



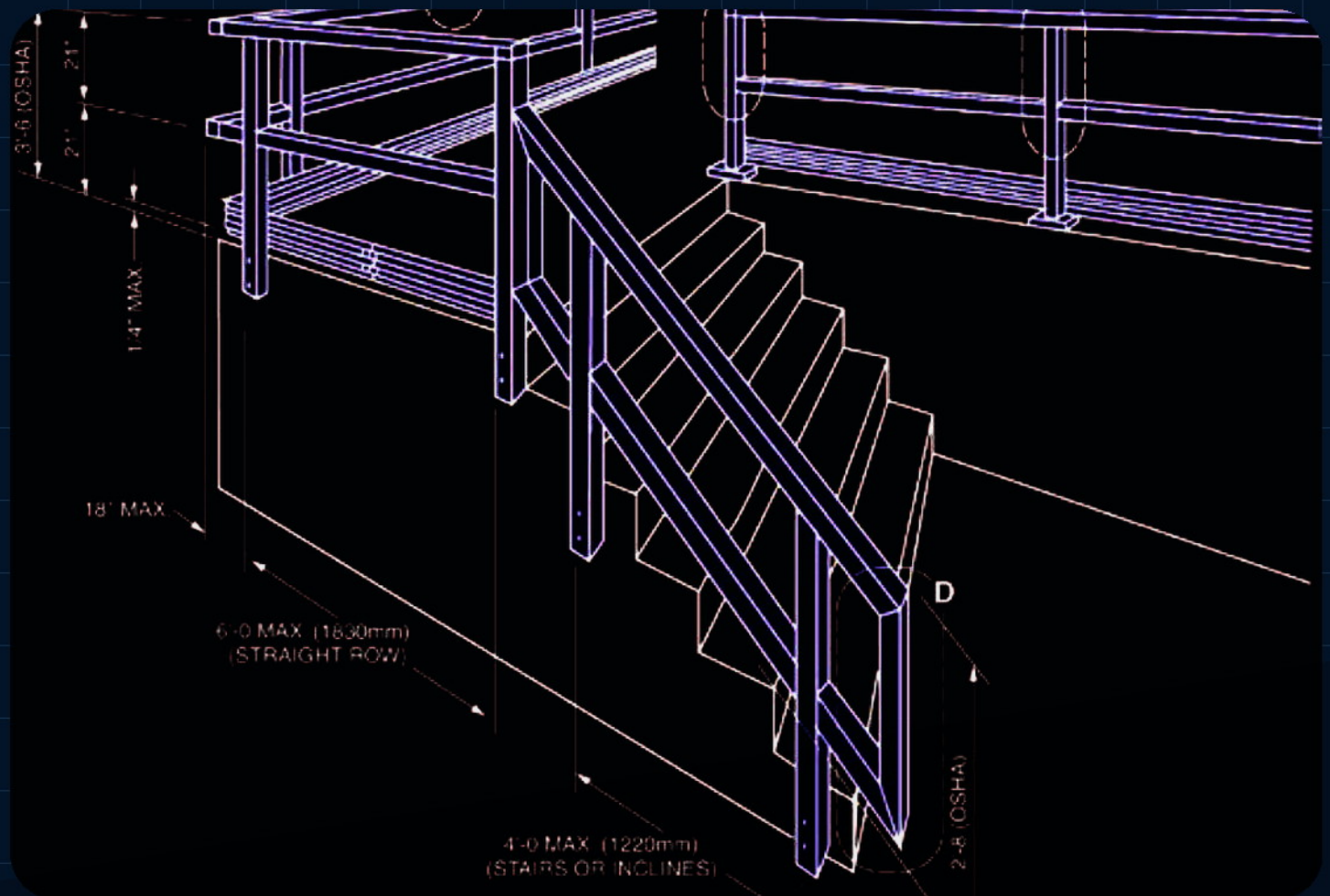
NABAK COMPOSITE CO.

ENGINEERED FRP / GRP SYSTEMS

TECHNICAL & EXECUTION HANDBOOK

FRP / GRP COMPOSITE HANDRAIL SYSTEMS

Selection • Structural Design • Installation • Inspection



CORROSION RESISTANT

NON-CONDUCTIVE

MODULAR SYSTEM

LOW MAINTENANCE

FRP/GRP composite handrails (Fiber Reinforced Polymer / Glass Reinforced Plastic) have today become one of the leading alternatives to steel handrail and guardrail systems in the oil, gas, petrochemical, refining, power generation, water/wastewater treatment and coastal/marine facility sectors. The main driver of this trend is the combination of corrosion resistance, low weight, electrical insulation and lower life-cycle cost compared with galvanized steel or stainless steel in many corrosive environments.

The purpose of this document is to provide a shared technical language for design engineers, site supervision, owners and contractors: understanding the engineering fundamentals and reference standards, the HR-series type-coding system, dimensional and loading requirements, correct installation and inspection practice, and a basis for preparing technical specifications, quantity take-offs and evaluating contractors' technical proposals.

Engineering Reminder

The figures and quantitative requirements in this document are drawn from reference standards (ASTM F1092, ISO 14122-3, EN 13706) and common pultrusion-industry practice, and must be checked against the official, current edition of each standard and the project-specific technical specification. This document does not replace project-specific engineering calculations or the approval of the supervising/design engineer.

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Engineering Quick Reference

Engineering Quick Reference Data Sheet

Summary of reference standards, dimensions, design loads, material mechanical properties and the calculation path for composite handrails — for a quick overview before entering each chapter's details.

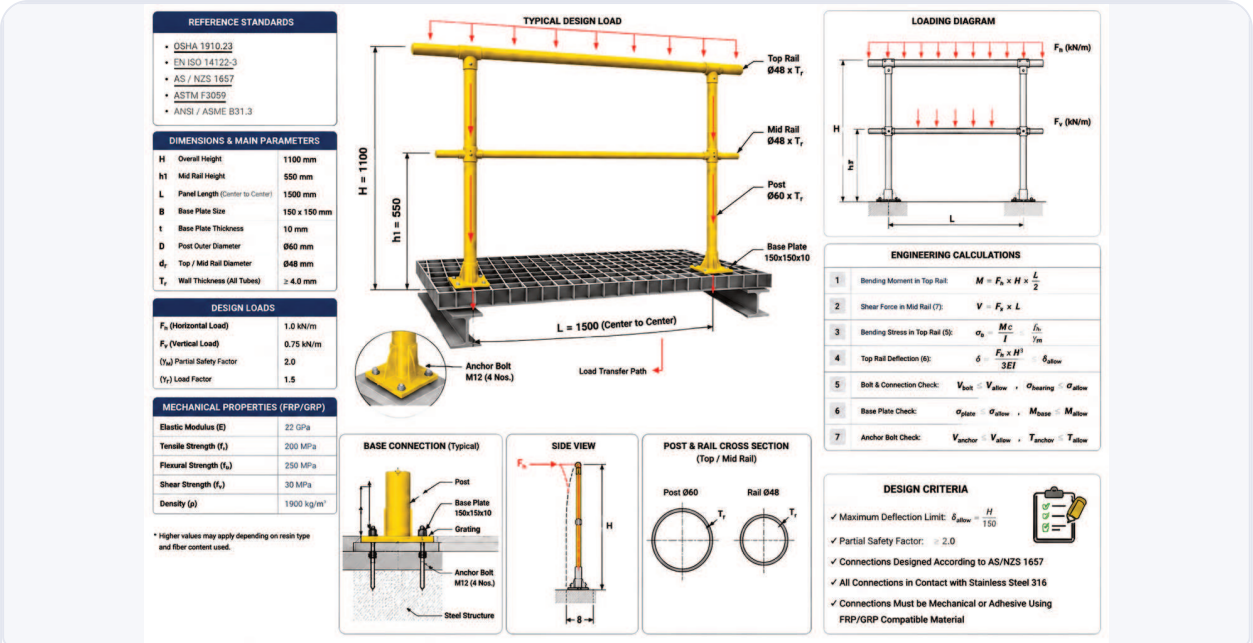


Figure 1— Summary of reference standards (OSHA 1910.23 · EN ISO 14122-3 · AS/NZS 1657 · ASTM F3059 · ANSI/ASME B31.3) dimensions, design loads (Fh = 1.0 kN/m, Fv = 0.75 kN/m), FRP/GRP mechanical properties and the system engineering calculation path — reference document of NABAK COMPOSITE CO.

2 Engineering Advantages of FRP Composite Handrails

2.1 Corrosion & Chemical Resistance

One of the most important reasons for using FRP handrails in the oil, gas, petrochemical, refining and chemical industries is their favorable performance in environments where metals are exposed to moisture, corrosive vapors, chemical splash, salt and other aggressive agents. The polymer matrix and glass-fiber-reinforced structure allow profiles to be designed with suitable resistance to a wide range of environmental conditions; however, the ultimate chemical resistance depends on resin type, composite structure, chemical concentration, temperature, contact time and actual service conditions.

Resin Type	Typical Application	Relative Chemical Resistance
Isophthalic Polyester	General industrial use, decks and platforms	Fair to good
Vinyl Ester	Refineries, acid/alkaline units, water treatment	Good to excellent
Fire-Retardant (FR) Resin	Enclosed spaces, control rooms, fire-safety requirements	Depends on additive package

This is especially important when designing handrails for chemical plants, refineries, petrochemical units and wastewater treatment facilities.

2.2 Low Weight & Ease of Installation

Pultruded FRP profiles are significantly lighter than equivalent steel systems; typical density is in the range of **1.6 to 1.9 g/cm³**, compared with roughly 7.8 for steel — about one-quarter to one-fifth the weight of an equivalent steel section. This makes handling, cutting, assembly and installation possible with simpler equipment and less manpower, and has a direct impact on logistics, installation time and execution cost on long runs.

2.3 Electrical Insulation

The very low electrical conductivity of FRP makes it a viable option near electrical equipment, cabling, switchgear and areas of electrical potential; a particularly useful property at substations, power plants and cable routes. Being electrically insulating does not, however, remove a project's electrical safety requirements.

Installation Note

Where metallic bolts and nuts are used at connections, the overall insulating property of the system is limited; where full electrical isolation is required, insulating washers/bushings must be used at metallic connection points.

2.4 Performance in Humid & Marine Environments

Permanent moisture, salt spray and marine conditions are the main causes of galvanic corrosion, pitting corrosion and under-film rusting in metallic systems. FRP handrails are a reliable option at jetties, ports, industrial platforms, coastal facilities, water treatment plants and other humid areas — particularly for projects with difficult access and costly maintenance.

2.5 Reduced Painting & Periodic Maintenance

In FRP handrails, color is applied during manufacturing via pigment in the resin mass; the need for periodic repainting, common with steel systems, is therefore reduced — an economically significant factor in the life-cycle cost analysis of large-scale projects.

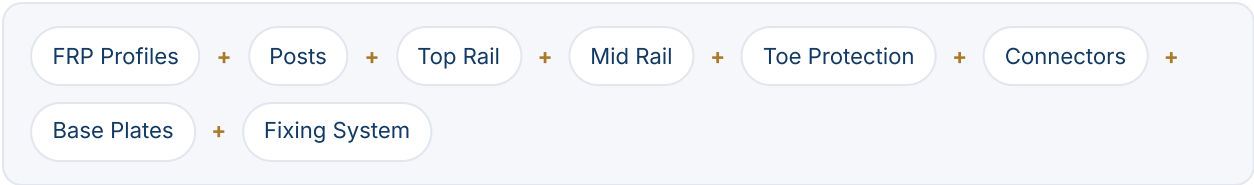
2.6 Environmental Stability & UV Resistance

In outdoor applications, resistance to UV radiation is a key material-selection parameter. To reduce surface degradation (fiber blooming/chalking), a UV stabilizer additive in the resin, a surface veil, and — where required — a final gel-coat layer are used.



The Handrail: An Engineered Protective System — Not Just a Railing

On industrial projects, a handrail should not be viewed merely as a railing or a collection of profiles. An engineered handrail system consists of a set of interrelated components:



The system's ultimate performance does not depend on profile strength alone; system geometry, post spacing, connection type, method of anchoring to the structure and project loading conditions all play a role. Handrail selection should therefore be based on service conditions and project requirements, not simply on apparent dimensions or price per meter.

From a structural engineering standpoint, a handrail is a **semi-rigid frame system** whose load path is defined as follows:



A weakness in any single link — even where the profile itself has adequate strength — can compromise the performance of the whole system; design review and inspection should therefore be carried out at the system level, not merely at the component level.

4 Industrial Applications of FRP/GRP Handrails

Oil, Gas & Petrochemical Around equipment, platforms, access routes and operating decks	Refineries & Process Units Perimeter protection of routes and operating surfaces, corrosion-priority areas	Industrial Stairs & Platforms Safety handrail & guardrail around stairways and elevated surfaces
Water & Wastewater Treatment Protection of basins, channels and tanks in humid, corrosive environments	Chemical Industries Resin selection matched to the surrounding chemical environment	Marine & Coastal Environments Marine facilities · ports · jetties · offshore structures
Power Facilities Power plants · substations · cable access areas	Other Applications Mining, food industry, wastewater treatment, parking structures, renewable energy	

5

Nabak Composite's Approach to Composite Handrails

On an industrial project, a handrail is not simply a ready-made product to be installed; it is part of the structure's safety and access system. Correct handrail selection should therefore take into account the operating environment, corrosivity, safety requirements, site geometry, anchoring method, substrate type and loading conditions.

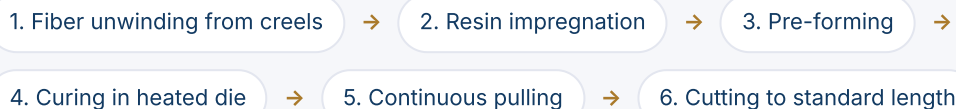
The goal of **NABAK COMPOSITE CO.** in designing FRP systems is to achieve a balanced combination of safety, durability, constructability, low weight and favorable life-cycle cost — a combination that makes composite handrail a dependable engineering solution for industrial environments.

6

Manufacturing Method of FRP/GRP Composite Handrails

6.1 Manufacturing of Composite Profiles by Pultrusion

The main profiles used in handrail manufacturing are generally produced by the **pultrusion** process. In this process, reinforcing fibers (mainly continuous glass roving and continuous filament mat), together with a polymer resin system, are pulled through a heated steel die of constant cross-section, producing a continuous composite profile:



The glass-fiber weight fraction in structural pultruded profiles is typically in the range of **55–65% by weight**, providing a suitable balance of mechanical strength, low weight, environmental stability and machinability.

Alongside pultruded profiles, base plates, shaped fittings (elbows, tees, crosses) and certain assembly parts are produced using suitable molding processes such as **compression molding** or hand lay-up for more complex geometries. FRP handrail should therefore be understood as an **engineered, assembled system**, not merely a collection of composite tube or profile sections.

6.2 Raw Materials & Production Additives at Nabak Composite

Reinforcing Fiber

Type-E glass fiber (E-Glass) — fiber content approximately 65% by weight

Base Resin

Anti-UV isophthalic polyester resin, resistant to sunlight

Custom Resin Option

Vinyl ester — produced to order; cost is roughly double that of the standard isophthalic polyester resin

Fire Resistance

A self-extinguishing additive is included as standard in the production process; for higher fire resistance, custom production with specialized fire-retardant resins is also available

Manufacturing Method for Shaped Fittings

Base plates, elbows, tees and crosses are produced by compression molding

The combination of E-Glass fiber with Anti-UV isophthalic polyester resin is the standard basis for Nabak Composite's profile production, providing a balanced combination of mechanical strength, UV stability and cost efficiency. For projects with special chemical-resistance or fire-resistance requirements, custom production using vinyl ester or specialized fire-retardant resins is also available.

7

Standards & Design Basis for FRP/GRP Handrails

Reminder

The figures below are a technical/educational summary and do not replace the official, current text of each standard. Before design, quantity take-off, tendering or fabrication approval, the official edition of the standard from its publishing body (ASTM, ISO/CEN) should govern.

7.1 ASTM F1092

Standard Specification for Fiberglass (GRP) Pultruded Open-Weather Storm and Guard, Square Railing Systems — the specialized reference for pultruded GRP square-section railing/guardrail systems. It covers material, fabrication, installation and testing requirements, and distinguishes two post grades, **Type 1F** and **Type 2F**. Testing of the installed system typically includes applying a horizontal load to at least one end post and one intermediate post per section.

Common industrial design loads (per OSHA 1910.29 / IBC practice, which North American FRP technical documents are also generally based on)

Load Type	Common Value	Note
Concentrated load	≈ 890 N (200 lbf)	In any direction, at any point on the top rail
Uniform (line) load	≈ 730 N/m (50 lbf/ft)	Not concurrent with the concentrated load
Design safety factor	Minimum 2.0	Ratio of ultimate strength to design load
Typical post spacing (international practice)	Up to ~1.83 m	Nabak's 1 m spacing is more conservative

7.2 ISO 14122-3 (equivalent to EN ISO 14122-3)

Safety of machinery — Permanent means of access to machinery — Part 3: Stairs, stepladders and guard-rails — the primary reference for safety, dimensional, layout and performance requirements of guardrails and handrails on permanent industrial access routes.

Parameter	Typical Requirement
Minimum guardrail height	1100 mm above the walking surface
Maximum clear gap between rails	~500 mm
Minimum toe-board height	~100 mm
Overall structural strength test	Line load ~300 N/m, permissible deflection ~30 mm
Local strength test	Concentrated load of 300–1000 N over a limited area (~250 mm)

7.3 EN 13706 — Pultruded Profile Standard Series

To control pultruded product specifications, raw-material quality, manufacturing process and final product properties, **EN 13706** is applied in three parts: **Part 1** the designation system, **Part 2** test methods and general quality requirements, **Part 3** performance requirements defining two main mechanical grades:

Parameter	Grade E17	Grade E23
Full-section flexural modulus	Min. 17 GPa	Min. 23 GPa
Axial tensile modulus	~17 GPa	~23 GPa
Transverse tensile modulus	~5 GPa	~7 GPa
Axial tensile strength	~170 MPa	~240 MPa
Axial flexural strength	~170 MPa	~240 MPa
Transverse flexural strength	~70 MPa	~100 MPa
Axial pin-bearing strength	~90 MPa	~150 MPa

Grade **E23** is better suited to primary, load-bearing structural members, and grade **E17** to secondary members; the grade to be used should be specified in the project's technical specification.

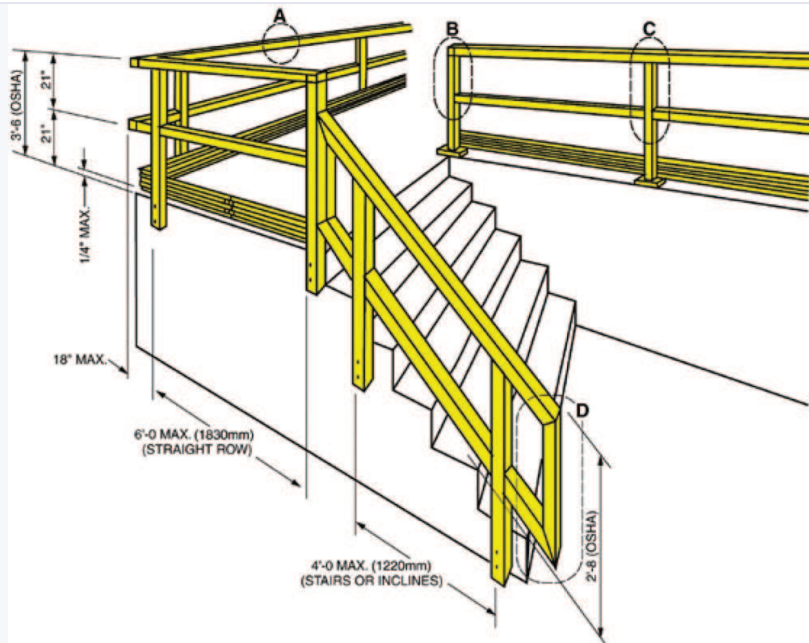


Figure 2 — International reference diagram of guardrail and stair geometry (imperial units, per OSHA practice) — for comparison with Nabak Composite's metric system.

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Safety Requirements & General Handrail Dimensions

In protective-system design, handrail dimensions are directly related to user safety. The following parameters must be defined at the design stage, before installation: handrail height, post spacing, horizontal rail spacing, arrangement of vertical members, presence/absence of a toe board, method of connection to floor/structure, and installation site conditions.

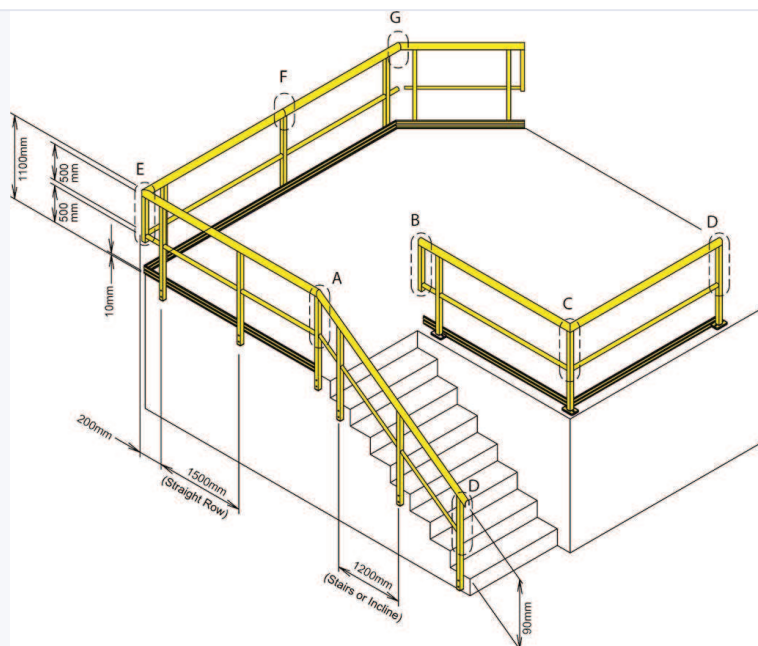


Figure 3— Metric dimensional drawing of a composite handrail at a landing and stairway: overall height 1100 mm, rail spacing 500/500 mm, clearance from wall 10 mm, post spacing on a straight run 1500 mm and on a stair/incline 1200 mm.

Summary of Nabak Composite's reference dimensions for the HR system

Parameter	Value
Finished handrail height	1100 mm
Post centre-to-centre spacing	1000 mm
Maximum recommended clear vertical gap between rails	500 mm
Toe-board height on K-type variants	Per toe-board section — 100 mm width

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Main Components of a Composite Handrail

1 — Top Rail
The user's hand-contact surface;
the most critical member under local
flexural load

2 — Intermediate Rail
Controls the open space between
protective members

3 — Toe Board / Kick Plate
Reduces the fall of tools and small
objects from the platform edge

4 — Vertical Post
Transfers horizontal load to the
base; the critical design point at the
connection

5 — Base Plate
Transfers force and connects the
post to the floor/supporting structure

6 — Vertical Members
In the V-type, reduce open space
and control the passage of small
objects

The dimensions, thickness, profile type and arrangement of each of these members should be selected in accordance with the project's application and service conditions.

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Mechanical & Physical Properties of FRP Profiles

Evaluation of a composite profile should not be based on cross-sectional dimensions alone. Tensile strength, flexural strength, shear strength, density and water absorption — together with fiber type, resin system, cross-sectional structure and manufacturing process — all influence profile behavior and durability.

Typical values for pultruded FRP profiles with glass fiber and polyester or vinyl ester resin

Property	Typical Range	Unit
Axial tensile strength	200–500	MPa
Axial flexural strength	240–400	MPa
Axial modulus of elasticity	17–45	GPa
Interlaminar shear strength	20–35	MPa
Density	1.6–1.9	g/cm ³

Property	Typical Range	Unit
Water absorption (24 h)	Less than 1	% by weight
Glass-fiber content	55–65	%

These parameters are typically measured per ASTM D638 (tension), ASTM D790 (three-point bending), ASTM D2344 (interlaminar shear) and ASTM D570 (water absorption), or the equivalent European framework in EN 13706-2. A mill test certificate is recommended for every batch or order and should be retained on file.

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Toe Board / Kick Plate

The toe board / kick plate is an important component of the protective system, used at the edges of platforms, decks and access routes; its main functions are: reducing the fall of tools and small equipment, completing the lower level of handrail protection, preventing feet from passing under the system, and increasing the level of edge protection at platforms.

In Nabak Composite's technical details, the kick plate is a profile/plate with a **width of 100 mm and thickness of 3 mm**, consistent with the minimum toe-board height recommended in ISO 14122-3. In practice, the toe board is usually installed with a small gap (5–10 mm) from the floor surface to allow drainage and floor washing.

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Connections & Anchoring Details

Handrail performance does not depend on profile strength alone; the force path must be engineered explicitly:



- **Connector material:** Grade 316 stainless steel (corrosive/marine environment) or grade 304 (general use); where full electrical isolation is required, FRP or polymer bolts/nuts.
- **Thread & installation torque:** Tighten to the controlled torque specified by the manufacturer; excessive torque causes local cracking or bearing failure.
- **Edge and hole spacing:** To prevent edge shear-out, the distance from a hole to the free edge of the profile should be at least 3–4 times the hole diameter.
- **Substrate type:** Cast-in-place/precast concrete, steel structure or FRP grating — must be identified before installation and noted on the installation drawing.
- **Anchoring into concrete:** Bolt load capacity must be checked against concrete strength, embedment depth, edge distance and bolt spacing per anchoring provisions (such as ACI 318 Ch.17 or equivalent).

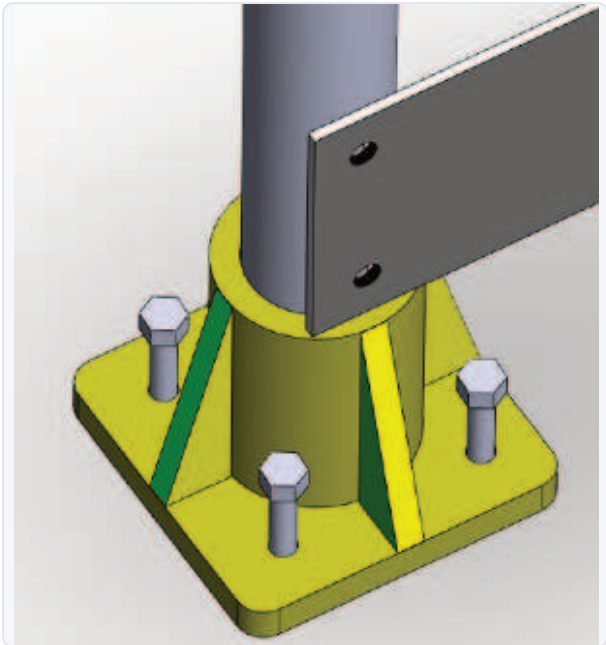


Figure 4— Post-to-base connection detail, floor mounted.



Figure 5— Side connection detail to a wall/structure (side mounted).

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Composite Handrail Type Schedule — HR Coding System

FRP/GRP handrails are divided into different types based on post type, profile type, number of horizontal rails, number of vertical members, presence/absence of a toe board, and installation method. Three main families: **S** — square post/column, **T** — tubular post/members, **V** — vertical-member arrangement. Coding: **2R** = two rails, **3R** = three rails, **6V** = six vertical members, **K** = with toe board, **N** = without toe board.

Composite handrail (HR) type schedule — Technical Type Schedule

Type Code	Family	Configuration	Toe Board	Brief Description
HR-S-3R-N	Square post (S)	3 rails	None (N)	Three-rail square-post handrail without toe board
HR-S-3R-K	Square post (S)	3 rails	With (K)	Three-rail square-post handrail with toe board
HR-S-2R-N	Square post (S)	2 rails	None (N)	Two-rail square-post handrail without toe board
HR-S-2R-K	Square post (S)	2 rails	With (K)	Two-rail square-post handrail with toe board
HR-T-2R-N	Tube post (T)	2 rails	None (N)	Two-rail tube-post handrail without toe board
HR-T-2R-K	Tube post (T)	2 rails	With (K)	Two-rail tube-post handrail with toe board
HR-V-6V-N	Vertical (V)	6-row vertical	None (N)	Six-row vertical-baluster handrail

Notes: Square post (S): 50×50 mm square section, or tube post (T): 42×2 mm tube section. Configuration: three-row (3R), two-row (2R) or six-row vertical (6V). The finished height of all handrails is 1100 mm, and post centre-to-centre spacing is 1000 mm.

Quantity Take-Off Note

In tender documents and progress statements, in addition to the type code, the total handrail length, number of corners/direction changes, number of connection points (floor/side mounted), final color and the profile's mechanical grade (E17/E23) should also be listed separately.

14**Profile Specifications Used**

Figure 6— Components of the composite handrail system: ergonomic top-rail profile, square/round base plate, shaped fittings (elbow, tee, cross), square and round profiles, and kick plate.

Profile Type	Section	Application
Square profile (post/base of family S)	50 x 50 x 4 mm	Vertical post and some rails of the S family
Tube profile (base of family T)	Ø50 x 4 mm	Vertical post and main rail of the T family
Intermediate tubular rail	Ø25.4 mm	Intermediate/mid rail in some arrangements
Top rail profile	~50 mm width	Top rail with ergonomic cross-section
Kick Plate	100 mm width x 3 mm thickness	Toe board

The final cross-section selection should be made based on the handrail type, service conditions, post spacing, loading and connection details. On spans greater than 1000 mm, or where design loads are higher, an increase in wall thickness, a change of mechanical grade (E17 to E23), or reduced post spacing may be

required.

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Square-Post Composite Handrail — HR-S Family

This family is one of the most common FRP handrail arrangements. The main posts are made from a 50×50 mm square profile with 4 mm wall thickness; an ergonomic top-rail profile is used for the top rail, and intermediate rails are arranged according to the selected type. This family is available in 2R/3R arrangements with or without a kick plate — suited to platforms, decks and industrial routes requiring a simple, repeatable, easily assembled system.

HR-S-2R-N

Two rails · No toe board

FRP square posts + one top rail + one intermediate rail. Overall height 1100 mm, post spacing 1000 mm. The lower area remains open; suited to applications that do not require a kick plate.

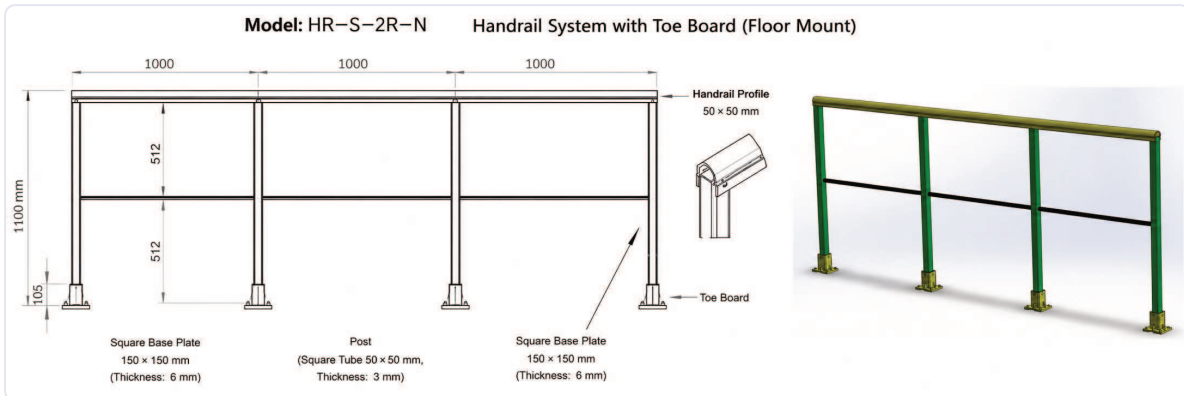


Figure 7— Dimensional drawing and 3D render of type HR-S-2R-N.

HR-S-2R-K

Two rails · With toe board

Similar to HR-S-2R-N with a kick plate added at the bottom of the system, forming a continuous barrier at the lower edge to increase the level of protection. The location of the toe board relative to the floor, posts and connection details should be verified on the installation drawing.

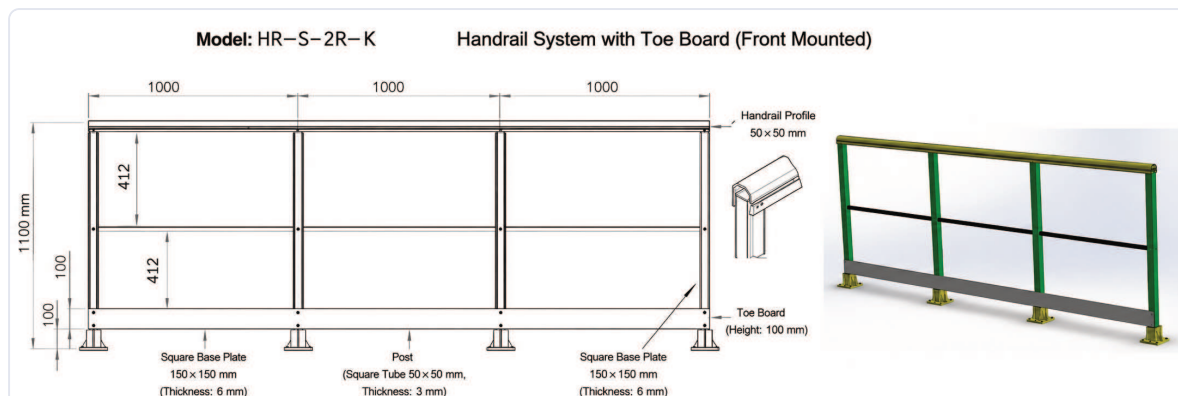


Figure 8— Dimensional drawing and 3D render of type HR-S-2R-K.

HR-S-3R-N

Three rails · No toe board

One additional intermediate rail compared with the two-rail system; reduces the open gap between protective members and better meets the 500 mm clear-gap limit. Height 1100 mm, post spacing 1000 mm, three rail rows, no kick plate.

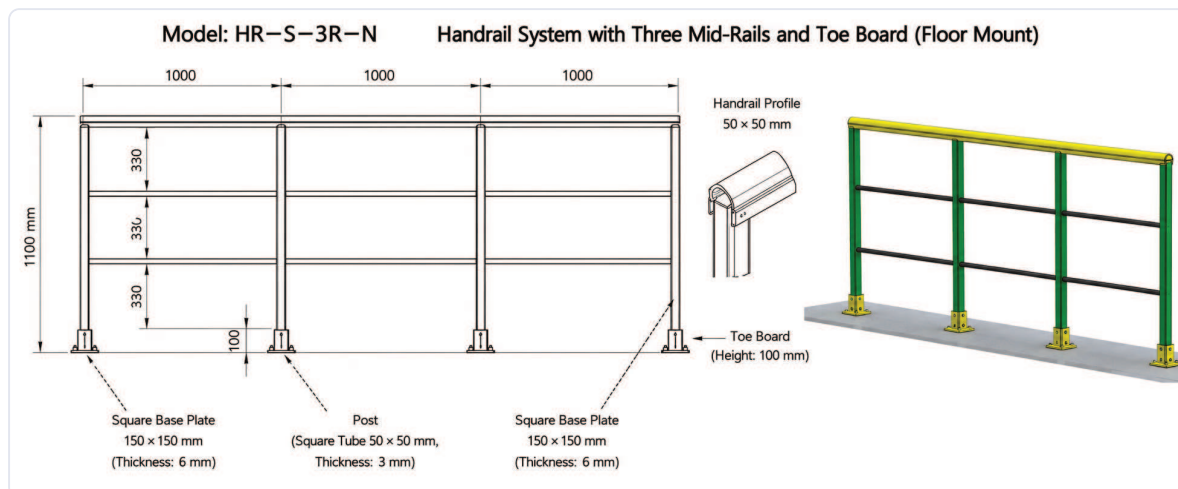


Figure 9— Dimensional drawing and 3D render of type HR-S-3R-N.

HR-S-3R-K

Three rails · With toe board

Combines the three-rail arrangement with a lower toe board; the most complete level of protection in the S family — suited to conditions where controlling the fall of small objects from the platform edge is also important.

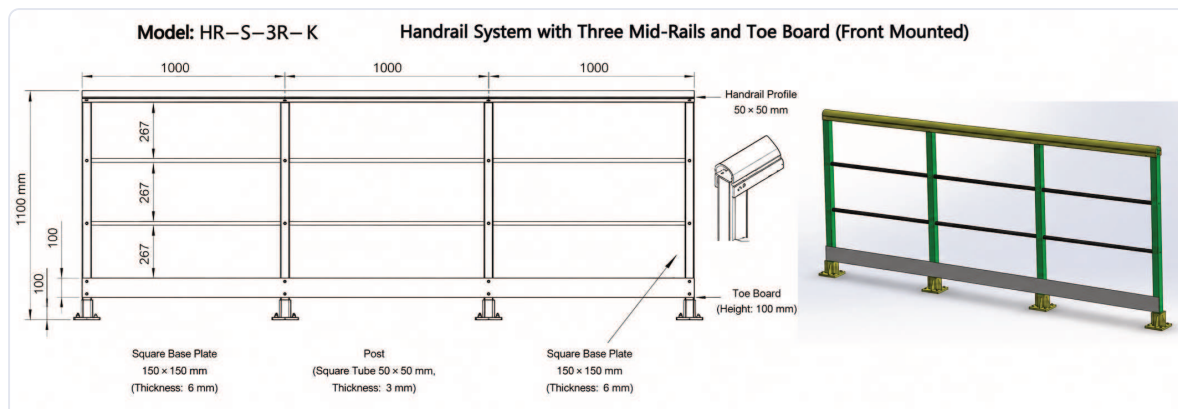


Figure 10— Dimensional drawing and 3D render of type HR-S-3R-K.

16**Tube-Post Composite Handrail — HR-T Family**

Posts and main rails are made of GRP tubular profiles ($\varnothing 50 \text{ mm} \times 4 \text{ mm}$ tube). Components are joined using shaped fittings including elbows, tees, crosses and other fittings matched to the route geometry; this assembly method produces a more unified appearance and is well suited to systems where assembly speed and a smooth tubular form are priorities.

HR-T-2R-N

Two rails · No toe board

Posts and rails from tubular profile; two rail rows, no toe board. Height 1100 mm, post spacing 1000 mm.

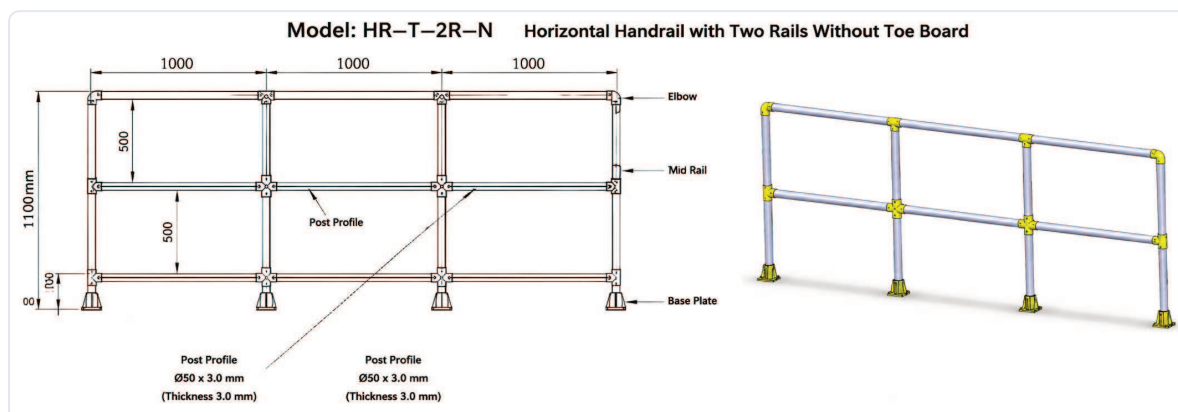


Figure 11— Dimensional drawing and 3D render of type HR-T-2R-N.

HR-T-2R-K

Two rails · With toe board

Similar to HR-T-2R-N with a kick plate added; the advantage of this family is the use of shaped fittings for changes of direction, corners and connecting horizontal/vertical members.

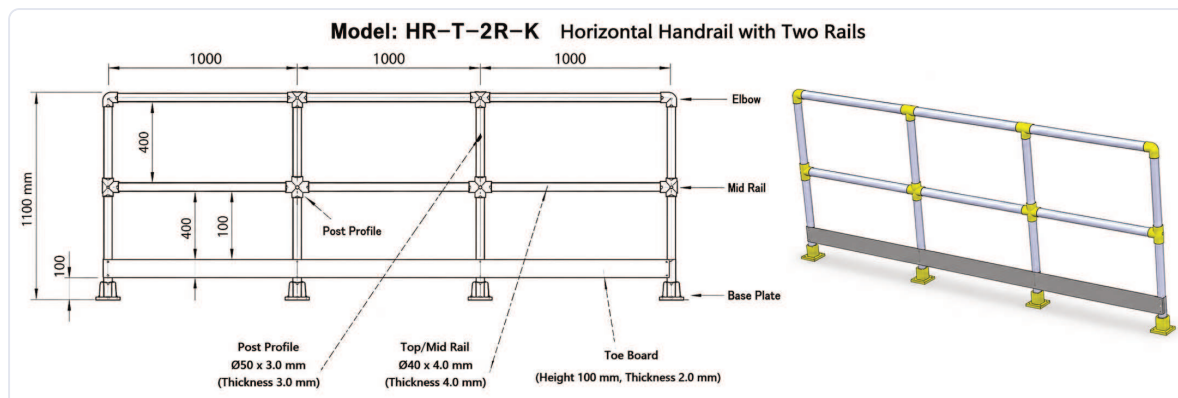


Figure 12— Dimensional drawing and 3D render of type HR-T-2R-K.

17**Vertical Composite Handrail — HR-V Family**

Instead of relying on multiple horizontal rails, a series of vertical members fill the protective space to reduce open area and limit the passage of people, equipment, parts and tools through the system.

HR-V-6V-N

6-row vertical · No toe board

Vertical arrangement, no toe board, height 1100 mm and post spacing 1000 mm. More commonly used in locations with pedestrian traffic of children/animals, or where strict control of open area is required.

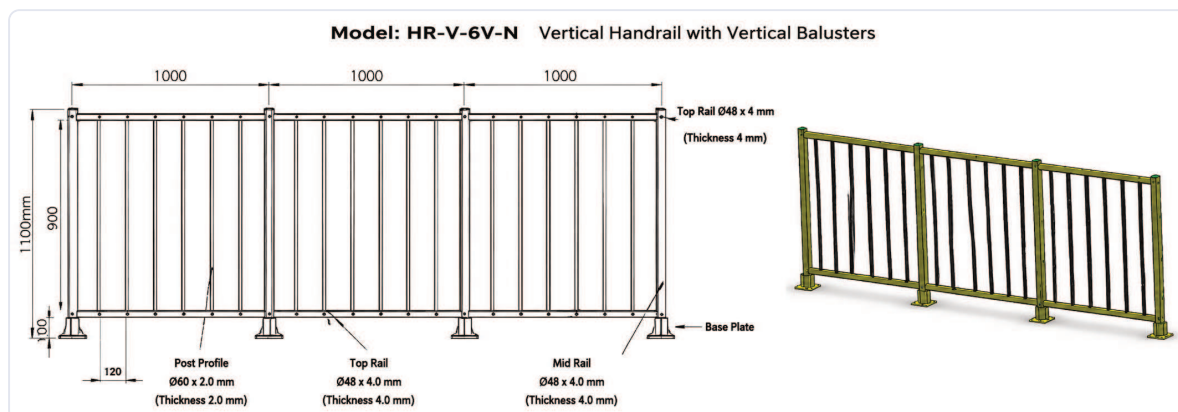


Figure 13— Dimensional drawing and 3D render of type HR-V-6V-N.

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Technical Comparison — Tube vs. Square Handrail

The choice between a tube and a square handrail should not be made on appearance alone; service conditions and use case should also influence type selection.

Criterion	Tube Handrail (T)	Square Handrail (S)
Hand-contact ergonomics	Excellent	Good
Simplicity of toe-board connection	Moderate (requires an intermediate part)	Simple (flat surface)
Curved/multi-directional routes	Well suited (with shaped fittings)	Requires additional corner fittings
Typical application	Stairways, ramps, walkways	Decks, industrial platforms, water treatment plants
Unified appearance	High	Moderate to high

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Composite Handrail Installation Process

Installation should be carried out according to the installation drawing and after verifying actual site conditions.

Step 1 — Site Survey

Levelness of the site, condition of the floor and underlying structure, exact post locations, walkway route, existing obstacles, and points where direction changes.

Step 2 — Setting Out Connection Points

Determine post locations per the installation drawing; verify post spacing and the exact position of base plates/brackets by surveying or string-lining and laser leveling.

Step 3 — Installing the Bases

Install and anchor base plates, brackets and connection components at the determined positions.

Step 4 — Installing the Vertical Posts

Set and secure the posts; verify verticality with a spirit or laser level.

Step 5 — Assembling the Rails

Assemble the top rail and intermediate rail with suitable connectors and bolts.

Step 6 — Installing the Kick Plate

On K-type variants, install the toe board at the bottom of the system.

Step 7 — Final Inspection

Handrail alignment, post verticality, rail alignment, connection integrity, base condition, installation quality, and conformance with the installation drawing.

Acceptance Checklist

It is recommended that the installation contractor complete a stage-inspection form for each section of the handrail route (date, type code, length installed, level/alignment check results, QC responsible person's name) and submit it to site supervision.

The reference documentation shows the two main connection methods: **floor mounted** and **side mounted** — detailed in Sections 20 and 21.

20 Floor-Mounted Connection

The handrail post is connected to the underlying surface via a base plate; suitable for concrete floors, decks, platforms and steel structures, subject to review of the connection type and substrate capacity for actual project conditions.

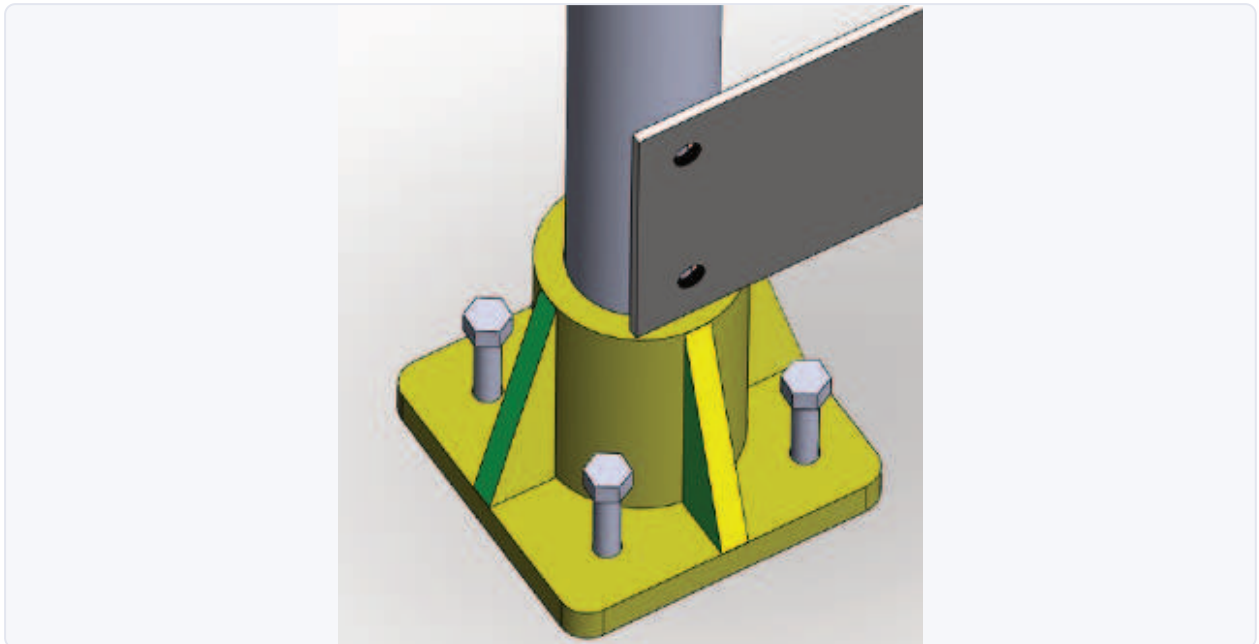


Figure 14— Base plate, post base and anchor bolt details for a floor-mounted connection.

- **Chemical/epoxy anchor** into cured concrete — refurbishment/retrofit projects.
- **Cast-in anchor bolt** installed concurrently with concrete pour — new-build projects.
- **Bolted to an existing steel flange/plate** on pre-installed steel structures.

21 Side-Mounted Connection

The handrail post is connected laterally to the edge or face of a structure; used where there is insufficient space for a base plate on a horizontal surface, or where the walkway must remain unobstructed (such as at a stair edge or a narrow floor strip).



Figure 15— Side connection detail of the post to a wall/structure with a bracket and bolts (3D render and line drawing).

Engineering Note

Because an eccentric moment is generated at the point where the bracket connects to the structure's edge, the bracket and its bolts must be designed with greater care than in the floor-mounted case, particularly regarding concrete edge breakout capacity.

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Maintenance & Periodic Inspection

FRP's lower maintenance requirement compared with metallic systems does not mean inspection can be omitted. Periodic inspections should check: connections, bolts, nuts, fasteners, base plates, the connection to the main structure, potential cracking, impact damage, wear and any local profile damage. Cleaning with water and a mild detergent (without strong solvents) helps preserve the surface.

In many cases, if a component is damaged it can be replaced locally without replacing the entire handrail run — one of the key advantages of an assembled system.

Suggested Interval

Visual inspection of connections and bases at least every 6–12 months, and a detailed inspection (bolt torque check and signs of fatigue) annually; the interval should be adjusted based on the severity of the operating environment and the owner's PM policy.

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Workshop Cutting, Drilling & Machining

Due to their low weight and non-metallic nature, FRP profiles are well suited to cutting, drilling and assembly. Cutting is performed with diamond/carbide blades designed for composites, and drilling with carbide or diamond bits.

- Use personal protective equipment (safety glasses, a respirator suitable for glass-fiber dust, gloves)
- Control dust (preferably local extraction or wet cutting)
- Use tools designed for composites — not general-purpose metal or wood-cutting tools
- Inspect and finish cut edges after machining to prevent local delamination
- Carry out drilling per the drawing and connection pattern (drilling template)

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Pre-Engineered Modular Handrail System

FRP handrail can be designed as a pre-engineered modular system, in which post + top rail + intermediate rail + kick plate + connectors are defined together from the outset. Benefits: faster installation, better quality control, fewer assembly errors, easier repair, the ability to replace parts locally, and easier future route extension or modification — of particular value during unit turnarounds/shutdowns and site expansion.

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Custom Design & Manufacturing

Not all projects share the same geometry. Specific projects may require changes to: handrail type, height, cross-sectional dimensions, number of rails, member arrangement, presence/absence of a kick plate, connection and installation type, color, execution details, and route geometry (curves, slopes, non-standard stairs). The environment's chemical conditions and actual installation location should be taken into account when selecting the system.

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Color Options & Surface Coating

FRP handrails are usually produced in industrial safety colors: **Safety Yellow** and **Grey**. Yellow increases the visibility of the protective system in industrial environments, platforms, power plants and treatment facilities.

26.1 Standard Colors in Stock

The color of the delivered product will match what is stated on the proforma invoice. In most cases, **yellow** and **grey** are available for delivery from stock.

26.2 Colors for New Production Runs

For orders that fall within a new production run, the customer may choose from the four colors below. Colors outside this set can also be produced on a custom basis for large-quantity orders.

No.	Color	Supply Type
1	Yellow	Standard stock
2	Grey	Standard stock
3	White	Custom — new production run
4	Black	Custom — new production run
Other colors	Upon customer request	Custom — subject to minimum order quantity

All of the colors above are **in-mass colored**; that is, the color pigment is added to the resin mass during manufacturing, giving higher wear resistance and color stability than a surface-applied coating.

26.3 Special & Decorative Surface Finishes

In addition to the standard in-mass colors, the following options are also available to order:

- **Wood-look finish:** production with a wood-pattern surface finish for architectural and facade applications.
- **Custom RAL top coat:** application of a coating specifically designed for composite parts, matched to the customer's chosen RAL code, with full adhesion to the surface; besides improving appearance, this coating also increases resistance to UV radiation in outdoor environments.

Standard Requirement

Per the composite handrail standard's provisions, the use of a **UV-resistant polyurethane** protective coating is **mandatory** for handrails installed in outdoor environments.

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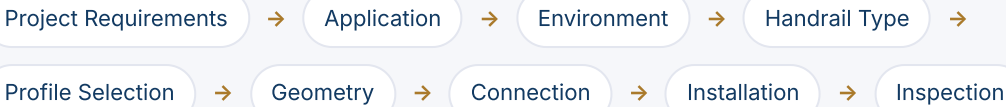
Pricing Basis for Composite Handrails

The price of an FRP handrail cannot be assessed on "price per meter" alone; the final price depends on a set of factors: profile type, cross-sectional dimensions, handrail type, number of rails, presence/absence of a kick plate, connection and resin type, color, environmental conditions, installation method, number and type of cuts, drilling, degree of customization, and order volume. Sales are based on running length, and profiles can be pre-cut and pre-drilled so that mainly assembly work is required on site.

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Engineering Summary & Decision Chain

FRP/GRP handrail is an engineered, modular and customizable composite protective system whose performance results from the interaction of several components. Correct selection should follow a defined chain:



In professional design and installation, three aspects must be controlled simultaneously: **system safety + mechanical performance + real-world constructability** — precisely the point that turns an FRP handrail from a "ready-made railing" into an engineered system for industrial protection.

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Appendix A — Reference Standards Comparison Table

Standard	Scope of Coverage	Key Parameters
ASTM F1092	Specification for pultruded GRP square railing/guardrail, fabrication, installation and testing	Type 1F/2F, horizontal load test on posts
ISO 14122-3 / EN ISO 14122-3	Safety requirements for permanent access routes, guardrail dimensions and loading	Height $\geq 1100\text{mm}$, clear gap $\leq 500\text{mm}$, toe board $\geq 100\text{mm}$, line/concentrated load test
EN 13706 (Parts 1–3)	Designation, testing and performance requirements for pultruded profiles	Grades E17 and E23, tensile/flexural properties, modulus

This table is provided for quick reference and should be used together with the complete, current text of each standard.

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Appendix B — Bilingual Technical Glossary

English Term	Persian Equivalent
Pultrusion	پالتروژن
Top Rail	ریل بالایی / دستک
Intermediate / Knee Rail	ریل میانی
Toe Board / Kick Plate	پاخور / قرنیز
Vertical Post	ستون قائم
Base Plate	صفحه پایه
Vertical Members	اعضای عمودی

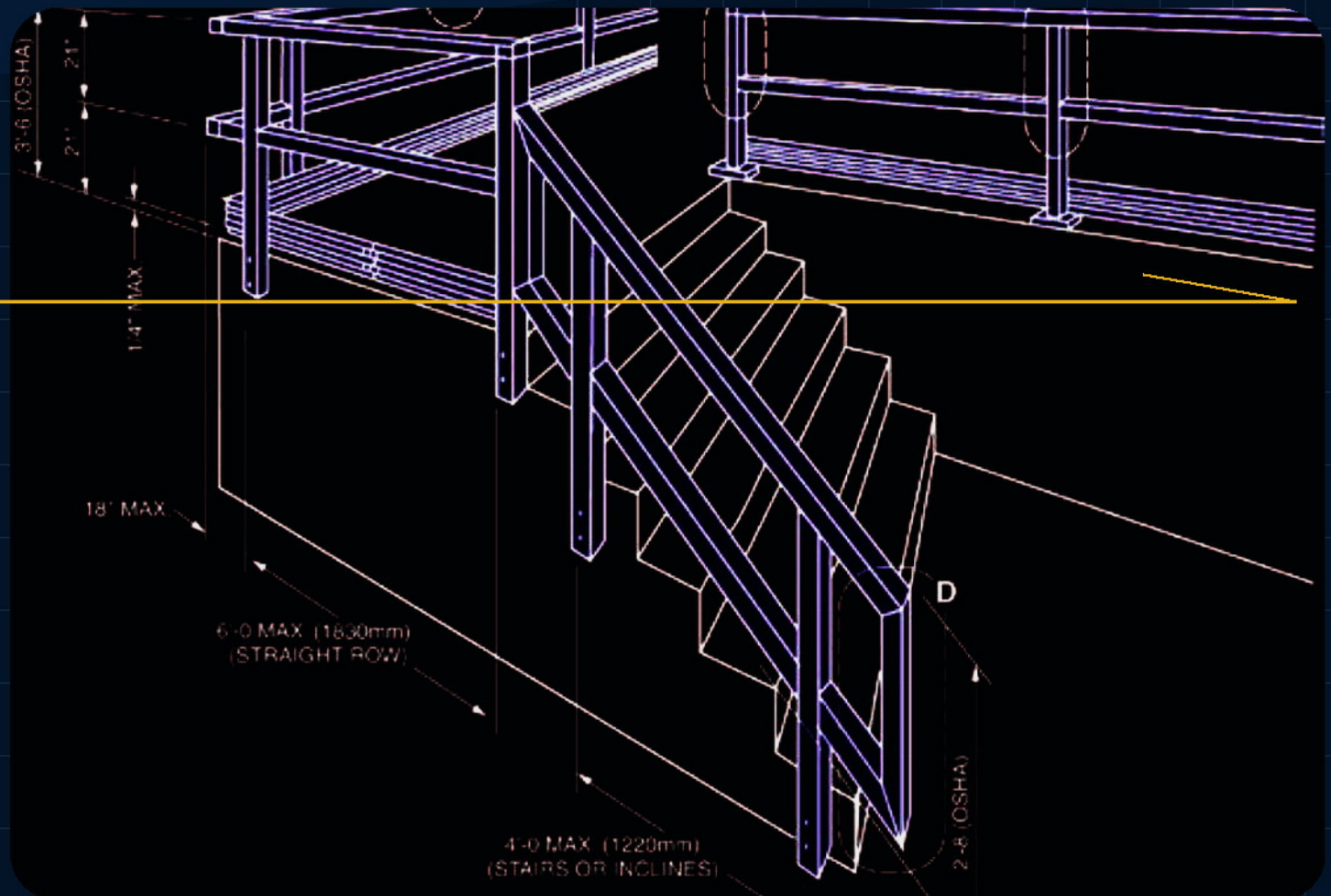


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