TECHNICAL DATA SHEET
Product Data · Design Formulas · Applications

FRP Composite Pipe

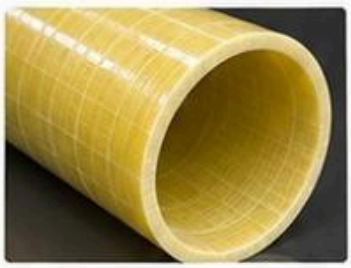
GRP / GRE FILAMENT-WOUND PIPE



PRODUCT SERIES
FRP/GRP COMPOSITE PIPE



Diameters & Wall



Specifications



Colors & Finish



Applications

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NABAK COMPOSITE FRP composite pipe (FRP / GRP Composite Pipe) is made by filament winding continuous glass fibre with polyester, vinyl ester or epoxy resin. It is lightweight, free of rust and scaling, has a smooth bore and a 50-year design life, and replaces steel, ductile-iron and concrete pipe for water, sewage, seawater, chemicals and industrial fluids.

DN 25 – 600	PN 6 – 32	SN 2500 – 10000	C = 150
Standard diameters (larger to order)	Pressure class (bar)	Stiffness class (N/m²)	Hazen-Williams coefficient

What is FRP composite pipe (GRP and GRE pipe)?

Composite pipe, also known as **FRP pipe**, **GRP pipe**, **GRE pipe**, **GFRP pipe**, **fiberglass pipe** and **filament-wound pipe**, is made by winding resin-impregnated continuous glass-fibre strands onto a rotating mandrel. The winding angle (typically ±55°) is chosen so that the pipe carries the hoop stress from internal pressure and the axial stress in the optimum ratio. After curing, the FRP pipe is extracted from the mandrel, cut and its ends machined for jointing.

FRP is the general name for fibre-reinforced polymers; GRP (or GFRP) is FRP made with glass fibre and polyester or vinyl ester resin, and GRE is its epoxy version. All these composite pipes share one feature: their walls do not rust, need no cathodic protection or coating, and the smooth bore does not scale or roughen over the service life.

Wall structure of composite pipe

Inner liner	Structural layer	Outer layer	Joint end
Resin-rich layer with veil and mat, 0.5 to 2.5 mm thick; barrier against corrosion and fluid permeation.	±55° filament winding of continuous glass fibre; carries internal pressure, soil load and axial stress.	Resin with UV additives to protect against sunlight, abrasion and weathering.	Machined spigot and socket, O-ring groove or integral composite flange.

Advantages of FRP pipe over steel and ductile-iron pipe

- **No corrosion:** composite pipe does not rust in saltwater, sewage, aggressive soil or chemicals; no cathodic protection needed.
- **Lightweight:** GRP pipe weighs about a quarter of steel pipe and a tenth of concrete pipe; transport and installation without heavy machinery.
- **Smooth bore:** Hazen-Williams coefficient of 150, constant over the service life; lower head loss and pumping cost.
- **Lower water hammer:** pressure-wave speed in FRP pipe is about half that of steel; smaller pressure surges.
- **Thermally and electrically insulating:** no stray currents or electrochemical corrosion.
- **50-year life:** design based on 50-year long-term strength and low life-cycle cost.

Applications of FRP composite pipe

Water and sewage	Seawater and desalination	Chemical industry
Potable water mains, gravity and pressure sewers in GRP pipe	Desalination intakes and outfalls, coastal cooling water	Acids, alkalis, brine and industrial effluent in vinyl ester FRP pipe
Oil and gas	**Power plants and cooling towers**	**Agriculture and irrigation**
Injection water, produced water and fire-water lines in GRE pipe	Large-diameter circulating and cooling-water lines	Pressurised irrigation mains and agricultural water transmission

Diameter and wall thickness table of composite pipe

Table 1 — Total wall thickness (mm) of filament-wound FRP pipe, stiffness SN 5000 (liner included)

Nominal diameter DN (mm)	Outside diameter PN16 (mm)	PN 10	PN 16	PN 25	PN 32	Weight PN16 (kg/m)
25	29.0	2.0	2.0	2.0	2.0	0.32
50	54.0	2.0	2.0	2.0	2.0	0.62
80	84.0	2.0	2.0	2.3	2.8	0.98
100	104.0	2.0	2.0	2.7	3.3	1.22
150	156.6	3.3	3.3	4.3	5.2	3.02
200	208.0	4.0	4.0	5.3	6.6	4.87
250	259.4	4.7	4.7	6.4	8.0	7.15
300	311.0	5.5	5.5	7.5	9.3	10.0
400	413.8	6.9	6.9	9.6	12.1	16.8
500	516.8	8.4	8.4	11.7	14.8	25.5
600	619.8	9.9	9.9	13.9	17.5	36.0

Thickness from Formulas 1 and 3 (page 4): the larger of the thickness needed for pressure (allowable hoop stress 60 MPa) and for stiffness SN 5000 (E_h = 20 GPa), plus a 0.5 mm liner (DN<150) or 1 mm. At PN10 and PN16 ring stiffness governs the thickness, at PN25 and PN32 pressure governs. Practical minimum thickness is 2 mm. The table is a calculation example; the thickness of each order is set by operating conditions, temperature and the project standard. Standard pipe lengths are 6 and 12 m.

Pressure and stiffness classes of GRP pipe

Table 2 — Nominal pressure class

Class	Operating pressure (bar)	Factory test pressure (bar)
PN 6	6	9
PN 10	10	15
PN 16	16	24
PN 25	25	37.5
PN 32	32	48

Table 3 — Ring stiffness class

Class	SN (N/m²)	Application
SN 2500	2500	Above ground and shallow burial
SN 5000	5000	Normal burial (standard)
SN 10000	10000	Deep burial, heavy traffic, vacuum

Joint types for composite pipe

Adhesive spigot and socket
Taper joint with epoxy adhesive; common for industrial GRE pipe

O-ring coupling
Rubber-sealed joint allowing angular deflection; fast installation of water lines

Restrained O-ring
Carries axial thrust without concrete blocks in pressure lines

Composite flange
Connection to valves, pumps and equipment; ANSI or DIN drilling

Laminated butt joint
Permanent joint made by laying up fibre and resin over the joint

Fittings
Composite elbows, tees, reducers and end caps of the same class as the pipe

Pressure class or stiffness class? Composite pipe has two independent ratings: pressure class PN for internal pressure and stiffness class SN for soil load, traffic and vacuum. For low-pressure buried lines (gravity sewers) SN governs; for above-ground pressure lines PN governs. GRP pipe for each project is ordered with the right combination of PN and SN.

Mechanical and physical properties of filament-wound composite pipe

Table 4 — Reference properties of the structural layer of FRP pipe wound at ±55°

Property	Test method	Hoop	Axial
Tensile strength	ASTM D2290 / D2105	200 – 250 MPa	80 – 100 MPa
Modulus of elasticity	ASTM D2105 / D2412	18 – 25 GPa	9 – 12 GPa
50-year long-term strength (HDB / LTHS)	ASTM D2992 / ISO 14692	100 – 150 MPa	—
Poisson's ratio	—	0.55 – 0.65 (hoop-axial)	0.3 – 0.4
Coefficient of thermal expansion	ASTM D696	—	18 – 25 ×10^{-6} /°C
Density	ASTM D792	1.8 – 2.0 g/cm³	
Thermal conductivity	—	0.25 – 0.35 W/m·K	
Absolute roughness of the bore	—	≈ 0.01 mm (Hazen-Williams C = 150)	

Table 5 — Pipe resin and service temperature

Resin	Maximum service temperature	Main use
Isophthalic polyester (GRP)	≈ 50 – 60 °C	Water, sewage, irrigation
Vinyl ester (GRP-VE)	≈ 90 – 100 °C	Acids, alkalis, chlorine, seawater
Amine-cured epoxy (GRE)	≈ 93 °C	Oil, injection water, fire water
Anhydride-cured epoxy (GRE)	≈ 110 – 120 °C	Hot water and high-temperature fluids

Table 6 — Reference standards

Standard	Topic
ISO 14692	GRP piping for the petroleum and natural gas industries
AWWA C950 / M45	Fiberglass pressure pipe for water
ISO 10639 / 10467	GRP pipe for water and sewerage
ASTM D2996	Filament-wound RTRP pipe
ASTM D2412 / D1599	Pipe stiffness / burst

Composite pipe compared with other pipes

Table 7 — FRP pipe vs steel, ductile iron, polyethylene and PVC pipe

Feature	FRP composite pipe	Steel	Ductile iron	HDPE polyethylene	PVC
Corrosion	None	Severe (coating required)	Coating required	None	None
Weight DN400 (kg/m, approx.)	17 – 25	60 – 90	90 – 110	45 – 70	25 – 35
Hazen-Williams C over service life	150	100 – 120	100 – 130	150	150
Pressure-wave speed (m/s, approx.)	400 – 600	1000 – 1300	1000 – 1200	200 – 350	350 – 450
Pressure in large diameters	High	High	High	Limited (thick wall)	Limited
Service temperature	Up to ≈ 100 °C	High	High	Up to ≈ 40 °C (pressure derating)	Up to ≈ 45 °C

Values are typical ranges of the FRP, GRP and GRE pipe industry and are not NABAK COMPOSITE's own laboratory results; the long-term strength of each production series is determined by ASTM D2992 or ISO 14692 testing.

Selecting the pipe resin: for drinking water, resin and liner approved for contact with potable water (e.g. NSF/ANSI 61 or WRAS) are required. For acids, alkalis, hypochlorite and warm seawater, choose FRP pipe with vinyl ester resin and a C-glass or thicker synthetic-veil liner. For high pressure and temperature in oil and gas, epoxy GRE pipe to ISO 14692 is the standard choice.

Wall design of composite pipe

1. Hoop stress and thickness required for pressure (Barlow)

$$\sigma_h = \frac{P \cdot D_m}{2\,t_s} \le \sigma_a\,, \quad t_s = \frac{P \cdot D_m}{2\,\sigma_a}\,, \quad \sigma_a = \frac{HDB}{FS}$$

t_s structural thickness (liner excluded), D_m mean diameter, HDB long-term hoop strength. With HDB ≈ 120 MPa and FS = 2: σ_a = 60 MPa. DN200 PN16 pipe (t_s = 3.0 mm, D_m ≈ 205 mm): σ_h = 1.6 × 205 / 6 ≈ 54.7 MPa ≤ 60 ✓

2. Ring stiffness SN (ISO 7685)

$$SN = \frac{E_h \cdot I}{{D_m}^3}\,, \quad I = \frac{{t_s}^3}{12}$$

DN200: SN = 20 000 × 2.25 / 205³ ≈ 5.22×10⁻³ N/mm² ≈ 5220 N/m² ≥ SN 5000 ✓

3. Thickness required for stiffness

$$t_s = D_m \cdot \left(\frac{12 \cdot SN}{E_h}\right)^{1/3}$$

SN 5000 and E_h = 20 GPa → $t_s \approx 0.0144\,D_m$; DN400: t_s ≈ 5.9 mm

4. Pipe stiffness in the parallel-plate test (ASTM D2412)

$$PS = \frac{E_h\,I}{0.149\,r^3}$$

DN200 with r = 102.5 mm: PS = 45 000 / (0.149 × 1.077×10⁶) ≈ 0.28 N/mm/mm ≈ 280 kPa (about 40 psi)

5. Critical buckling pressure (vacuum and external pressure)

$$P_{cr} = \frac{2\,E_h}{1-\nu^2}\left(\frac{t_s}{D_m}\right)^3$$

DN200 SN5000: P_{cr} ≈ 43 956 × (3/205)³ ≈ 0.138 MPa = 1.38 bar; full vacuum with FS = 2.5 requires ≥ 2.5 bar → choose class SN 10000 or a thicker wall.

Buried composite pipe

6. Diametric deflection of buried pipe (modified Iowa formula, AWWA M45)

$$\frac{\Delta y}{D} = \frac{D_L \cdot K \cdot q}{0.149\,PS + 0.061\,E'} \le 5\%$$

Example — GRP pipe DN200 SN5000, burial depth 2 m, soil γ = 19 kN/m³, live load 10 kPa, moderately compacted backfill:

q = 19 × 2 + 10 = 48 kPa ; D_L = 1.5 ; K = 0.1 ; PS = 280 kPa ; E′ ≈ 6900 kPa

Δy/D = 1.5 × 0.1 × 48 / (0.149 × 280 + 0.061 × 6900) ≈ 7.2 / 462.6 ≈ 1.6 % ≤ 5 % ✓

The soil reaction modulus E' (backfill quality and compaction around the pipe) matters far more than the stiffness of the composite pipe itself; correct bedding and backfill are therefore the most important factor in the performance of buried FRP pipe.

Why long-term strength? Under sustained pressure, composite pipe gradually loses strength (creep and resin micro-cracking). Design is therefore based on HDB (ASTM D2992) or LTHS (ISO 14692) — strength extrapolated to 50 years — not on short-term burst strength; the short-term strength of GRP pipe is typically 2 to 3 times the HDB.

Hydraulics and water hammer in FRP pipe

7. Head loss (Hazen-Williams)

$$h_f = \frac{10.67 \cdot L \cdot Q^{1.852}}{C^{1.852} \cdot D^{4.87}}$$

DN200, Q = 40 L/s, L = 1 km: FRP pipe (C = 150) → h_f ≈ 6.5 m; old steel (C = 100) → ≈ 13.8 m. Half of the pumping energy is saved.

8. Wave speed and water hammer (Joukowsky)

$$a = \sqrt{\left(\frac{K/\rho}{1 + K\,D\,/\,(E_h\,t)} \right)}, \quad \Delta P = \rho\, a\, \Delta V$$

DN200, ΔV = 1.5 m/s: FRP pipe (t = 4.0 mm) → a ≈ 580 m/s and ΔP ≈ 8.6 bar; steel (t = 6.35 mm) → a ≈ 1280 m/s and ΔP ≈ 19.2 bar

Temperature and supports of above-ground pipe

9. Thermal expansion and axial thermal force

$$\Delta L = \alpha\, L\, \Delta T, \quad F = E_a \cdot A \cdot \alpha \cdot \Delta T$$

DN200, α = 22×10⁻⁶, ΔT = 40 °C: 10 m of free pipe ΔL ≈ 8.8 mm; restrained pipe (E_a = 10 GPa, A ≈ 2560 mm²): F ≈ 22.5 kN — far less than steel pipe of the same diameter

10. Support spacing of above-ground pipe

$$L_s = \left(\frac{384\, E_a\, I \cdot \delta_a}{5\, w} \right)^{1/4}$$

w weight of water-filled pipe per unit length, δ_a allowable deflection (≈ 12.7 mm). DN100 PN16 full of water: w ≈ 0.089 N/mm → L_s ≈ 3.1 m (up to about 20% more for continuous spans)

Installation guide for composite pipe

1. **Handling and storage:** lift FRP pipe with fabric slings; avoid chains, dragging on the ground and impacts to pipe ends.
2. **Trench bedding:** prepare a uniform bed of sand or fine gravel 100 to 150 mm thick, free of sharp stones.
3. **Jointing:** clean and lubricate the spigot and coupling and push home axially with a jack or lever; no hammering.
4. **Backfill:** compact granular soil around the composite pipe in layers to achieve the required E' (Formula 6).
5. **Thrust blocks:** provide concrete blocks or restrained joints at bends, tees and line ends to resist thrust.
6. **Pressure test:** hydrostatically test the line at 1.5 times operating pressure before final backfilling.

Is composite pipe suitable for drinking water?

Yes. GRP pipe with liner and resin approved for potable-water contact imparts no taste or odour and, because it neither rusts nor scales, preserves water quality over the life of the line.

Is FRP pipe resistant to sunlight?

The outer layer of above-ground composite pipe is protected with UV additives or polyurethane paint; without it, the resin surface dulls and fibres become exposed in the long term.

NABAK COMPOSITE

Request a quote for FRP composite pipe: send diameter, pressure and stiffness class, fluid and temperature, resin type, joint type, line length and buried or above-ground conditions.
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Disclaimer: The information in this data sheet is based on general, typical data of the FRP, GRP and GRE pipe industry and the ISO 14692 and AWWA C950 standards, and is intended as guidance only. Examples are for illustration; pipeline design must be carried out by an engineer. NABAK COMPOSITE reserves the right to change technical specifications without notice.