth Rebar

PLAIN GFRP FIBERGLASS ROD



PRODUCT SERIES
FRP/GRP SMOOTH REBAR



Diameters & Sizes



Specifications



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Applications

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NABAK COMPOSITE FRP smooth rebar (Smooth FRP / GRP Rebar) is a solid pultruded GFRP rod whose continuous glass fibres run fully parallel along its length. It offers about twice the tensile strength of steel rebar at a quarter of its weight, does not rust, is non-magnetic and electrically insulating, and is used for concrete pavement dowels, adhesive anchoring, tension rods and industrial and insulating applications.

Ø 6 – 32 mm	700 – 1100 MPa	≈ 50 GPa	≈ 27%
Composite rebar diameters	Guaranteed tensile strength	Tensile modulus of elasticity	of the weight of steel rebar of equal diameter

What is FRP smooth rebar (plain GFRP bar)?

FRP smooth rebar, also known as **composite rebar**, **FRP rebar**, **GFRP rebar**, **fiberglass rebar**, **non-metallic rebar** and **plain FRP bar**, is made by pultrusion: dozens of continuous glass-fibre rovings pass through a vinyl ester or epoxy resin bath, are shaped to final diameter in a heated round die and cured. The result is a GFRP bar with more than 70% glass fibre by weight, a uniform section and a smooth surface.

FRP is the general name for fibre-reinforced polymers, and GFRP (or GRP) is FRP made with glass fibre. Unlike steel rebar, composite rebar is **fully elastic up to failure** (no yielding), its modulus is about one quarter of steel, and it does not corrode in alkaline, chloride or humid environments.

Smooth or deformed? The smooth surface of plain composite rebar provides only limited mechanical bond with concrete. Smooth FRP bar is therefore chosen where **slip in concrete is desirable** (pavement joint dowels), where load is transferred by **adhesive or mechanical anchorage**, or where no concrete is involved. For structural concrete reinforcement to ACI 440.1R and ASTM D7957, ribbed or sand-coated GFRP rebar is required.

Applications of smooth composite rebar

Concrete pavement dowels
FRP dowels in contraction joints of roads, airports and industrial floors; no rust and no corrosion cracking

Adhesive anchoring
GFRP bars bonded with epoxy adhesive into concrete, rock and masonry

Tension rods and anchors
Tie rods anchored with plates and wedges or threads in corrosion-resistant structures

Insulating and non-magnetic structures
Substations, MRI rooms, transformer foundations and sensitive equipment

Agriculture and landscaping
Tree stakes, vineyard trellis posts, fencing and rot-proof posts

Industry and equipment
Insulating rods, lightweight shafts, springs and reinforcement of composite parts

Benefits of FRP smooth rebar

- **No corrosion:** composite rebar does not rust in de-icing salt, seawater, sewage or sulphate soils; rust-induced cracking and spalling are eliminated.
- **Lightweight:** GFRP rebar weighs about one quarter of steel rebar; faster manual handling, loading and installation.
- **High tensile strength:** the tensile strength of FRP rebar is two to three times the yield stress of ordinary steel rebar.
- **Electrically insulating:** no induced currents or earth paths; suited to substations, railways and cathodic protection.
- **Non-magnetic and radio-transparent:** suited to MRI rooms, airports, radar and measuring equipment.
- **Easy to cut:** fiberglass rebar can be cut by drilling machines and TBMs; used in temporary tunnel walls (soft-eye).

Diameter, weight and strength table of composite rebar

Table 1 — Smooth GFRP rebar specifications (ρ = 2.1 g/cm³, E = 50 GPa)

Diameter (mm)	Cross-section area (mm²)	FRP weight (g/m)	Steel weight, same diameter (g/m)	Guaranteed tensile strength f_{fu}* (MPa)	Ultimate tensile force (kN)	Ultimate strain (%)
6	28.3	59	222	1100	31.1	2.2
8	50.3	106	395	1050	52.8	2.1
10	78.5	165	617	1000	78.5	2.0
12	113.1	238	888	950	107.4	1.9
14	153.9	323	1208	920	141.6	1.8
16	201.1	422	1578	900	181.0	1.8
18	254.5	534	1998	880	223.9	1.8
20	314.2	660	2466	850	267.0	1.7
22	380.1	798	2984	830	315.5	1.7
25	490.9	1031	3853	800	392.7	1.6
28	615.8	1293	4834	750	461.8	1.5
32	804.2	1689	6313	700	563.0	1.4

The tensile strength of composite rebar decreases as diameter increases (shear-lag effect in large sections). The f_{fu}* values are typical market ranges for GFRP rebar; the guaranteed value of each order is determined by ASTM D7205 testing. Force and strain are calculated with Formulas 2 and 3 (page 4).

Supply form and packing of FRP rebar

Table 2 — Lengths and supply forms of smooth composite rebar

Diameter (mm)	Supply form	Length	Remarks
6 – 10	Coil or straight bar	Coil 50 to 100 m or bar 6 / 12 m	Coil inside diameter ≥ 1.2 m to avoid fibre damage
12 – 16	Straight bar	6 / 12 m and cut to order	Bundles strapped with plastic bands
18 – 32	Straight bar or dowel pieces	6 / 12 m or pieces 300 to 500 mm	Ready-made dowels with chamfered ends and end caps

Colour and surface of smooth GFRP rebar

Table 3 — Colour, resin and surface options

Option	Specification	Remarks
Natural colour (cream / light green)	Vinyl ester resin, unpigmented	The most common colour of composite rebar; fibre uniformity is visible
Yellow, green, black	Pigment through the whole section	Identification of diameter or project, visible and agricultural uses
Vinyl ester resin	Excellent alkali resistance	Standard choice for contact with concrete and soil
Epoxy resin	Higher Tg and chemical durability	Special industrial and higher-temperature uses
Smooth surface	Pultruded, uncoated	Dowels, adhesive anchoring, non-concrete uses

Metres per tonne: the length of rebar in one tonne is $L = 10^6 / w$ (metres). For Ø12, composite rebar gives about 4,200 m and steel rebar about 1,130 m per tonne, so transport and handling cost per metre of FRP rebar is about one quarter of steel.

Physical and mechanical properties of composite rebar

Table 4 — Reference properties of GFRP rebar and ASTM D7957 minimum requirements

Property	Test method	Typical value, smooth GFRP rebar	ASTM D7957 minimum
Glass fibre content (by weight)	ASTM D2584 / D3171	75 – 82%	≥ 70%
Density	ASTM D792	2.0 – 2.1 g/cm³	—
Tensile modulus of elasticity	ASTM D7205	48 – 55 GPa	≥ 44.8 GPa
Guaranteed tensile strength	ASTM D7205	700 – 1100 MPa (Table 1)	Based on the minimum force for each size
Transverse shear strength	ASTM D7617	150 – 200 MPa	≥ 131 MPa
Moisture absorption (24 h)	ASTM D570	≤ 0.15%	≤ 0.25%
Glass transition temperature Tg	ASTM E1356 / E1640	105 – 130 °C	≥ 100 °C
Degree of resin cure	ASTM E2160	≥ 95%	≥ 95%
Coefficient of thermal expansion, longitudinal / transverse	ASTM E831	6 – 10 / 21 – 30 ×10^{-6} /°C	—
Bond strength to concrete	ASTM D7913	Low (smooth surface)	≥ 7.6 MPa (deformed)

ASTM D7957 specifies solid GFRP bars for concrete reinforcement, and its bond requirement is met only by a ribbed or sand-coated surface; smooth composite rebar meets the other material requirements. Values are typical ranges of the FRP and GFRP composites industry and are not NABAK COMPOSITE's own laboratory results.

Composite rebar compared with steel rebar

Table 5 — Smooth GFRP rebar vs steel rebar, epoxy-coated steel and stainless steel

Feature	FRP rebar	Ordinary S400 steel	Epoxy-coated steel	Stainless steel
Density (g/cm³)	2.1	7.85	7.85	8.0
Tensile strength (MPa)	700 – 1100	Yield 400 / ultimate 600	Yield 400	Yield 500 – 650
Modulus of elasticity (GPa)	≈ 50	200	200	200
Behaviour up to failure	Linear elastic, no yielding	Ductile	Ductile	Ductile
Corrosion in chlorides and alkalis	None	Severe	At coating damage	Low
Electrical conductivity / magnetism	Insulating / none	Yes	Yes	Yes / low
Bending on site	Not possible	Easy	With care	Easy
Fire behaviour	Strength loss above Tg	Good	Good	Excellent

Durability of GFRP rebar in service environments

Table 6 — Behaviour of composite rebar in corrosive and thermal environments

Condition	Evaluation method	Behaviour of smooth vinyl ester GFRP rebar
Alkaline concrete environment (pH ≈ 13)	ASTM D7705 / ACI 440.3R	Most tensile strength is retained; the C_E factor covers this effect
Chlorides and de-icing salt	—	No corrosion or expansion; the main advantage of FRP rebar
Freeze–thaw cycles	—	No damage in bars with low moisture absorption
UV radiation (open storage)	—	Surface degradation of resin; keep bars covered and out of the sun
High temperature and fire	—	Stiffness loss near Tg; adequate concrete cover and fire protection are required

Concrete cover: because the transverse expansion of composite rebar (21 to 30 ×10^{-6}) is higher than that of concrete, a cover of at least one bar diameter and not less than 20 – 25 mm is recommended over GFRP rebar to avoid longitudinal cracking in hot conditions.

Section and material formulas for GFRP rebar

1. Cross-section area and weight of the bar

$$A = \frac{\pi\, d^2}{4}\ ,\quad w = \rho \cdot A \quad [\text{g/m}]$$

Ø12: A = 113.1 mm²; w = 2.1 × 113.1 ≈ 238 g/m (steel: 7.85 × 113.1 ≈ 888 g/m)

2. Ultimate tensile force

$$T_u = f_{fu}^* \cdot A$$

Ø12 with f_{fu}^* = 950 MPa: T_u = 950 × 113.1 ≈ 107 kN

3. Ultimate strain (linear behaviour)

$$\varepsilon_{fu} = \frac{f_{fu}}{E_f}$$

950 / 50 000 ≈ 1.9%; composite rebar is fully elastic without yielding up to this strain.

4. Longitudinal modulus (rule of mixtures)

$$E_f = V_f E_g + (1 - V_f) E_m$$

V_f = 0.65, E_g = 72 GPa, E_m = 3.5 GPa → E_f ≈ 48 GPa; close to the measured modulus of GFRP rebar

FRP rebar design formulas per ACI 440.1R

5. Design strength with environmental factor

$$f_{fu} = C_E \cdot f_{fu}^*\ ,\quad \varepsilon_{fu} = C_E \cdot \varepsilon_{fu}^*$$

Service condition	C_E factor for GFRP
Concrete not exposed to earth or weather (interior)	0.8
Concrete exposed to earth or weather	0.7

Ø12 exposed to weather: f_{fu} = 0.7 × 950 = 665 MPa

6. Sustained stress limit (creep rupture)

$$f_{f,s} \le 0.20 \cdot f_{fu}$$

GFRP rebar is subject to creep rupture under sustained load. Ø12: $f_{f,s}$ ≤ 0.2 × 665 = 133 MPa → allowable sustained load ≈ 133 × 113.1 ≈ 15 kN

7. Replacing steel rebar: strength criterion and stiffness criterion

$$A_{f,\sigma} = A_s \cdot \frac{f_y}{f_{fu}}\ ,\quad A_{f,E} = A_s \cdot \frac{E_s}{E_f}$$

Example — steel Ø12 at 200 mm (A_s = 565 mm²/m, f_y = 400 MPa):

Strength: A_f = 565 × 400 / 665 ≈ 340 mm²/m → GFRP Ø12 @ 330 mm

Stiffness: A_f = 565 × 200 / 50 ≈ 2260 mm²/m → GFRP Ø20 @ 135 mm

One-for-one replacement of steel rebar with composite rebar is not correct; because of the lower modulus, design is usually governed by crack and deflection control (serviceability) and must be carried out by a structural engineer to ACI 440.1R or CSA S806.

Design of composite dowels in concrete pavements

8. Concrete bearing stress under the dowel (Friberg / Timoshenko)

$$\beta = \left(\frac{K\,d}{4\,E\,I}\right)^{1/4}, \quad y_0 = \frac{P_t\,(2+\beta\,z)}{4\,\beta^3\,E\,I}, \quad \sigma_b = K \cdot y_0$$

K modulus of dowel support (≈ 407 N/mm³), z joint width, P_t load transferred by one dowel, I = πd⁴/64

Example — FRP dowel Ø32, E = 50 GPa, z = 6 mm, P_t = 8 kN, concrete f'c = 30 MPa:

$\beta \approx 0.0335$ /mm ; $y_0 \approx 0.045$ mm ; $\sigma_b \approx 18.5$ MPa (steel dowel Ø32: ≈ 12.7 MPa)

$f_{b,allow} = (4 - d_{in})/3 \times f'c = (4 - 1.26)/3 \times 30 \approx 27.4$ MPa ≥ 18.5 ✓

Because of the lower modulus, bearing stress under a composite dowel is higher than under a steel dowel of the same diameter; for heavy loads, choose a larger diameter or closer spacing of FRP dowels. The smooth surface of plain bar is exactly what a dowel needs to slide freely in the joint.

9. Embedment length of adhesive-anchored bar

$$l_b = \frac{N}{\tau_b \cdot \pi \cdot d}$$

N = 20 kN, Ø12, $\tau_b \approx 6$ MPa (epoxy adhesive on a sanded surface): $l_b \approx 88$ mm → practical minimum 10d = 120 mm

10. Dowel spacing across the slab

$$n = \frac{B}{s} - 1, \quad P_t \approx \frac{\eta \cdot P_{axle}/2}{n_{eff}}$$

B slab width, s dowel spacing (300 mm typical), η load-transfer share (≈ 0.45), n_{eff} effective dowels under the wheel

Installation and care of composite rebar

1 **Handling and storage:** store FRP rebar on bearers at ≤ 2 m spacing, out of direct sun, and never drag it on the ground.	**2** **Cutting:** cut composite rebar with a diamond disc or abrasive saw; rebar shears and impact crush the fibres.
3 **No bending:** do not bend or heat cured GFRP rebar; bent pieces must be made in the factory before cure.	**4** **Tying:** use plastic wire, cable ties or coated wire to tie the bars.
5 **Dowels:** install FRP dowels parallel to the slab axis and road surface in a dowel basket; lubricate half of the dowel length for free sliding.	**6** **Safety:** wear a mask, goggles and gloves when cutting; collect glass-fibre dust with a vacuum cleaner.

Is composite rebar durable in soil and saltwater?

Yes. GFRP rebar with vinyl ester resin is a leading corrosion-free choice for coastal structures, jetties, marine retaining walls and foundations in sulphate soils.

What advantage do composite dowels have over steel dowels?

FRP dowels do not rust or lock up in pavement joints, so slab expansion movement stays free and cracking and spalling at joint edges are reduced.

NABAK COMPOSITE

Request a quote for FRP smooth rebar: send diameter, bar or piece length, quantity or metres, resin type, colour and application (dowel, anchoring, industrial).
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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 ACI 440 and ASTM D7957 standards, and is intended as guidance only. Structural design with composite rebar must be carried out by a structural engineer. NABAK COMPOSITE reserves the right to change technical specifications without notice.